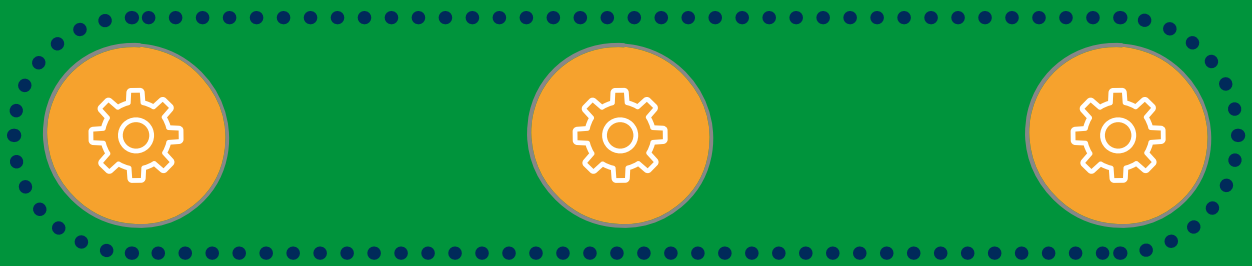
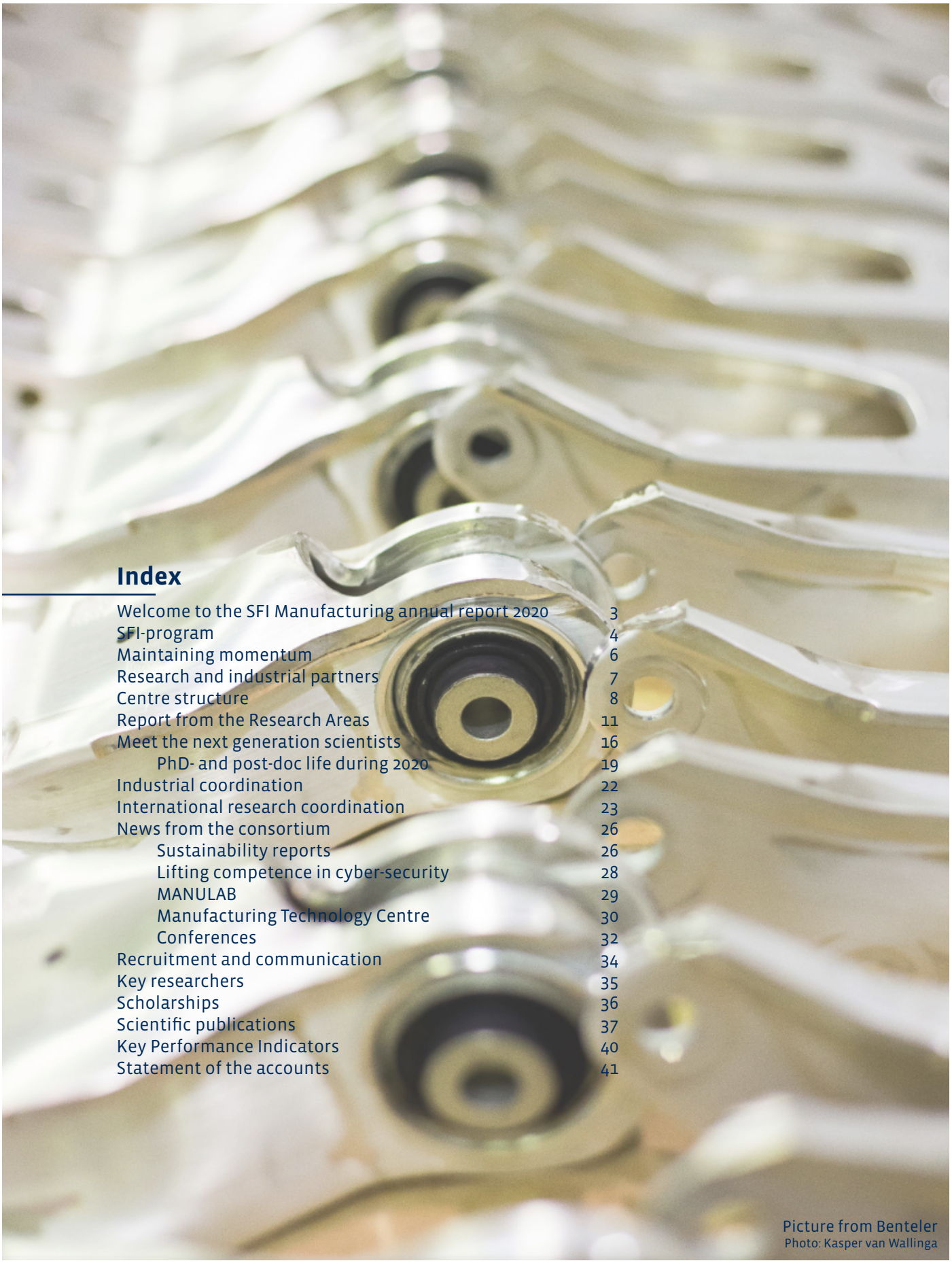
manufacturing

Annual report 2020



sfi Centre for Research-based Innovation

The Research Council of Norway



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Picture from Benteler
Photo: Kasper van Wallinga

Welcome to the SFI Manufacturing annual report 2020

To say that 2020 has been an odd year for SFI Manufacturing must be the most cliché term used in the Corona-period. However, 2020 has been a challenging and different year for our centre and the partners of the centre.

Knowledge and skills are resources that we rely on when we meet extra challenging situations. All the involved partners in SFI Manufacturing have utilised this during 2020. Some have experienced a total marked collapse for their product, while others have experienced considerable marked increase. In common, all have had to deal with the challenging situation to maintain a safe work environment within changing regulations and advises, and regional differences. All this have required use of cross-disciplinary knowledge and skills. Perhaps the very cross-disciplinary nature of manufacturing has been an extra asset for us during this situation?

The academic partners have also faced a challenging situation with limited access to laboratory facilities, a volatile market and the challenging organisational issues regarding infection control at work facilities. In particular, I will use the opportunity to express my recognition of the work of PhD and post doc candidates that have been able to maintain progress in their work and develop new knowledge within manufacturing.

In these trying times, it is essential to use our resources within R&D to be well prepared for the opportunities that most likely will appear at the other end of this challenging situation.

The workshop we had with ISAB in December gave us a perspective on our work from outside of the SFI. As well as receiving good reviews, the recommendations from ISAB emphasize our scope of further research.

Lars Stenerud
CEO Plasto AS
Chair of the board, SFI Manufacturing
Åndalsnes, 26th of March 2021

Centre for Research-based Innovation

The Research Council of Norway

SFI: A program for industrially oriented research in active cooperation between innovative companies and prominent research groups

- **High potential for innovation and value creation**
- **Active cooperation between innovative companies and prominent research groups**
- **High scientific quality of research**
- **Bridgehead for international cooperation**
- **Recruitment of talented researchers**

manufacturing

SFI Manufacturing builds on existing national capabilities and aims to strengthen the Norwegian manufacturing companies' ability to innovate. The centre seeks to mirror the inherent cross-disciplinary innovation systems in the industry and combine research on multi-material product solutions, flexible automated manufacturing and organisational processes.

The innovation process itself is a core research topic and SFI Manufacturing strives to be a basis for unleashing innovation potentials and research challenges embedded in the cross disciplinary interfaces, and to develop new research methods. The objectives of the SFI Manufacturing's research areas which support this vision are:

Multi-material products and processes
To develop the ability to optimise material choice, multi-materials geometry, and processes simultaneously.

Robust and flexible automation
To further develop and link novel technologies and methodologies within automation to support innovation processes and advanced work systems in the manufacturing industries.

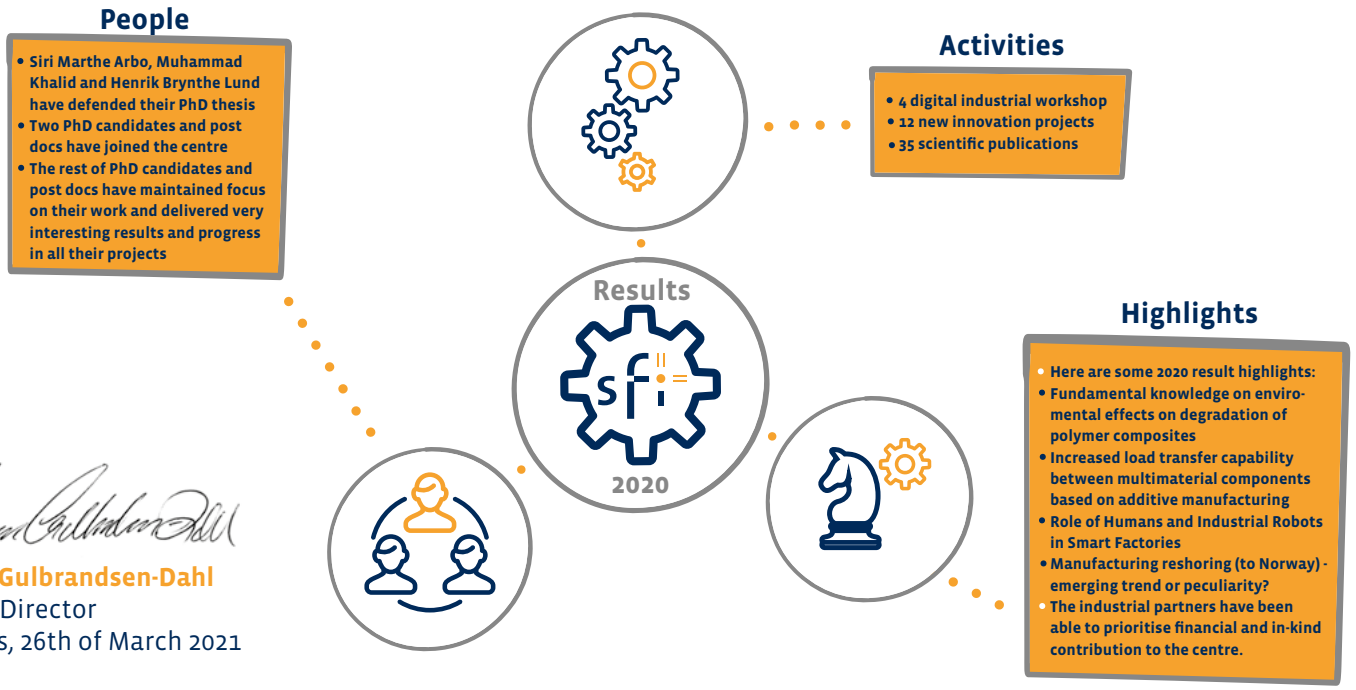
Innovative and sustainable organisations
To develop advanced work systems enabling utilisation of new technology and flexible and automated processes to manufacture sustainable multi-material product solutions.

Picture from Benteler Aluminium Systems Norway, Raufoss

Maintaining momentum

In 2020 the centre has introduced new working methods with digital 1-1 meetings and industrial workshops due to the pandemic. I am pleased that we have been able to maintain contact with the centre partners even though we have not been able to meet physically during 2020. However, we are aware that that the digital tools are not complete substitutes for the direct contact but an important tool to manage a challenging situation.

Despite the challenges in 2020 the centre has delivered several high-end results. I will express my sincere acknowledgment to all centre participants for the joint effort to deliver these excellent results during a very challenging situation.



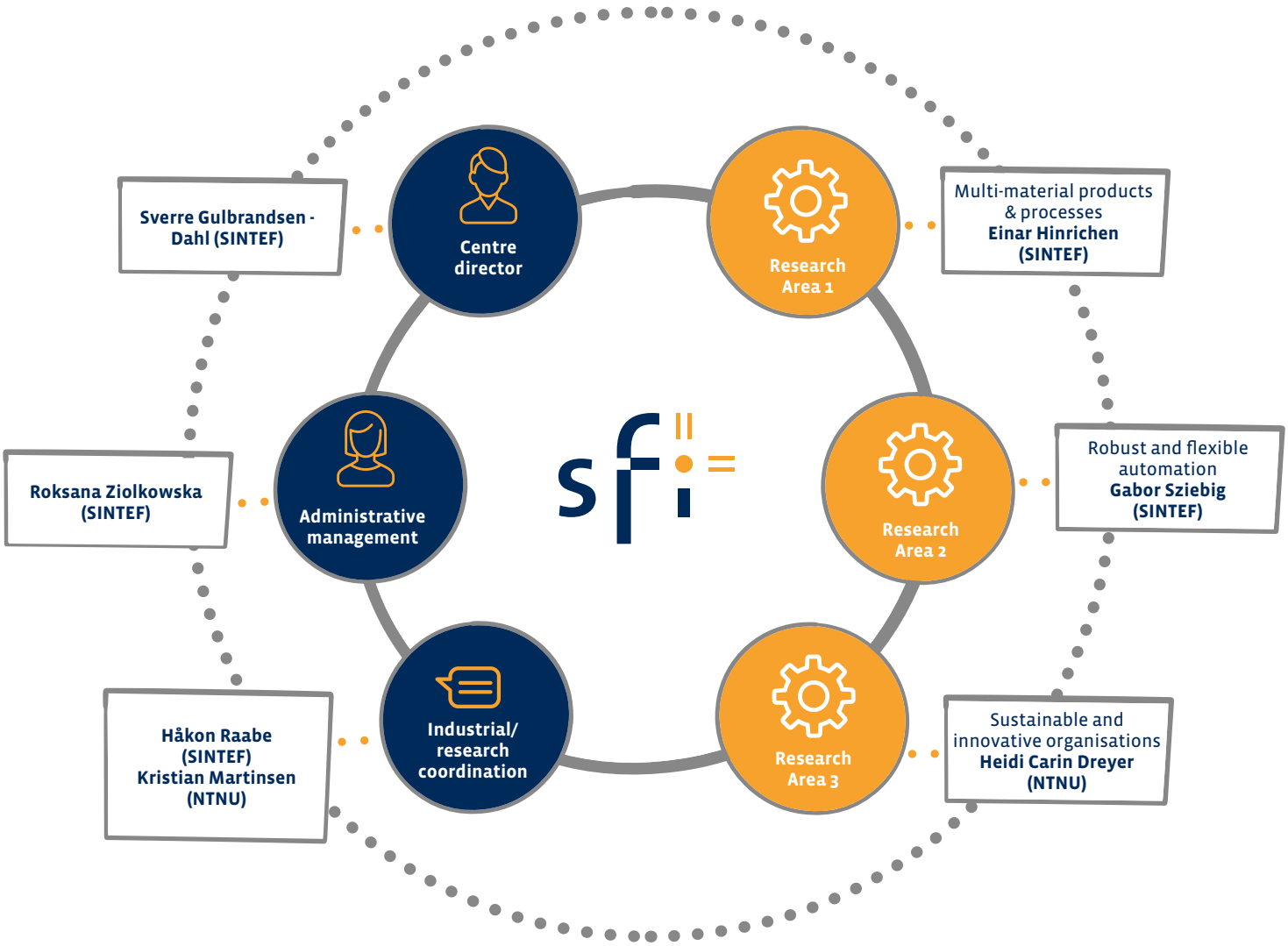
Sverre Gulbrandsen-Dahl
Centre Director
Raufoss, 26th of March 2021

