

# NEWSLETTER

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SFI  
Manufacturing



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**manufacturing**

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## WORDS FROM THE CENTRE MANAGER

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

The centre has maintained a good progress during the pandemic both with respect to research and academic publications, and the use of digital solution for centre activities. However, it was very nice to have a physical work-shop in October. I sincerely hope that we over the next months are getting back to a more normal situation, and I think that the experience from the pandemic period will give us important input to what we shall focus on in our meetings and what can be done on digital platform.

## PhD news



**Eirik B. H. Korsen's date for disputation is 10.02.2022.**

His thesis is on **Aligning performance management across organisations.**

After working more than ten years as a consultant within performance management, Eirik is now studying the underlying dynamics between how people in an organisation understand the management system.

In his research, he has done a qualitative case study of a limited number of manufacturing organisations participating in SFI Manufacturing.



## Our first physical workshop in two years

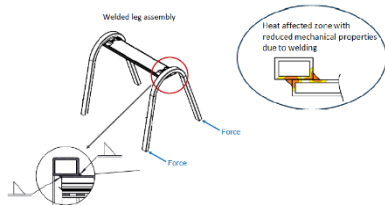
**For the first time in two years, we held a physical industrial workshop in SFI Manufacturing, this time in Gjøvik. Over 60 eager participants from the industry and the research partners started at Strand Hotel in the evening of Monday 25<sup>th</sup> of October.**

We got to hear about the past and future of Raufoss Industrial Park from both the research perspective (SINTEF Digital) and from the perspective of the industrial park's CEO. Disserted PhD-students was announced and celebrated, before we all went to have dinner at Smag Lounge for some long-awaited mingling.

On Tuesday the following day we gathered at campus Kallerud, NTNU Gjøvik, where the centre manager Sverre Gulbrandsen-Dahl started the workshop by updating the participants on the centre status, followed by excellent presentations from Mads Iddberg and Mathias Arbo, both from SINTEF Manufacturing.

Mads Iddberg presented the Hydro project "PRO3 and Adaptive control of aluminium production" in collaboration with Trond Furu (Hydro corp. technology) and Ole Runar Myhr (Hydro Aluminium Metal R&D). In IPN AdaptAI, the overall idea of the project is to develop and demonstrate a product-service-system that integrate multi-physics models, process models, advanced sensors, and virtual data through an optimizing software.

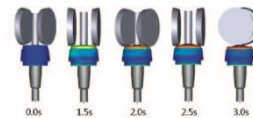
The basis for the product-service system is a digital twin called PRO3. PRO3 has been developed by Hydro, NTNU and SINTEF and is capable of simulating and optimizing process and product designs in the aluminium value chain. In IPN AdaptAI, PRO3 was used to optimize a chair design made by project partner FLOKK. The work resulted in a weight optimized and environmentally friendly design applying 75% post consume aluminium.



Mathias Arbo, a former PhD in SFI Manufacturing, presented a case on adaptive assembly of ball joints. Mathias got a challenge from Neuman Aluminium Raufoss; to look at a previous project from 2006 from a cybernetics perspective. The goal of the 2006-project where to achieve higher torque precision on the ball joint, by measuring the torque during assembly. The results were good torque precision, but too much variation in the stiffness of the ball joints. With this project as a starting point, the project looked at various ways to achieve better control over the process, such as Cloud computing, Big data, Machine learning and Bayesian methods, and advanced control.



**Mathias Arbo** presenting at the workshop



In a comprehensive session lead by Torbjørn Høiland, Neuman's Head of R&D and Advanced Development, we got an insight in interesting challenges around ball joint assembly, individual tracking in production and material technology.

A virtual visit in the assembly-line in B260 was conducted by Neuman's plant manager Thomas Wasenden in Raufoss, placing all 60 workshop participants into the assembly line at once using RealWear glasses and Teams.

After lunch, we received a thorough review of ManuLab's facilities at NTNU Gjøvik before the meeting ended with a general meeting of SFI Manufacturing.



A review of **ManuLab's facilities** at NTNU Gjøvik



## Trends influencing the Norwegian manufacturing industry in the next decade

Close to 50 participants entered the digital workshop/webinar Thursday 16<sup>th</sup> of dec where Gaute Knutstad presented the paper Trends shaping Norwegian manufacturing in the next decade.

The ambition of the paper is to be a summary of the vast and exciting work that has been conducted in RA3 this far.

## About the white paper

The trends discussed in the paper are divided into four main categories:

- Environmental
- Technological
- Social
- Economical

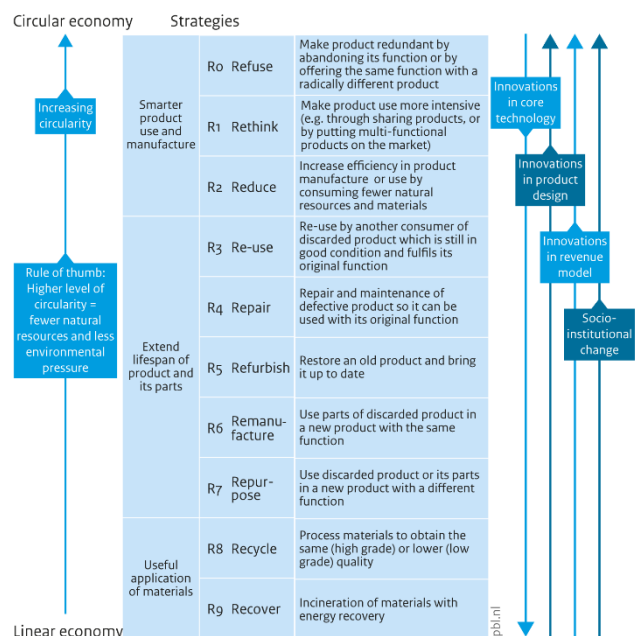
All though the trends are divided in this paper, its clear that it's all connected. The trends intertwine and creates a complex landscape to navigate through as a company.

The discussion afterwards revolved around how the industry sees this landscape and what factors come into play when they now make their choices into a greener and unknown future.

You can read the white paper on the SFI website:

<https://www.sfimanufacturing.no/white-paper-on-manufacturing-trends.html>

### Circularity strategies within the production chain, in order of priority



Source: RLI 2015; edited by PBL

www.pbl.nl

Figure 1: Circularity strategies within the production chain, in order of priority