Research and industrial partners

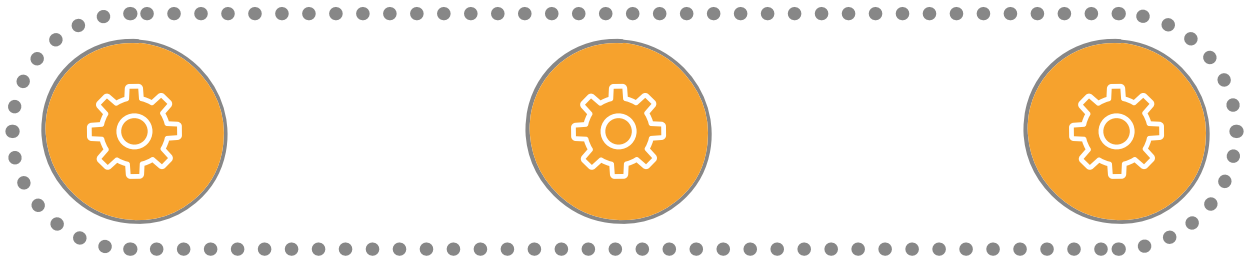
Education and Research:
Physics, Materials Science, Cybernetics, Industrial economics and technology management, Geography, Manufacturing

Host institution: SINTEF Manufacturing
Research: SINTEF Manufacturing, SINTEF Industry, SINTEF Digital

Organisation
Centre structure



Organisation
Centre structure



RA1 Multi-material products and processes

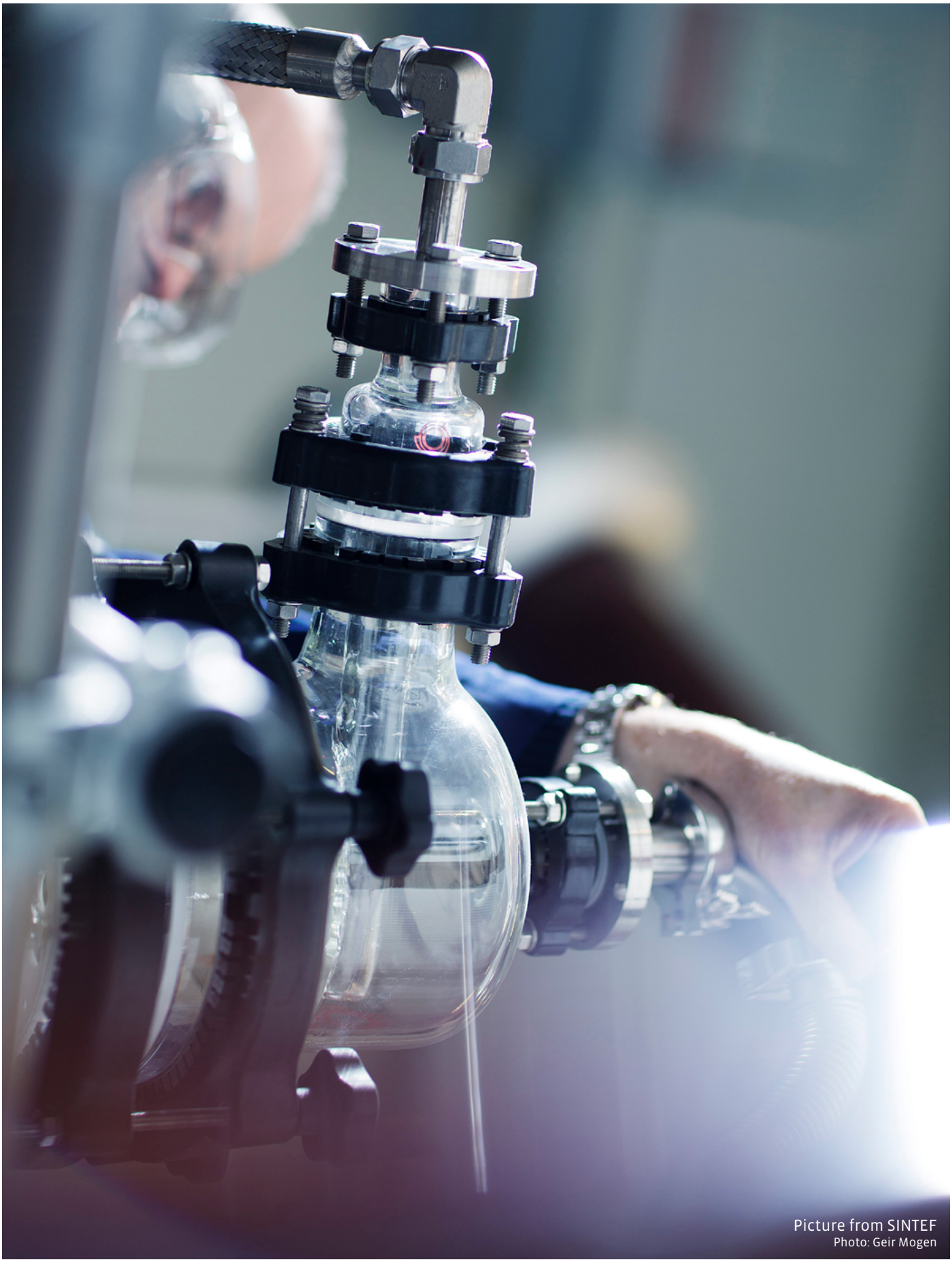
- WP 1.1: Additiv Manufacturing
- WP 1.2: MMP of Dissimilar Metallic Materials
- WP 1.3: MMPs Containing Polymer Based Materials
- WP 1.4: Multi-scale modeling

RA2 Robust and flexible automation

- WP 2.1: Robotic technologies for flexible manufacturing
- WP 2.2: Flexible and integrated production systems

RA3 Sustainable and innovative organisations

- WP 3.4: Future manu-facturing organization models
- WP 3.5: Sustainable business model development



Picture from SINTEF
Photo: Geir Mogen

Report from the research areas

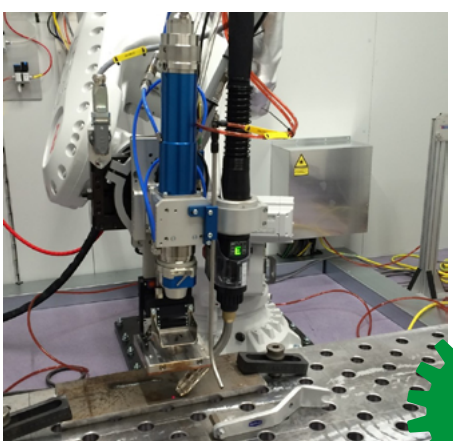
SFI Manufacturing aims to strengthen the Norwegian manufacturing companies' ability to innovate, by doing research on multi-material product solutions, flexible automated manufacturing, and organizational processes. In this part of the annual report, we will give an insight into the research highlights that has been done in 2020. In the newsletters, available on the website www.sfimanufacturing.no, more information can be found.

RA1 Multi-material products and processes

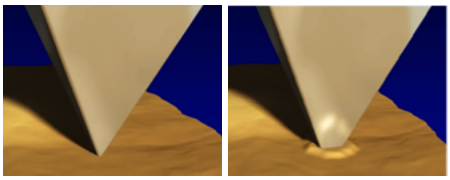
In this research area we work towards an integrated understanding of multi-material product design and production processes by focusing on selected scientific challenges in the chain "Material – Process – Structure – Property - Performance". The overall objective is to develop the ability to optimize material choice, multi-material geometry and processes simultaneously. In this work we use a methodology where we combine advanced experimental characterization, experimental studies of production process and both physical simulation and numerical modelling of these.

Up until 2020 the two main topics for this research area has been challenges in joining of dissimilar materials with a special focus on interface region and adhesion, and additive manufacturing of metals and polymers. Based on input from both the Scientific Advisory Board and Mid-term evaluation a focus this year has been towards identifying activities in cross-disciplinary topics both between work packages in RA1 and between the other research areas. This focus on cross-disciplinary activities will continue in 2021. As we have written in our newsletters this year, the global trend towards circular economy thinking will have an influence on product design, including choice of materials. Solutions to this important challenge depends on innovations in all three research areas.

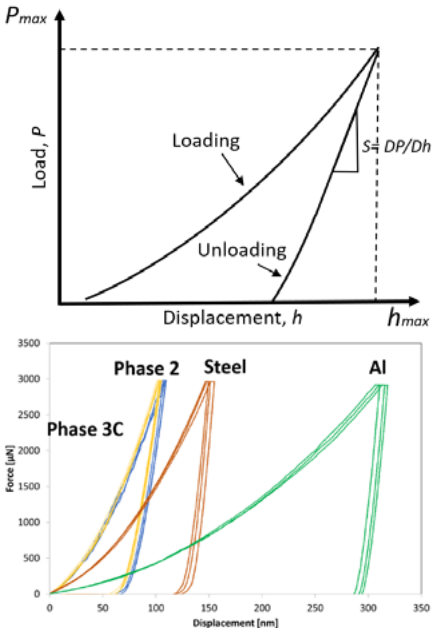
The research work in RA1 is heavily dependent on activities in our laboratories. The misfortunate Covid situation has caused some delays in our work in 2020. However, despite this we have largely managed to carry out most of our activities according to plan. Throughout the year two SOTA (State-of-the-art) reviews have been updated; one SOTA in WP1-2 on joining technology for dissimilar metallic materials, and one SOTA in WP1-3 on polymer products and processes. The latter have been updated to include topics such as mechanically joining polymers to metal parts by clinching, and additive manufacturing of multi-material parts (such as fibre reinforced composites).



Work in the research area also includes developing new characterisation methods to push the research frontier. One example this year has been our investigation into the possibilities of small-scale mechanical testing to study local mechanical properties and deformation mechanisms: By combining advanced characterization and mechanical testing of each single-ntermetallic phase through in-situ micromechanical experiments inside a SEM, a better insight into the mechanical behaviour and deformation phenomena will guide future



Nanoindentation Hysitron Nanoindenters



development and improvement of such alloys. Among the opportunities, fracture mechanical testing of cantilevers, compression testing of micro-pillars and tension/compression testing have been frequently performed both ex-situ and in-situ. Additionally, experiments can be extended to environmental testing (vacuum or water vapor) using Environmental Scanning Electron Microscopy.

New equipment has been purchased and installed linked to SFI Manufacturing and the national Manulab program supported by the Research Council of Norway. In the Laser Welding Lab a new 16KW fiber laser station for robot-based and hybrid welding have been installed, and work exploring the possibilities have started. Also, we have started using our new Gleeble system for physical simulation of thermo-mechanical processes such as forging, casting, and welding to investigate material properties as a function on temperature and mechanical load and deformation histories. At the Additive Manufacturing Lab at NTNU Trondheim a new SOTA Additive Manufacturing machine (SLM 280 HL) have been installed and taken into use. In addition, the Polymer and Composite Materials Group at SINTEF Industry in Oslo have a new stereo lithography 3D-printer for the additive manufacturing of polymer parts from liquid resins, enabling the production of small parts with either hard or flexible resins. This new printer complements the powder bed fusion and multi-head filament polymer printers the Polymer and Composite Materials Group already has. These equipment's will strengthen SFI Manufacturing's research work and our ability to innovate.

Ongoing RA1 PhD/post-docs:

"Electron microscopy characterization of the interfaces of joined aluminium and steel."
PhD 2 (Tina started August 2016)

"Characterising and modelling the performance of TPE in 2 component injection moulded products. "
PhD 4 – Associated (Anna-Maria started February 2017)

"Lifetime prediction and structural degradation of polymer and polymer composite components."
PhD 5 (Chaman Srivastava started May 2019)

"Material properties and geometry tolerances in additive manufacturing (AM) of multi-material metallic components."
PhD 6 (Håkon Linga started August 2020)

"Advanced electron microscopy characterization to understand interface physics in metal additive manufacturing of multi-material products."
PostDoc 1 (Ding Peng started October 2020)

"Focusing on large-scale, robotized additive manufacturing (AM) using industrial robot arms and cold metal transfer (CMT) welding "
PhD in RA2 + RA1
(Linn started December 2016)

RA2 Robust and flexible automation

The research area Robust and Flexible Automation concerns new ways of automation and robotics in manufacturing systems. The overall objective is to further develop and link novel technologies and methodologies within automation to support innovation processes and advanced work systems in manufacturing industries.

Novel automations technologies and methodologies, and smart integration of those, open new ways to use automation and robotics in manufacturing systems. Within this research area we focused on bin-picking, safe and efficient motion planning in dynamic environments, "batch size one" robotic assembly, robotic flexibility in additive manufacturing, and effective and safe development of robotic assembly processes. Several of these challenges also link to the other research areas within the SFI.
The research area 2 had a very productive year in 2020. 10 conference publications and 2 journal articles were published. RA2 PhD's and Post-doc's shave participated on IFAC World Congress 2020, Germany (organized as a virtual event) and on the symposium arranged partly by the research area (SIMS 2020, Gjøvik). Also results from on-going research projects connected to the SFI Manufacturing (e.g. KO-PROD) and first tests in the MANULAB (https://www.ntnu.edu/ivb/manulab) has been presented on SIMS 2020.

RA2 is also working on automatic loading of objects onto a swinging conveyor trolley using a robot manipulator arm. The hardware in the experimental set-up consists of a UR10E robot, two Azure Kinect 3D cameras, and trolleys made from welded steel bars. The work so far is focused on camera integration and calibration, tracking of trolley using Aruco markers, and planning of manipulator arm motion.

Ongoing RA2 PhD/post-docs:

"Wire Arc Additive Manufacturing"
PhD in RA1 + RA2: Linn Danielsen Evjemo (started December 2016)

"Robots for Flexible and Robust Assembly"
Post Doc: Mathias Hauan Arbo (started August 2019)

"Deburring Using Robot Manipulators"
PhD: Ingrid Fjordheim Onstein (started August 2019)

"Closed-loop Additive Manufacturing"
PhD: Andreas Moltumyr (started August 2019)

"Digital twins in production"
Researcher: Tamal Gosh (started January 2021)

RA3 Sustainable and Innovative Organisations

This research area concerns organisational and innovative sustainability aspects of advanced manufacturing companies. The overall objective is to develop knowledge and solutions for advanced work systems that are able to utilize new technology and flexible and automated pro-cesses to manufacture sustainable multi-material products.

White paper update, " The trends that that will shape Norwegian manufacturing in the next decade" The white paper is based on an extensive study of numerous national and international reports focused on future trends. The trends are divided into four areas, sustainability trends, economical tends, technological trends and social/work related trends. Potential effects and consequences of the pandemic is also reflected upon. The White paper is put together with the purpose and intention that the reader can be enlightened and to be able to reflect upon existing and coming trends, their implication and potential impact on the industry. The white paper is about to be finalized and will be published during spring 2021.

In addition to the white paper there is developed three scenarios containing different mix of the trends and hence different development path. The scenarios are built to create discussion and reflections through workshops between industry and academia. The scenario guide, together with the White paper, will be a good platform to support cross disciplinary activities within SFI Manufacturing.
The covid-pandemic has hindered field work for the researchers, PhD and post-docs, but to no stand-still in the research work.

In collaboration with the industry partners, Eirik Hamre Korsen does research on how digitalization and industry 4.0 technologies change the performance measurement system and its effects on how organizations manage performance. In short, new technology is implemented incremental to support employee's ability to drive continuous improvement, and thereby reinforcing existing management practice. Articles are under review for publications. Eirik will deliver his PhD by summer 2021.

Assiya Kenzhegaliyeva has through her first year in her PhD-project done a literature review and oriented towards current cases for her thesis and refined the disciplinary approach. Adjacent to the circular economy, she goes into the institutional infrastructure and analyses the role of standards in relation to global production networks and global value chains. That is, on the one hand, they can act as a barrier for companies that we increase the circularity of their products, or on the other hand act as a driver for circular economy models.

Henrik Brynthe Lund, Markus Steen and Asbjørn Karlsen has continued to work on two papers: *"The roles of intermediaries in upgrading of manufacturing clusters: enhancing cluster absorptive capacity"* which is sent to an international journal for review. *"The role of state agency in path development: A longitudinal study of two Norwegian manufacturing regions"* will be sent to an international journal during February 2021 as an invited contribution to a special issue.

Sourav has been working on Sales and Operations Planning (S&OP) which is considered as a vital process that facilitates cross-functional planning and developing of an integrated set of plans to efficiently balance demand and supply for competitiveness. The research seeks to answer how digitalization potentially influences S&OP, and how the facilitating capabilities address the planning barriers, thus filling a distinct research void at this intersection. For the purpose, we adapt a novel integrative review approach involving industry practitioners as research partners. We conceptualize digitalization capability as a multidimensional dynamic capability and contribute to the understanding of the "digitalization paradox" (that is, heavy investments on digitalization does not always produce the expected returns).

Picture from SINTEF

Marit Moe Bjørnbet is in the final stage of her PhD-project. Her research focuses on circular economy in manufacturing companies. More specific she explores how the use of life cycle assessment (LCA) to evaluate and promote circular economy efforts in the manufacturing industry can ensure a positive contribution to environmental sustainability. Her review paper: *"Circular Economy in Manufacturing Companies: A Review of Case Study Literature"* was recently published in Journal of Cleaner Production. Further, the paper *"On the Interplay Between Life Cycle Assessment and Circular Economy - A Longitudinal Case Study of Circular Business Model Development"* with Hexagon Ragacso as the case company is in the finalizing stage and will be sent to the same journal. Marit will deliver her PhD during spring 2021. After finalizing her PhD, Marit will go back to her job as a research manager in SINTEF Manufacturing.

Velte Engesbak published one paper in 2020 together with his supervisor. Entitled *"Organizational learning and bureaucracy: an alternative view"* (The Learning Organization 27(5)), it explores how formal organization structures can support organizational learning in companies where innovation involves the accumulation and deepening of knowledge, not its periodic replacement

Ongoing RA3 PhD/post-docs:

"Life cycle assessment as a tool to evaluate and develop circular strategies in manufacturing companies"
PhD Marit, started in 2016
cofounded by SISVI-prosject

"How to organize for step-change improvements"
PhD Vetle, started in 2016
cofounded by Sprangforbedringer I modne produksjonssystemer

"How manufacturing companies align their performance, management across the organization, linking the strategy to operation"
PhD Eirik, started in 2017

"Developing sustainable supply chain based on emerging technologies"
PhD Assiya, started in 2020

"How digitalization affects the organization and planning of manufacturing supply chains"
Post Doc Sourav, started in 2020

" Business management, innovation and implementation of changes"
PhD Vetle, started in 2015

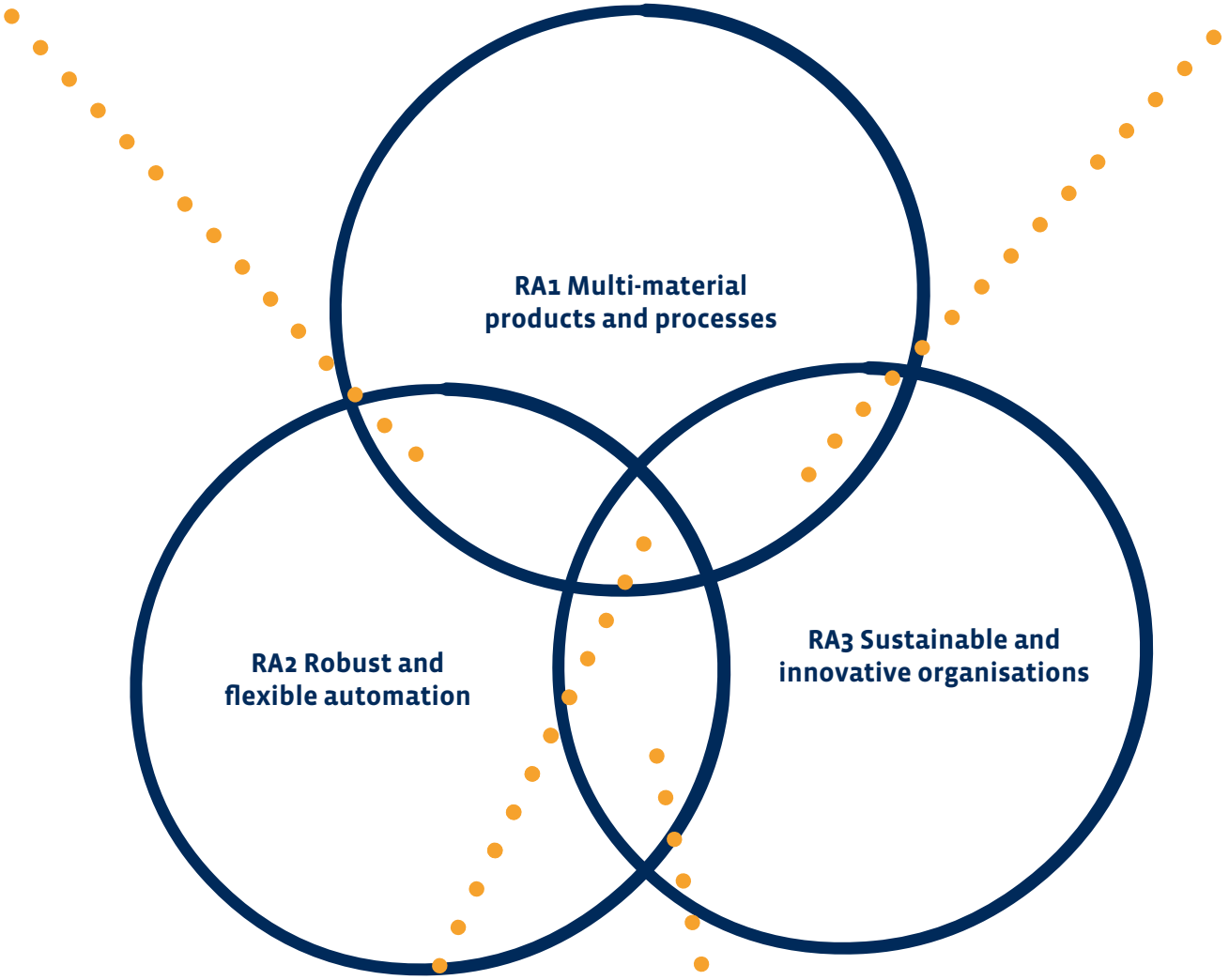
Increased Multi-Disiplinarity Through Focus on Research Thematics that are on, or close to, the intersection of the RA's

Additive manufacturing with robots

Systems for in-line monitoring of processes and quality control of products based on novel automated cognitive processes to increase robustness, mass customization, enabling first-time-right manufacturing and reduced ramp-up time.

Demonstrate the integration of the UN Sustainable Development Goals in business model development, with emphasize on circular material streams

Develop adhesive joining technologies to reduce manufacturing costs, increase product quality or ease end-of-use disassembly.



Develop scenarios for future manufacturing organization and related stakeholders that can be used as roadmaps for strategic choices within the participating companies and the multi-disciplinary research in the consortium.

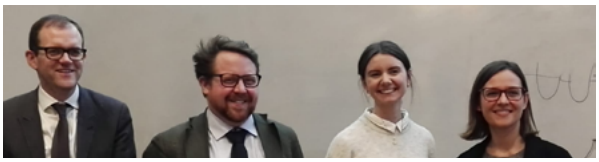
Human-oriented automation through man-robot cooperation, intuitive programming methods and virtual reality immersion.

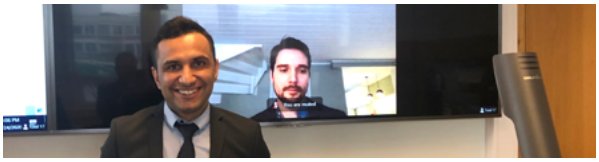
Competitive interaction between digital work and the Norwegian model

Socio-technical approach for integration of emerging technologies into existing and future manufacturing systems in order to test for maturity and applicability.

Meet the next generation scientists

Siri Marthe, Zeeshan, and Henrik finished and defended their PhD's in 2020, and Sourav and Assiya started their PhD's in 2020. Assiya took a pause from her research by taking a maternity leave from August until December, congratulations on the new citizen of the world! Tamal, our new guest researcher started his work in 2020 as well. You can read more about their studies below and other ongoing PhD- and Post Doc projects in the newsletters.





Disputants

Doctor Siri Marthe Arbo defended her thesis for the phd. Grade at at Norwegian University of Science and Technology, Department of Materials Science and Engineering. The title of the PhD-thesis is: *"Cold welding of steel and aluminum alloys - Joining processes, intermetallic phases and bond strength"*

Doctor Henrik Brynthe Lund defended his thesis for the phd. grade at Norwegian University of Science and Technology, Department of Geography. The title of the PhD-thesis is: *"Navigating emerging technologies and knowledge demands: system perspectives in knowledge development in Norwegian manufacturing industry"*

Doctor Muhammad Zeeshan Khalid defended his thesis for the phd. grade at Norwegian University of Science and Technology, Department of Materials Science and Engineering. The title of the PhD-thesis is: *"Atomistic modelling of Fe-Al and Đ-AlFeSi intermetallic compound interfaces"*

Figure 1: foto: berre/sintef

Newcomers

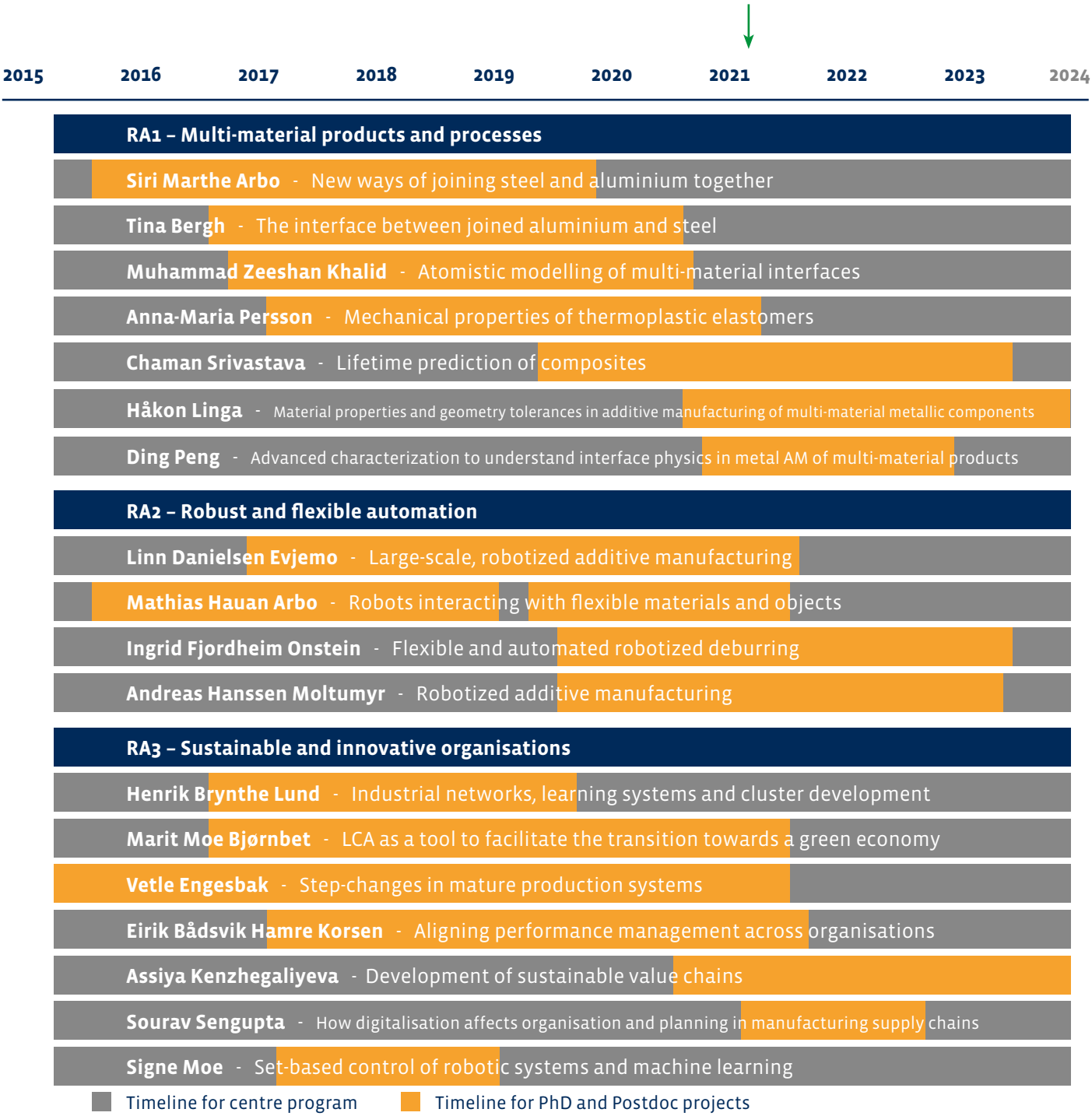
Assiya Kenzhegaliyeva started her PhD-project *"Developing sustainable supply chain based on emerging technologies"* in 2020, paused her work due to her maternity leave from August and out the year.

Sourav Sengupta, Post Doc *"Exploring barriers and potential for digitalization in integrated tactical planning"*. The research seeks to answer how digitalization potentially influences S&OP, and how the facilitating capabilities address the planning barriers, thus filling a distinct research void at this intersection.

Håkon Linga, PhD *"Material properties and geometry tolerances in additive manufacturing of multi-material metallic components"*. During his PhD he will be working on additive manufacturing of metals.

Ding Peng, Post Doc *"Advanced electron microscopy characterization to understand interphase physics in metal additive manufacturing of multi-material products"*. The project is devoted to characterization of additive-manufactured multi-materials at the nano- and microscale. Since the properties for additive-manufactured multi-materials is highly affected by the microstructure of their joint, which is controlled by the additive manufacturing process parameters, an investigation of the interphase using electron microscopy makes it possible to better understand how different process parameters can result in different microstructure of the interphase and therefore help the industry optimize the industrial fabrication process.

For more reading about the PhD's and post-docs go to our newsletters.


2015
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RA1 – Multi-material products and processes
Siri Marthe Arbo - New ways of joining steel and aluminium together
Tina Bergh - The interface between joined aluminium and steel
Muhammad Zeeshan Khalid - Atomistic modelling of multi-material interfaces
Anna-Maria Persson - Mechanical properties of thermoplastic elastomers
Chaman Srivastava - Lifetime prediction of composites
Håkon Linga - Material properties and geometry tolerances in additive manufacturing of multi-material metallic components
Ding Peng - Advanced characterization to understand interface physics in metal AM of multi-material products
RA2 – Robust and flexible automation
Linn Danielsen Evjemo - Large-scale, robotized additive manufacturing
Mathias Hauan Arbo - Robots interacting with flexible materials and objects
Ingrid Fjordheim Onstein - Flexible and automated robotized deburring
Andreas Hanssen Moltumyr - Robotized additive manufacturing
RA3 – Sustainable and innovative organisations
Henrik Brynthe Lund - Industrial networks, learning systems and cluster development
Marit Moe Bjørnbet - LCA as a tool to facilitate the transition towards a green economy
Vetle Engesbak - Step-changes in mature production systems
Eirik Bådsvik Hamre Korsen - Aligning performance management across organisations
Assiya Kenzhegaliyeva - Development of sustainable value chains
Sourav Sengupta - How digitalisation affects organisation and planning in manufacturing supply chains
Signe Moe - Set-based control of robotic systems and machine learning
Timeline for centre program
Timeline for PhD and Postdoc projects

PhD- and post-doc life during 2020

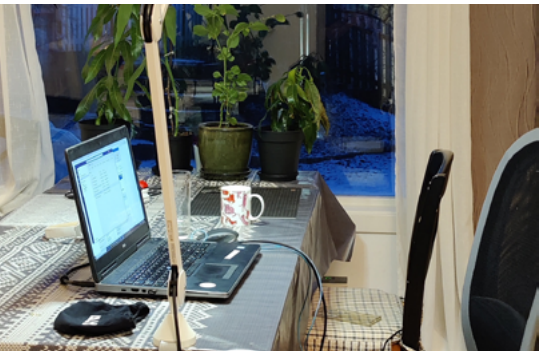
We asked some of our PhD-students and Post Docs if they would give us an insight in their professional life during the pandemic.

Andreas Moltumyr, Malvik/Trondheim, Norway
During 2020, I have been working from a range of places in Trøndelag: Among them a student apartment in Trondheim, basement in Malvik and the office at NTNU Gløshaugen, before moving into my own apartment in Trondheim in January 2021.

When the pandemic hit last March, I was assisting with the course in control theory at NTNU. We quickly had to change how the subject was taught to the students, while at the same time helping students returning from interrupted studies abroad to salvage their semester and avoid falling behind on their study progress.

It quickly became apparent that home-office led to less disruptions from co-workers and increased productivity. Suddenly you had a lot of time to write articles. However, after a while, the isolations led to exhaustion and reduced focus on the tasks at hand.
A definitive low was reached in the summer with the participation at two completely virtual conferences. The return to office a few months later was well appreciated.

Ingrid Onstein, Nordmarka/Oslo, Norway
I belong to NTNU Gjøvik but live in Oslo. Before the corona-pandemic, I had access to an office at SINTEF Digital, but I no longer have access to it due to infection prevention rules. I have therefore been almost continuously working from my home office since March 2020. I was used to working from home, so it was easy to adapt to the new situation. My biggest challenge has been unstable network and frequent power outages because I live in the middle of the forest in Nordmarka. Another challenge is that I am not allowed to be in the lab, but this has not been a big problem in my research, for now. The advantage of working from home is greater flexibility and then the opportunity to go skiing when the weather is at its best. I hope the pandemic leads to a possibility to combine working at office and working from home in the future.



Anna Maria Persson, Oslo, Norway
Past year the PhD was worked on from a small apartment in Oslo, which is shared with my partner, also having home office. The view out the windows was peaceful. But inside, the space was not ideal. There were challenges with ergonomics and work peace, but also issues related to unreliable Internet connection and IT infrastructure. Fortunately, I was gradually allowed back to office, a benefit we now know not to take for granted. As a whole, my PhD progress ran somewhat behind schedule, but a small extension of the funding accounted for some of the loss. I plan to deliver the PhD in a few more months. Then hopefully vaccines and lifted restrictions give a renewed opportunity to interact with the world, both professionally and privately. Another set of delights, not to take for granted.

Sourav Sengupta, Kolkata, India

In the so called “new” normal way, I started my postdoc from my home 7000KM away from Trondheim, in the city of joy, Kolkata, India. The video calling and VPN, however, didn’t let the distance matter. Shortly after, as the borders opened, I travelled to Trondheim cautiously dodging the virus, and resumed work from my NTNU office. However, the new strain again forced us to move back home. The challenge for me was not the workspace at home which is pretty cozy (as the picture shows), but was being at home for days without any human interaction and still remain energetic and motivated to work. I tried different tricks, but cooking to my surprise (which I was really bad at) turned out to be the best escape and a fine way of breaking the monotony. Of course, this skill upgrade should be handy even after the pandemic. I feel the pandemic has taught us to appreciate what we have and to look for happiness within. It has made us realize the importance of friends and family while everything else could be reimagined and redesigned to suit our needs.

Linn Danielsen Evjemo, Trondheim, Norway

In the year that has gone by since everything shut down in March 2020, I have spent most of my workdays in my 40 m2 apartment in Trondheim. Entering what was then going to be my final year as a PhD student I had planned to do a lot of practical work in the lab, but this had to be put on hold. As many others I found it difficult to adapt to being confined to an apartment that also had to serve as both office and gym, but fortunately it is possible to get used to almost anything. Things got better as society gradually opened back up: After the summer I could go back to the lab and do my experimental work, and it was possible to use the office again for most of the fall.

I do not think I can honestly say that the last year’s working situation had many upsides. But I have learnt to truly value the social network provided by my colleagues, and everything that happens in the workplace in between the actual work.

Industrial coordination

Digital workshops
Due to Covid-19 the physical workshops were first postponed, then cancelled. Nevertheless, converting the workshops from physical into digital went beyond expectations. We optimized the digital events, planned them with a shorter timeframe of 2 hrs and used multiple formats such as; presentations, video-clips, Q&A, group discussions etc.. SFI Manufacturing arranged more workshops than ever and had a record attendance with 240 participants in 2020. So far, we have held 18 industrial workshops with over 1000 participants in the project period.

Having the workshops on a digital platform has led to more people being able to participate and we have almost eliminated travel. This have saved us travel time and cost, and most likely a fair amount of CO_2 emissions. We look forward to a more normalized situation where we can take advantage of the socializing in between the professional lectures and presentations, avoiding the technical hiccups we now are so accustomed to, e.g. “you’re muted!”, “did his video freeze for you too?”

1-to-1-meetings
This year started out with a couple of physical meetings, but most were digital after the Covid-19 outbreak. If one term should be chosen to mark this year’s discussions, it must be ‘sustainable manufacturing’. In the newsletter from December the trends and topics were listed regarded to their relation to the RA’s. We think this clearly shows that companies now feel a greater need to move their business and operations in a sustainable direction.

International research coordination

INTPART (International Partnerships for Excellent Education, Research and Innovation) are funded by the Norwegian Research Council and may be used for coordination and support activity by Norwegian research organisations. The objective of this call for proposals is to develop world-class research groups in Norway through long-term international institutional cooperation

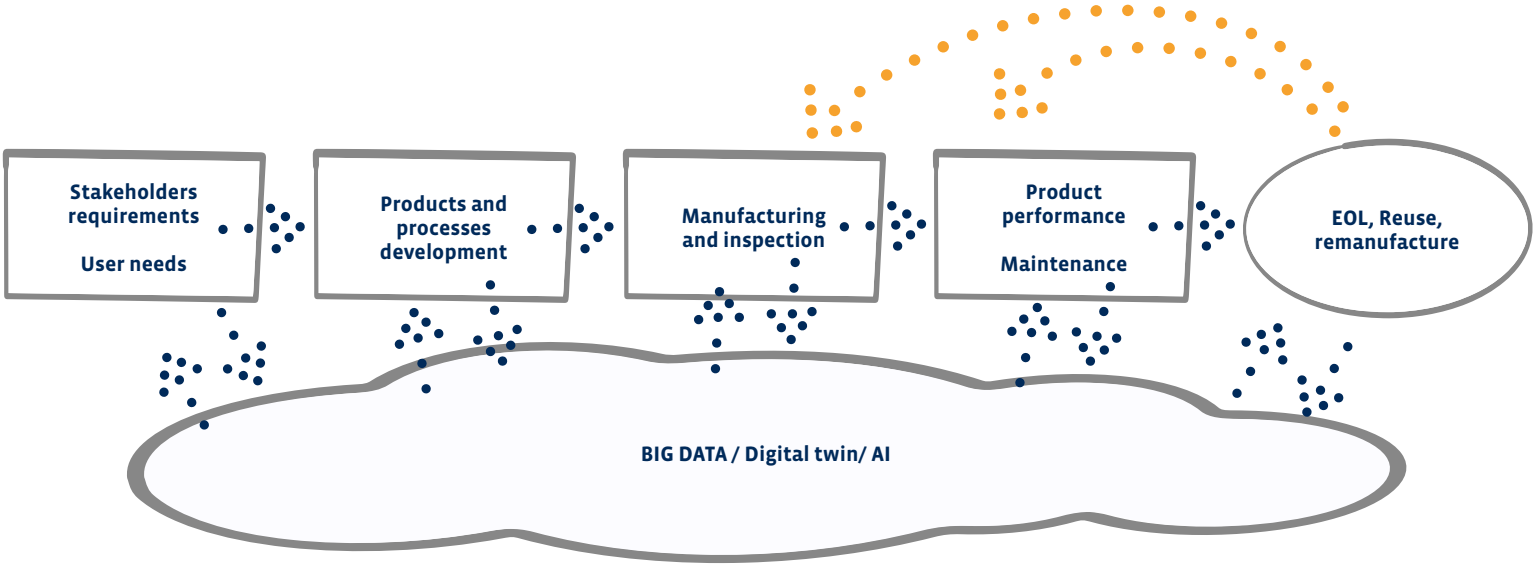
INMAN project: Intelligent Circular Manufacturing research and educational collaboration with India and Japan
The main objective is to develop world-class research and education on Circular Manufacturing

Partners:
NTNU, SFI Manufacturing (Norway)

Waseda University and National Institute of Advanced Industrial Science and Technology (AIST) (Japan)

Indian Institute of Technology (IIT) (India)

Read more at the project website.



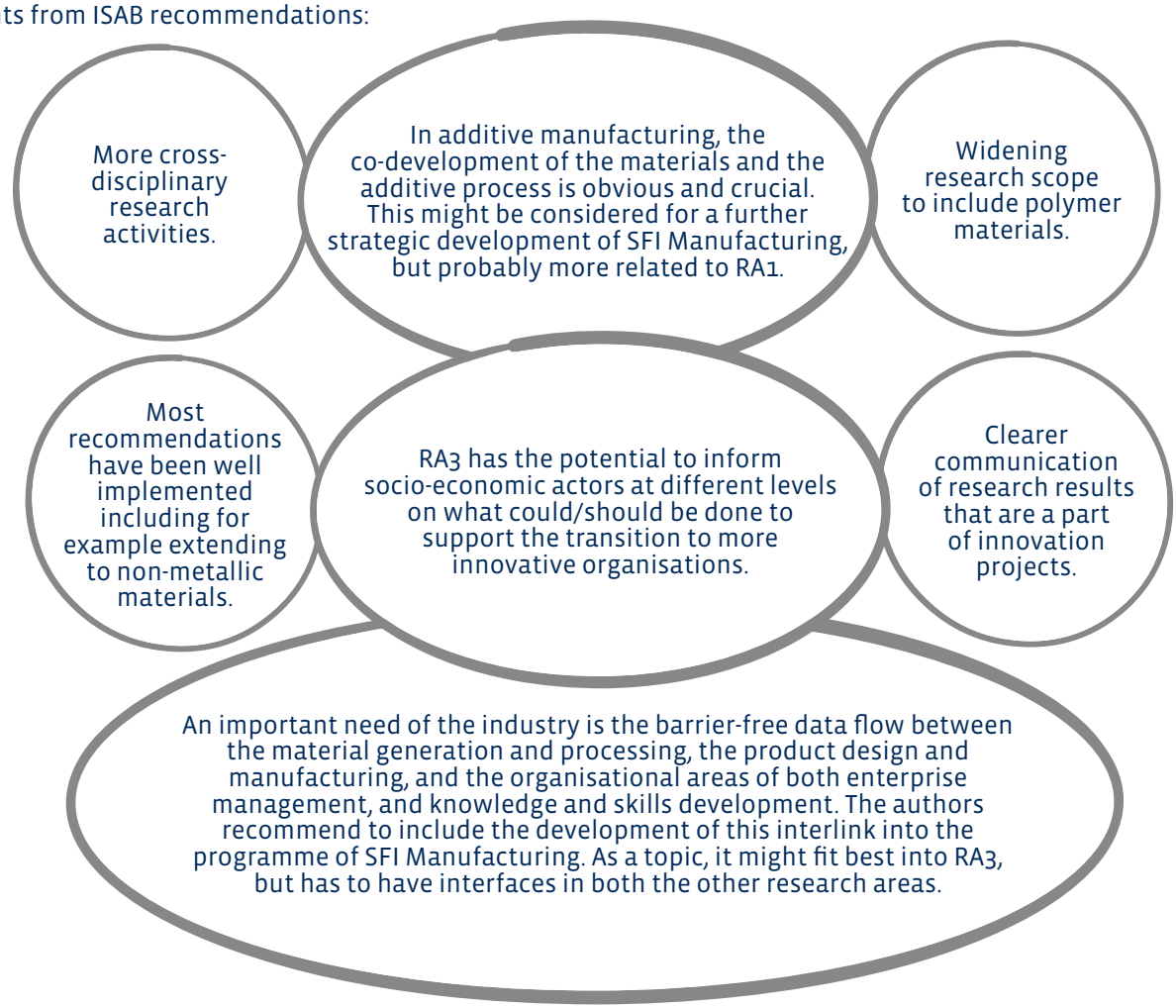
MAVIS INTPART project: Industry 4.0 and Management of Variations in a Sustainable manufactured product life cycle
The main objective is to find out how digitalisation can be useful, create better products and contribute to UN SDGs? Research and education collaboration within Industry 4.0 and how IoT and cyber-physical systems can be useful to manage the inevitable variations in manufacturing of products, the product life cycle and at the end-of life/ reuse / remanufacturing.

Partners:
NTNU, SFI Manufacturing (Norway)

University of Stuttgart, Fraunhofer IPA and IAO, (Germany)

Grenoble INP, University of Technology of Compiègne, IRT Jules Verne (France)

Highlights from ISAB recommendations:



ISAB workshop

The purpose of the International Scientific Advisory Board (ISAB) is to provide the Director and the Centre's Management with a scientific perspective of the Centre from the outside, and feedback on the Centre's ability to meet its scientific objectives. The Board comprises of a group of internationally recognised and experienced scientists who have both the general knowledge of the field and expertise in specific areas that are relevant to the Centre's activities.

The digital workshop with ISAB was held in December and its main focus was on PhD-candidates and the work in the RA's. We received good review and the research we already conduct, and in addition, a number of advises which we will consider when planning further scientific work in SFI Manufacturing.

EU-projects

As a part of the ISAB workshop. The board looked at the research done in SFI Manufacturing and how it relates to themes in Europe 2020;

Horizon Europe Missions
The Green Deal
Resilient Value Chains
Digitalisation

Their recommmodation regarding Europe themes was this:
"RA1, 2, 3 interactions could be stimulated between the respective projects/students by asking how these would collaboratively address the themes and build a joint consortium in response to future Horizon Europe calls, which are often cross-disciplinary. Just as an exercise, but it could stimulate interactions."

A subtheme under Digitalisation is Industry Commons: *"systems for an accountable open innovation production value network, which enables innovative solutions by combining existing industry capabilities"*: Common Data Representations. OntoCommons is a project within Industry Commons and is *"an H2020 CSA project dedicated to the standardisation of data documentation across all domains related to materials and manufacturing."* The overarching goal is overcoming inter-operability bottlenecks & facilitating data sharing and valorisation. The expected impact is fostering data sharing, open and a standardised data documentation, citizen involvement and contribute to the shift to a circular economy. The latter expected impact are by improving the level of information and knowledge about products & materials. SINTEF are one of the partners and the project started in October 2020.
Go to www.ontocommons.eu for more information.

Sustainability reports

Hexagon and SINTEF published their first sustainability reports. Another company in the consortium, Hydro, uses their annual report for 2019 to communicate their new strategic agenda: "Lifting profitability, driving sustainability." In addition to actively working for a more sustainable products it's a must to communicate this to create awareness within the company as well as externally. Link to Hexagon's sustainability report and SINTEF's sustainability report .

An important insight from WP3.5 is that manufacturing companies are increasingly adopting the United Nations 17 Sustainable Development Goals (SDGs) as a strategic framework for their operations. This is a complex task in practice since these high-level goals contain 169 sub-goals and 231 unique indicators that span social, economic, and environmental issues.

A key point is the dynamic nature of innovation processes framed by the SDGs, which means that companies will have to adapt their priorities based on technology development, market demands and organization learning. For example, goal nr. 12 on "responsible consumption and production" is popular among manufacturing companies because it relates to the trend of circular economy, but this focus may change in the coming years. A practical tool in this regard is to adopt sustainability reports that are made publicly available to all stakeholders, which in turn enables feedback and inspiration for future work. Such reports typically include promotion of successful projects and initiatives, but research insights highlight the importance of addressing dilemmas that stem from adopting the SDGs in business operations. By also addressing challenging aspects, companies will build legitimacy among their stakeholders and key partners.


1 UTRYDDE FATTIGDOM
2 UTRYDDE SULT
3 GOD HELSE OG LIVSKVALITET
4 GOD UTDANNING
5 LIKESTILLING MELLOM KJØNNENE
6 RENT VANN OG GODE SANITÆRFORHOLD
7 REN ENERGI TIL ALLE
8 ANSTENDIG ARBEID OG ØKONOMISK VEKST
9 INDUSTRI, INNOVASJON OG INFRASTRUKTUR
10 MINDRE ULIKHET
11 BÆREKRAFTIGE BYER OG LOKALSAMFUNN
12 ANSVARLIG FORBRUK OG PRODUKSJON
13 STOPPE KLIMAENDRINGENE
14 LIVET I HAVET
15 LIVET PÅ LAND
16 FRED, RETTFERDIGHET OG VELFUNGERENDE INSTITUSJONER
17 SAMARBEID FOR Å NÅ MÅLENE

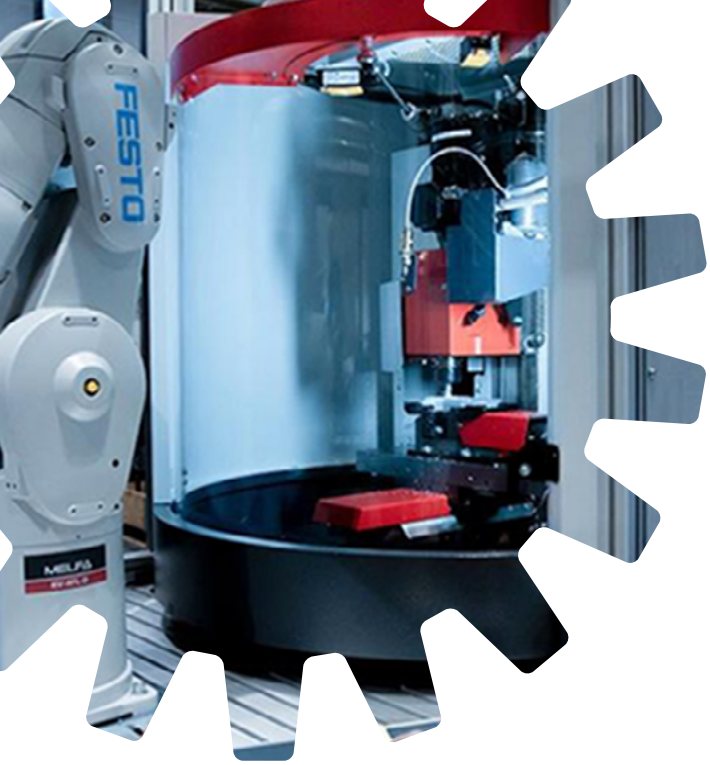
Lifting competence in cyber-security

In today's digital world Norwegian companies have a growing need to strengthen the competence on cybersecurity. More and more of the production are being digitized and connected which leads to amazing opportunities for resource optimization on one hand, and on the other a more vulnerable IT-safety.

The project "Cybersikkerhet og Industri 4.0" aims to help raise the competence in cyber security in the production companies, and one of the deliveries are a set of free e-learning courses in Norwegian. These courses are recommended for all companies and employees connected to the internet in some way.

The courses are developed by expertise from NTNU CCIS (Center for Cyber and Information Security), SINTEF Manufacturing and ten pilot companies from the industry association Teknobedriftene.

Read more and take the courses here.

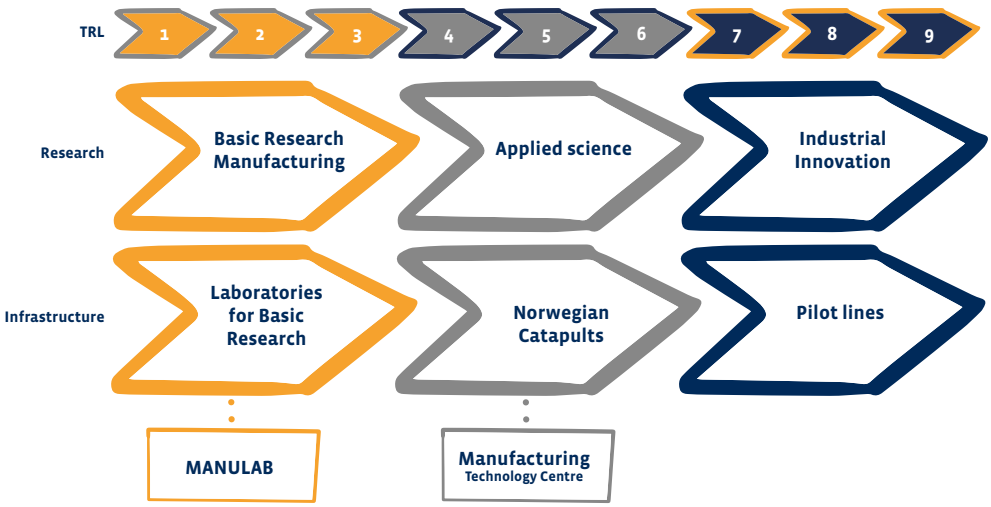


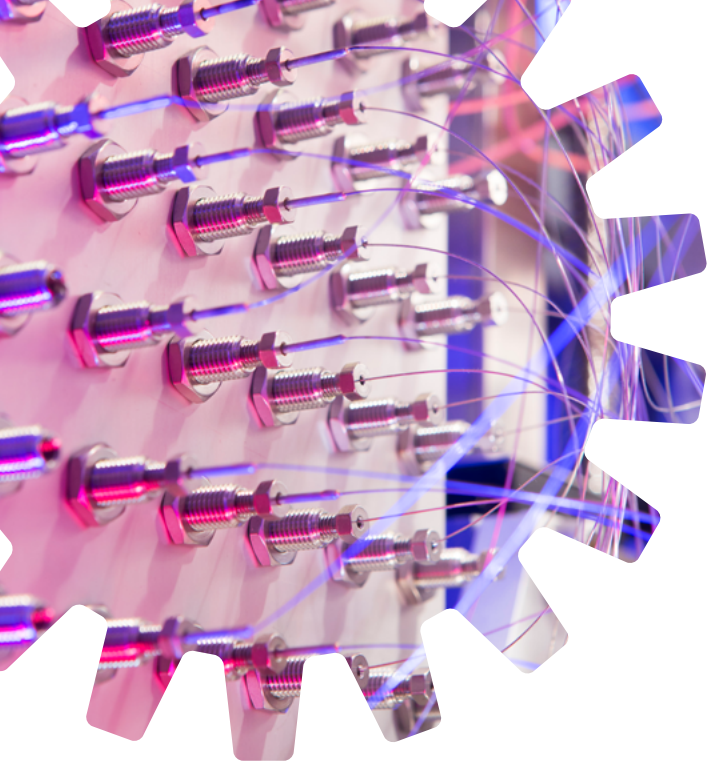
MANULAB

MANULAB is the National infrastructure for manufacturing basic research in Norway. NTNU is the coordinator, SINTEF Industri and SINTEF Manufacturing are partners. The lab consists of nodes in Gjøvik, Raufoss, Trondheim and Ålesund, and is open for all; industry, research and students.

The infrastructure is operational with equipment such as a 16 KW laser welding machine, Gleeble thermomechanical test machine, Additive manufacturing machines, a CT scanner, a aluminium flexible and adaptive forming line, wireless sensors and industrial communication, Industry 4.0, flexible and intelligent automation.

This is a result of the phase 1 investments of approx. 100 MNOK with 78 MNOK from the Norwegian Research Council. Read more here.





Manufacturing Technology Catapult Centre

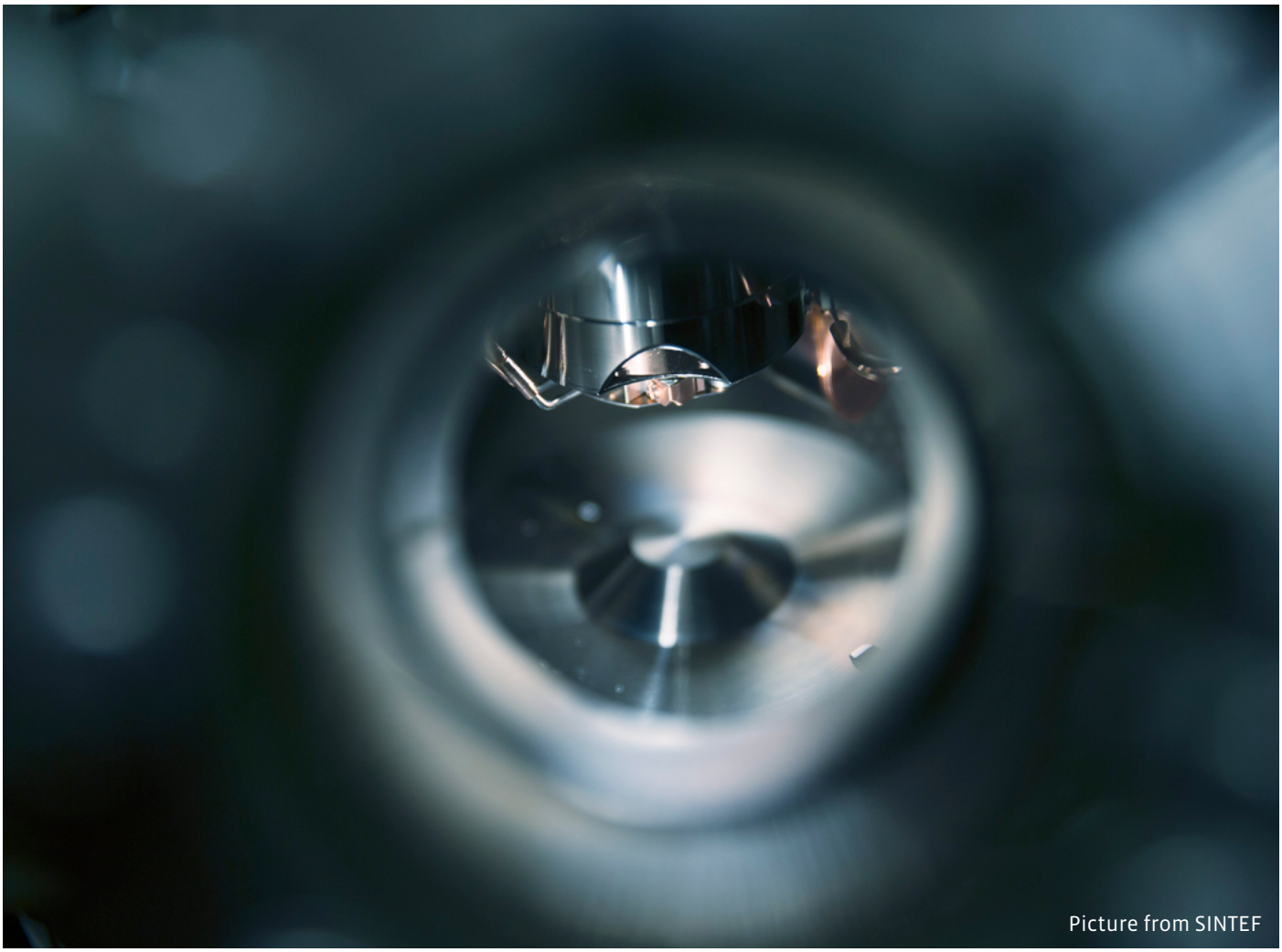
Manufacturing Technology Norwegian Catapult Centre have currently completed 203 projects and has reached cruising speed. Emma Østerbø is the Centre CEO and has its HQ in Raufoss Industrial park.

The Norwegian Catapult program are intended to contribute to industrial value creation in Norway. This will be done by developing relevant services under the auspices of internationally leading catapult centers and make the path from the concept stage to market introduction easier for SME's in the Norwegian industry.

The program was launched as one of nine prioritized measures to increase industrial activity when the Norwegian government presented the "Meld. St. 27 (2016–2017) - A greener, smarter and more innovative industry" in March 2017. Ahead of this SFI gave an input to the Norwegian Ministry of Trade, Industry and Fisheries, here is an excerpt of the short version:

"Our (SFI Manufacturing) research mandate for the next eight years is to produce research to strengthen and further develop Norwegian, mainland-based industry. The relevance of this work has increased significantly after the oil crisis. The situation today is that mainland industry accounts for about 9 per cent of GDP or 15 per cent of total Norwegian production value. In addition, there are significant ripple effects in other product and services industries. In recent years, companies have relocated operations from low-cost countries to a significant extent, through so-called insourcing. Furthermore, the industry contributes with local competence development in schools and the public sector, to innovation and new start-ups of companies, and is an industry that largely uses research as an integral part of its strategy.

In order to strengthen Norwegian industry, in the consortium's opinion, it is important to take into account the advantages we have of producing in Norway, not just the obvious cost disadvantages through higher hourly wages and generally higher cost



Picture from SINTEF

levels. The advantages of producing in Norway are many: We have a high level of knowledge in the population, there is a close collaboration between companies, universities and research institutes through a number of different research projects both at basic research level and for user-driven research. We have a working life characterized by a high degree of trust and responsibility, which creates less need for control and hierarchies than in other countries we compete with. The last point contributes to significantly lower costs and higher quality, and together with a high degree of automation, it can largely compensate for higher hourly wages. Close interaction between different levels and departments in companies is also beneficial for the pace of innovation; how quickly one manages to develop and test new products, which is very crucial in the working life of the future. Based on its industrial history, Norway has built up a strong material competence that offers great opportunities when it is connected to the manufacture of products. It is precisely this link we largely build on in SFI Manufacturing, and which sets us apart from many other countries when addressing manufacturing.

Although we have many advantages, we also have significant challenges. The need for rapid innovation in the future requires infrastructure and laboratories for development and testing along the path from idea to finished product. We have a significant infrastructure for basic research at NTNU and other universities, although this also requires continuous upgrading and new investments. The companies similarly have their own infrastructure for final testing of their own products. But there is a link in the middle where we have a significant weakness. In recent years, the United Kingdom and Germany have built up technology centers to cover the gap between the research laboratory and finished, producible products, through so-called "Catapults" and "Tech centers". Access to such infrastructure is crucial. Another challenge is related to knowledge and competence building, especially aimed at digitization."

Conferences

Industri Futurum
Before Covid-19 lock-down hit us in March we were able to attend “Industri Futurum” in Oslo. Multiple people from SFI and SINTEF Manufacturing gave lectures and moderated sessions within areas of additive manufacturing, robotics, automation, work culture and workplace 4.0. In addition, several of our SFI-partners attended the conference; GKN Aerospace, Hydro and Ekornes, to name a few.

SIMS symposium
Another highlight, connected to RA2, that between 10-12 June 2020 the SIMS 2020 (3rd International Symposium on Small-scale Intelligent Manufacturing Systems) conference was successfully arranged as a virtual event. Participants from over 6 countries, academics, research institutes and industry have shared their knowledge with each other.

This is the second of the two international conferences we intended to host during the SFI Centre period, and with 3 years left there might be room for another.

Figure 2Hosts of the SIMS symposium

Picture from SINTEF

Recruitment and communication

We are according to our plan with our PhD education. In 2020, SFI Manufacturing had 12 PhD candidates, and 3 Postdocs. We are pleased to inform that close to 50% of our candidates are female, and that all candidates are equally distributed over the different research areas.

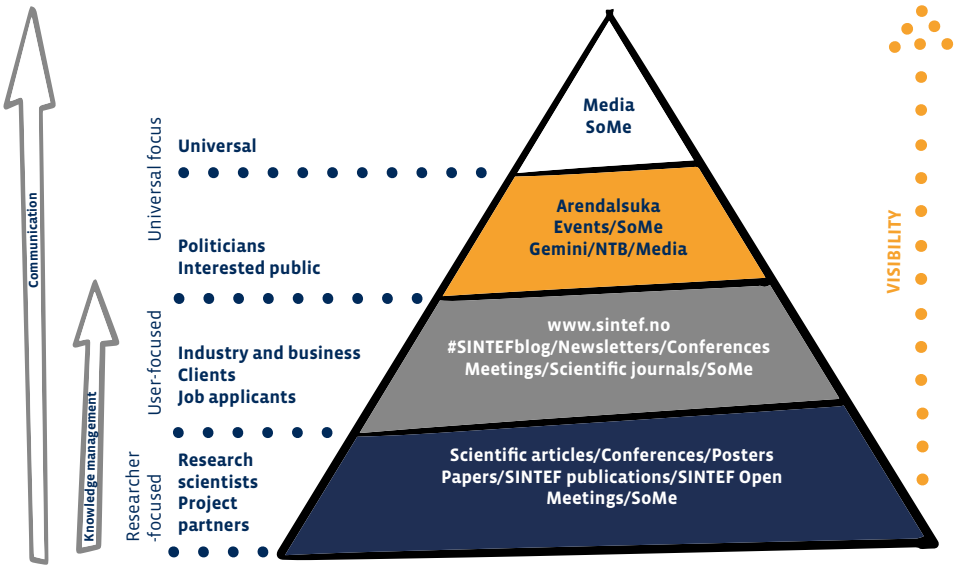
Our web, www.sfimanufacturing.no, includes updated information on the centre, partners, research areas, PhD candidates and publications. The website includes a blog as well, with news about mainly the workshops, PhD candidates and partners. We are sharing all blogposts on Twitter, and most of the blogposts on SINTEF Manufacturing's social media as well. We are using Twitter actively during conferences, workshops, meetings, and other gatherings where the centre is involved. SFI Manufacturing has tweeted 178 times until now and has 272 followers.

We have published two newsletters last year and its aim is to keep the community up to date with the current research that is being carried out within and related to the centre. The newsletter for 2020 and previous years can be found at this link.

In addition to the newsletter, we published the annual report of 2019 in the start of 2020, including a summary of the main scientific results, and link to the newsletters as appendix as well.

We are communicating internally about the centre's activities as well. Besides email, eRoom and OneDrive, information is being shared on the info screens at SINTEF Manufacturing's locations at Raufoss and in Trondheim

In our communication, we use the SINTEF channel triangle to guide our efforts in reaching our target audiences.



Key Researchers

Name	Institution	Main research area
Are Strandlie	NTNU-IV-IVB	Multi material metallic products, Multiscale modelling
Per Harald Ninive	NTNU-IV-IVB	Multi material metallic products, Multiscale modelling
Sotirios Grammatikos	NTNU-IV-IVB	Multi material products cont. Polymers
Per Erik Vullum	NTNU-NV-IF	Multi material metallic products
Randi Holmestad	NTNU-NV-IF	Multi material metallic products
Erik Andreassen	SINTEF Industry	Additive manufacturing
Per Erik Vullum	NTNU-NV-IF	Multi material metallic products
Randi Holmestad	NTNU-NV-IF	Multi material metallic products
Bjørn Holmedal	NTNU-NV-IM	Multi material metallic products
Ida Westermann	NTNU-NV-IM	Multi material metallic products
Erik Andreassen	SINTEF Industry	Additive manufacturing
Ben Alcock	SINTEF Industry	Additive manufacturing, Multi material products cont. Polymers
Bård Nyhus	SINTEF Industry	Multi material metallic products
Dirk Nolte	SINTEF Industry	Multi material metallic products
Bård Nyhus	SINTEF Industry	Multi material metallic products
Dirk Nolte	SINTEF Industry	Multi material metallic products
Gaute Gruben	SINTEF Industry	Multi material metallic products
Hoang Hieu Nguyen	SINTEF Industry	Multi material metallic products
Magnus Eriksson	SINTEF Industry	Multi material metallic products
Odd M. Akselsen	SINTEF Industry	Multi material metallic products
Ragnhild Aune	SINTEF Industry	Multi material metallic products
Xiaobo Ren	SINTEF Industry	Multi material metallic products, Multiscale modelling
Afaf Saai	SINTEF Industry	Multi material metallic products, Multi material products cont. polymers, Multiscale modelling
Einar Hinrichsen	SINTEF Industry	Multi material metallic products, Multi material products cont. polymers, Multiscale modelling
Jesper Friis	SINTEF Industry	Multi material metallic products, Multi material products cont. polymers, Multiscale modelling
Ben Alcock	SINTEF Industry	Multi material products cont. Polymers
Christian Karl	SINTEF Industry	Multi material products cont. Polymers
Kjell Olafsen	SINTEF Industry	Multi material products cont. Polymers

Virgile Delhaye	SINTEF Industry	Multi material products cont. Polymers
Ole Martin Løvvik	SINTEF Industry	Multiscale modelling
Klas Boivie	SINTEF Manufacturing	Additive manufacturing
Olav Åsebø Berg	SINTEF Manufacturing	Additive manufacturing
Vegard Brøtan	SINTEF Manufacturing	Additive manufacturing, Multi material products cont. Polymers
Sverre Gulbrandsen-Dahl	SINTEF Manufacturing	Multi material metallic products
Kristin Kaspersen	SINTEF Digital	Robotic technologies for flexible manufacturing
Synne Fossøy	SINTEF Digital	Robotic technologies for flexible manufacturing
Ahmed Kedir Muhammed	SINTEF Digital	Robotic technologies for flexible manufacturing
Magnus Bjerkeng	SINTEF Digital	Robotic technologies for flexible manufacturing
Marianne Bakken	SINTEF Digital	Robotic technologies for flexible manufacturing
Esten Ingar Grøtli	SINTEF Digital	Robotic technologies for flexible manufacturing, Flexible and integrated production systems
Geir Ole Tysse	SINTEF Manufacturing	Flexible and integrated production systems
Per Nyen	SINTEF Manufacturing	Flexible and integrated production systems
Sebastian Dransfeld	SINTEF Manufacturing	Flexible and integrated production systems
Eirik Njåstad	SINTEF Manufacturing	Robotic technologies for flexible manufacturing
Gabor Sziebig	SINTEF Manufacturing	Robotic technologies for flexible manufacturing, Flexible and integrated production systems
Morten Lind	SINTEF Manufacturing	Robotic technologies for flexible manufacturing, Flexible and integrated production systems
Asbjørn Karlsen	NTNU-SU-GEO	Sustainable business model development
Jonas Ingvaldsen	NTNU-Økonomi-IØT	Future Manufacturing Organization models
Heidi Dreyer	NTNU-Økonomi-IØT	Future Manufacturing Organization models, Sustainable business model development
Pål Kamsvåg	SINTEF Digital	Future Manufacturing Organization models
Sven-Vegard Buer	SINTEF Digital	Future Manufacturing Organization models
Eli Fyhn Ullern	SINTEF Digital	Sustainable business model development
Henrik Brynthe Lund	SINTEF Digital	Sustainable business model development
Eirin Lodgaard	SINTEF Manufacturing	Future Manufacturing Organization models
Gaute Knutstad	SINTEF Manufacturing	Future Manufacturing Organization models
Maria Flavia Mogos	SINTEF Manufacturing	Future Manufacturing Organization models
Ragnhild Eleftheriadis	SINTEF Manufacturing	Future Manufacturing Organization models
Johanne Sørumsbrenden	SINTEF Manufacturing	Sustainable business model development
Sigurd Vildåsen	SINTEF Manufacturing	Sustainable business model development
Jan Tommy Gravdahl	NTNU-IE	Senor fusion
Kristian Martinsen	NTNU-IV-IVB	Additive manufacturing, Work systems and organization

Postdoctoral researchers with financial support from the Centre budget

Name	Nationality	Period	Sex M/F	Topic
Mathias Hauan Arbo	Norwegian	2019-2021	M	Sensor Based Robot Programming
Sourav Sengupta	Indian	2020-2022	M	How digitalisation affects organisation and planning in manufacturing supply chains
Ding Peng	Chinese	2020-2022	M	Advanced characterization to understand interface physics in metal AM of multi-material products

PhD students with financial support from the Centre budget

Name	Nationality	Period	Sex M/F	Topic
Tina Bergh	Norwegian	2016-2020	F	Advanced characterisation of aluminium steel joints
Linn Danielsen Evjemo	Norwegian	2016-2021	F	Automatisaton of additive manufacturing
Eirik B.H. Korsen	Norwegian	2017-2021	M	Robustnes of MES and work systems
Andreas Molturmyr	Norwegian	2019-2023	M	Automatisaton of additive manufacturing
Chaman Srivastava	Indian	2019-2023	M	Liftime prediction of polymer and composites
Ingrid Fjordheim Onstein	Norwegian	2019-2023	F	Flexible and automated robotized deburring
Håkon Linga	Norwegian	2020-2024	M	Material properties and geometry tolerances in additive manufacturing of multi-material metallic components
Assiya Kenzhegaliyeva	Norwegian	2020-2023	F	Development of sustainable value chains

PhD students working on projects in the centre with financial support from other sources

Name	Funding	Nationality	Period	Sex M/F	Topic
Vetle Engesbak	IPN Sprangforbedring	Norwegian	2015-2021	M	Business management, innovation and implementation of changes
Marit Moe Bjørnbet	KPN SISVI	Norwegian	2016-2021	F	Life cycle assessment as a management tool
Anna Maria Persson	SINTEF Institute funding	Norwegian	2017-2021	F	Mechanical properties of thermoplastic elastomers in injection moulded components

Master Degrees

Name	Sex M/F	Period	Topic
Marte Løkken Myrvold	F	2020	Kraftestimering i robotmanipulatorer
Synne Fossøy	F	2020	Lyapunov kontroll i Konform Geometrisk Algebra
Espen Lunden	M	2020	Kraftkontroll i Constraint-based task spesifisering for robotisert vareproduksjon
Abdulrahim Habboush	M	2020	Robotisert Kutting for Matvareproduksjon

Visiting Researchers

Name	Affiliation	Nationality	Sex M/F	Duration	Topic
Jos Benders	Professor KU Leuven	Belgium	M	20% position	

Scientific publications

Reporting year: 09/2020
Type: Article
Authors: N. Adamovic, J. Friis, G. Goldbeck, A. Hashibon, K. Hermansson, D. Hristova-Bogaerds, R. Koopmans, E. Wimmer
Title of work: EMMC Roadmap - Materials Modelling and Digitalisation of the Materials Sciences
Book/compendium/journal: EMMC ASBL 2020, Avenue Louise 54, 1050 Brussels, Belgium
Page no.: 1-46

Reporting year: 2020
Type: Article
Authors: M.H. Arbo, I. Eriksen, F. Sanfilippo, J.T. Gravdahl
Title of work: Comparison of KVP and RSI for Controlling KUKA Robots Over ROS
Book/compendium/journal: IFAC-PapersOnLine
Page no.:
ISSN/ISBN: 2405-8963

Reporting year: 173/2020
Type: Article
Authors: T. Bergh, L. Sandnes, D.N. Johnstone, Ø. Grong, F. Berto, R. Holmestad, P.A. Midgley, P-E. Vullum
Title of work: Microstructural and mechanical characterisation of a second generation hybrid metal xtrusion & bonding aluminium-steel butt joint
Book/compendium/journal: Materials Characterization
Page no.:
ISSN/ISBN: 1044-5803

Reporting year: 1/2020
Type: Article
Authors: L.D. Evjemo, T.B. Gjerstad, E.I. Grøtli, G. Sziebig
Title of work: Trends in Smart Manufacturing: Role of Humans and Industrial Robots in Smart Factories
Book/compendium/journal: Current Robotics Reports
Page no.: 35-41
ISSN/ISBN: 2662-4087

Reporting year: 2020
Type: Article
Authors: L.D. Evjemo, S. Moe, J.T. Gravdahl
Title of work: Robotised Wire Arc Additive Manufacturing Using Set-based Control: Experimental Results
Book/compendium/journal: IFAC-PapersOnLine
Page no.:
ISSN/ISBN: 2405-8963

Reporting year:	2020
Type:	Article
Authors:	J. Fahlström, G. Sziebig
Title of work:	Automated Stacking and Screwing of Low Volume Electromechanical Products with Industrial Robot
Book/compendium/journal:	Proceedings of the IEEE International Symposium on Industrial Electronics
Page no.:	525-529
ISSN/ISBN:	9781728198644

Reporting year:	634/2020
Type:	Article
Authors:	I.A.Ø. Gamme, S.H. Aschehoug, E.A. Lodgaard
Title of work:	Lean Implementing Facilitating Integrated Value Chain
Book/compendium/journal:	Lecture Notes in Electrical Engineering
Page no.:	358-365
ISSN/ISBN:	1876-1100

Reporting year:	2020
Type:	Article
Authors:	I.A.Ø. Gamme, B.S. Andersen, H. Raabe, D. Powell
Title of work:	Value Chain Integration – A Framework for Assessment. I: Advances in Production Management Systems: The Path to Digital Transformation and Innovation of Production Management Systems
Book/compendium/journal:	IFIP WG 5.7 International Conference, APMS 2020, Novi Sad, Serbia, August 30 – September 3, 2020
Page no.:	243-249
ISSN/ISBN:	978-3-030-57992-0

Reporting year:	13/2020
Type:	Article
Authors:	T. Hekneby, J. Ingvaldsen, J. Benders
Title of work:	Managing Adoption by Cultural Development: Exploring the Plant-Level Effect of a Company-Specific Production System in a Norwegian Multinational Company
Book/compendium/journal:	Journal of Industrial Engineering and Management
Page no.:	402-416
ISSN/ISBN:	2013-0953

Reporting year:	15/2020
Type:	Article
Authors:	J. Ingvaldsen, J. Benders
Title of work:	Back through the back door? On removing supervisors to reduce hierarchy
Book/compendium/journal:	Baltic Journal of Management
Page no.:	473-491
ISSN/ISBN:	1746-5265

Reporting year:	27/2020
Type:	Article
Authors:	J. Ingvaldsen, V. Engesbak
Title of work:	Organizational learning and bureaucracy: an alternative view
Book/compendium/journal:	The Learning Organization
Page no.:	174/2020
ISSN/ISBN:	0969-6474

Reporting year:	174/2020
Type:	Article
Authors:	M.Z. Khalid, J. Friis, P.H. Ninive, K. Marthinsen, A. Strandlie
Title of work:	Ab-initio study of atomic structure and mechanical behaviour of Al / Fe intermetallic interfaces
Book/compendium/journal:	Computational Materials Science
Page no.:	
ISSN/ISBN:	0927-0256

Reporting year:	2020
Type:	Article
Authors:	S. Kuzin, G. Sziebig
Title of work:	SROS: Educational, Low-cost Autonomous Mobile Robot Design Based on ROS
Book/compendium/journal:	Proceedings of 2020 IEEE/SICE International Symposium on System Integration
Page no.:	1052-1057
ISSN/ISBN:	978-1-7281-6667-4

Reporting year: 2020
Type: Article
Authors: L.H. Lied, F.M. Mogos, D.J. Powell
Title of work: Organizational enablers for digitalization in manufacturing industry
Book/compendium/journal: In production management systems : Towards smart and digital manufacturing: FIP WG 5.7 International Conference, APMS 2020, Novi Sad, Serbia, August 30 – September 3, 2020, Proceedings, Part II. Springer
Page no.: 83-90
ISSN/ISBN: 9783030579975

Reporting year: 69/2020
Type: Article
Authors: S. Moe, K.Y. Pettersen, J.T. Gravdahl
Title of work: Set-based collision avoidance applications to robotic systems
Book/compendium/journal: Mechatronics
Page no.:
ISSN/ISBN: 0957-4158

Reporting year: 2020
Type: Article
Authors: A.H. Moltumyr, M.H. Arbo, J.T. Gravdahl
Title of work: Towards Vision-based Closed-loop Additive Manufacturing: A Review
Book/compendium/journal: Proceeding of 3rd International Symposium on Small-scale Intelligent Manufacturing Systems (SIMS2020). IEEE conference proceedings
Page no.:
ISSN/ISBN: 978-1-7281-6419-9

Reporting year: 2020
Type: Article
Authors: A.H. Moltumyr, M.R.P. Ragazzon, J.T. Gravdahl
Title of work: Fractional-order Control: Nyquist Constrained Optimization
Book/compendium/journal: IFAC-PapersOnLine
Page no.:
ISSN/ISBN: 2405-8963

Reporting year: 2020
Type: Article
Authors: O. Ogorodnyk, M. Larsen, O.V. Lyngstad, K. Martinsen
Title of work: Towards a general application programming interface (API) for injection molding machines
Book/compendium/journal: PeerJ Computer Science
Page no.:
ISSN/ISBN: 2376-5992

Reporting year: 2020
Type: Article
Authors: I.F. Onstein, L.D. Evjemo, J.T. Gravdahl
Title of work: Additive Manufacturing Path Generation for Robot Manipulators Based on CAD Models
Book/compendium/journal: IFAC-PapersOnLine
Page no.:
ISSN/ISBN: 2405-8963

Reporting year: 2020
Type: Article
Authors: I.F. Onstein, O. Semeniuta, M.C. Bjerkeng
Title of work: Deburring Using Robot Manipulators: A Review
Book/compendium/journal: Proceeding of 3rd International Symposium on Small-scale Intelligent Manufacturing Systems (SIMS2020). IEEE conference proceedings
Page no.:
ISSN/ISBN: 978-1-7281-6419-9

Reporting year: 60/2020
Type: Article
Authors: A-M.M.R. Persson, E.L. Hinrichsen, E. Andreassen
Title of work: Adhesion between thermoplastic elastomers and polyamide12 with different glass fiber fractions in twocomponent injection molding
Book/compendium/journal: Polymer Engineering and Science
Page no.: 1642-1661
ISSN/ISBN: 1548-2634

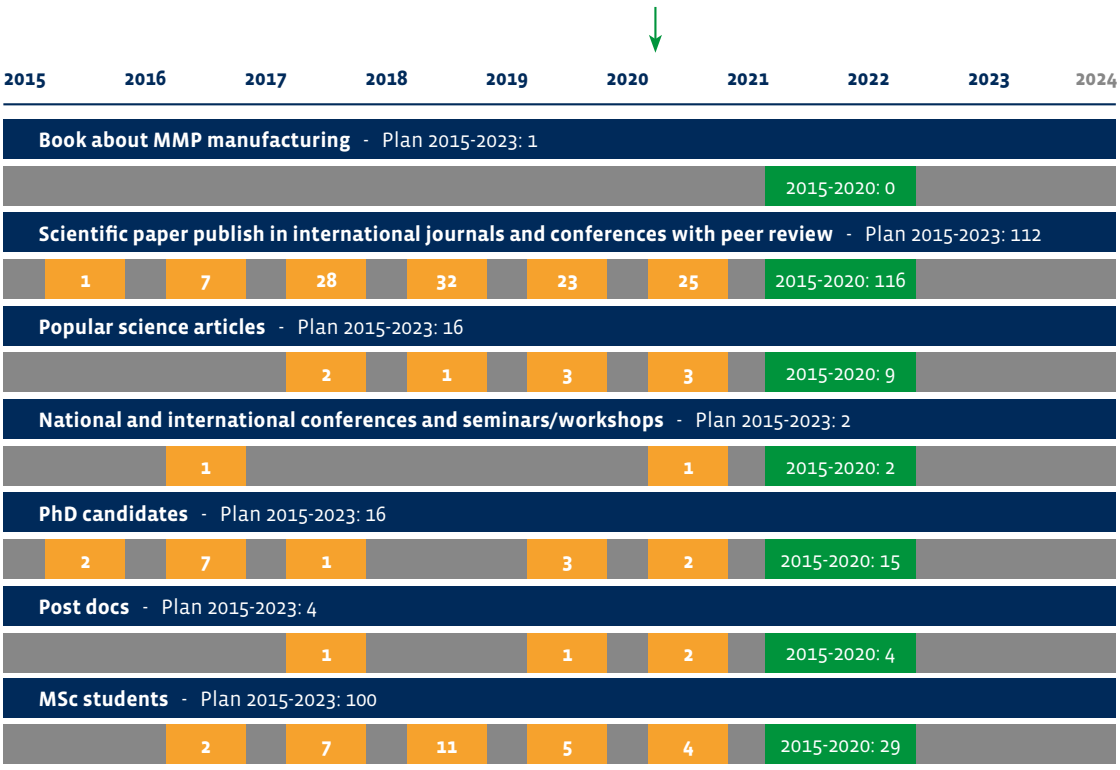
Reporting year:	2020
Type:	Article
Authors:	D.J. Powell, Daryl; B. Fernandez, K. Paloma
Title of work:	Enterprise-wide Value Stream Mapping: From Dysfunctional Organization to Cross-Functional, Collaborative Learning and Improvement.
Book/compendium/journal:	Proceedings of the 2020 IEEE International Conference on Industrial Engineering and Engineering Management. IEEE 2020
Page no.:	551-555
ISSN/ISBN:	978-1-5386-7220-4

Reporting year:	93/2020
Type:	Article
Authors:	D.J. Powell, P. Coughlan
Title of work:	Corporate Lean Programs: Practical Insights and Implications for Learning and Continuous Improvement
Book/compendium/journal:	Procedia CIRP 2020
Page no.:	820-825
ISSN/ISBN:	2212-8271

Reporting year:	40/2020
Type:	Article
Authors:	D.J. Powell, P. Coughlan
Title of work:	Rethinking lean supplier development as a learning system
Book/compendium/journal:	International Journal of Operations & Production Management
Page no.:	
ISSN/ISBN:	0144-3577

Reporting year:	634/2020
Type:	Article
Authors:	G.Sziebig
Title of work:	Survey and Planning of High-Payload Human-Robot Collaboration: Multi-modal Communication Based on Sensor Fusion
Book/compendium/journal:	Lecture Notes in Electrical Engineering
Page no.:	454-551
ISSN/ISBN:	1876-1100

Reporting year:	113/2020
Type:	Article
Authors:	H.B. Lund, M. Steen
Title of work:	Make at home or abroad? Manufacturing reshoring through a GPN lens: A Norwegian case study
Book/compendium/journal:	Geoforum
Page no.:	154-164
ISSN/ISBN:	0016-7185



Statement of accounts

An overview of the funding and costs is presented below. All figures are in 1000 NOK.

Funding	2020
The Research Council	9 628 381
The Host Insitiution (SINTEF Manufacturing AS)	943 088
Research Partners*	5 632 895
Enteprise Partners*	10 191 317
Total	26 395 681

Costs	
The Host Insitiution (SINTEF Manufacturing AS)	5 272 861
Research Partners*	14 906 503
Enteprise Partners*	6 216 317
Public Partners	
Equipment	
Total	26 395 681

Enterprise partners*

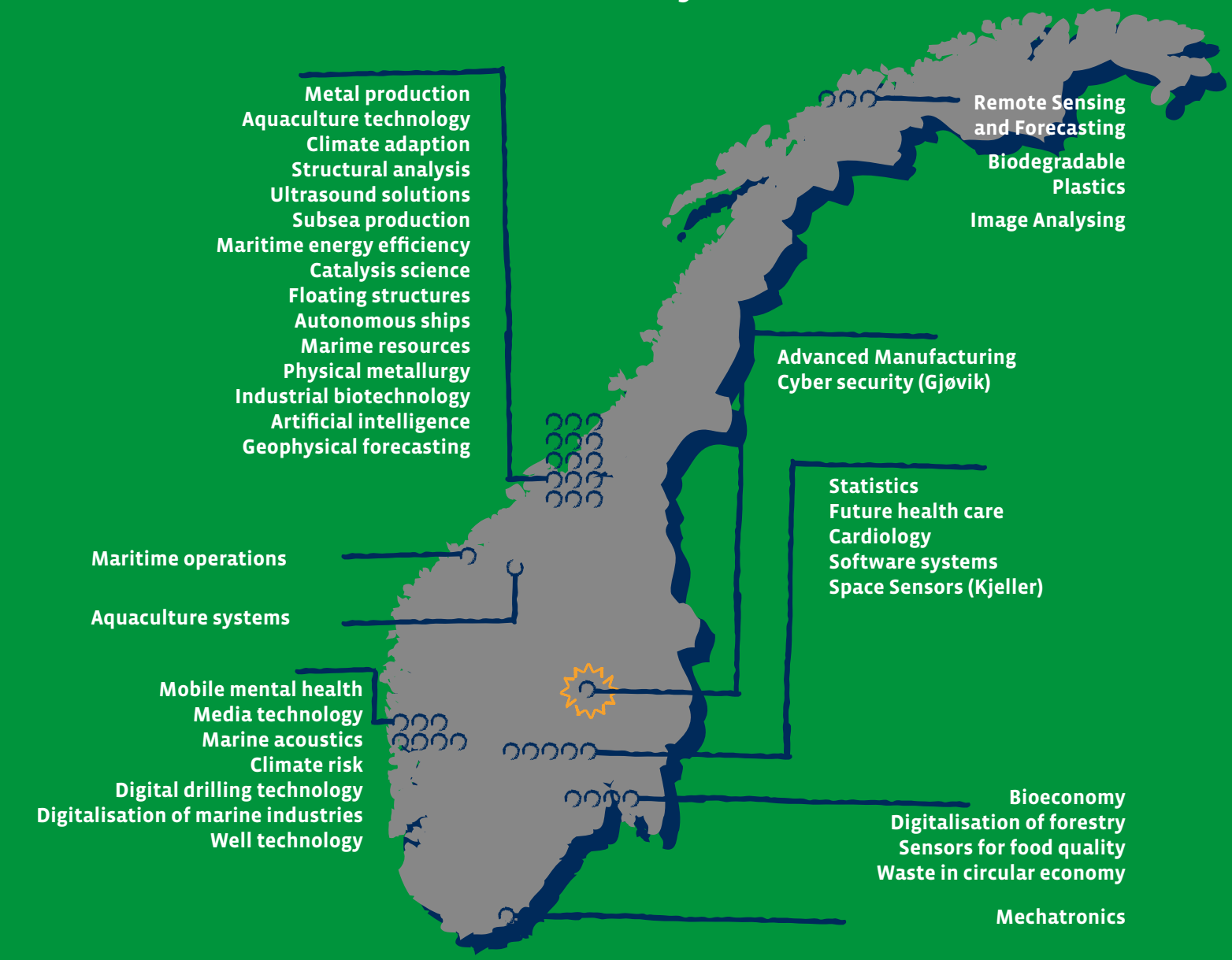
Børdrene Aa (private sector)
Benteler Automotive Raufoss (private sector)
Ekornes (private sector)
GKN (private sector)
Heagon Ragasco (private sector)
Kongsberg Automotive (private sector)
Kongsberg Maritime (private sector)
Mjøs Metallvarefabrikk (private sector)
Nammo Raufoss (private sector)
Norsk Hydro (private sector)
Plasto (private sector)
Raufoss Technology (private sector)
HyBond (private sector)
Sandvik Coromant (private sector)

Research Partners*

SINTEF Digital (research institute)
SINTEF Industry (research institute)
NTNU-IE (university faculty)
NTNU-IV (university faculty)
NTNU-NV (university faculty)
NTNU-SU (university faculty)
NTNU-ØK (university faculty)

SFI Manufacturing

One of the 39 SFI's in Norway



sfi Centre for Research-based Innovation
The Research Council of Norway

manufacturing

SFI Manufacturing
SINTEF Manufacturing
Enggata 40, 2830 Raufoss
www.sfimanufacturing.no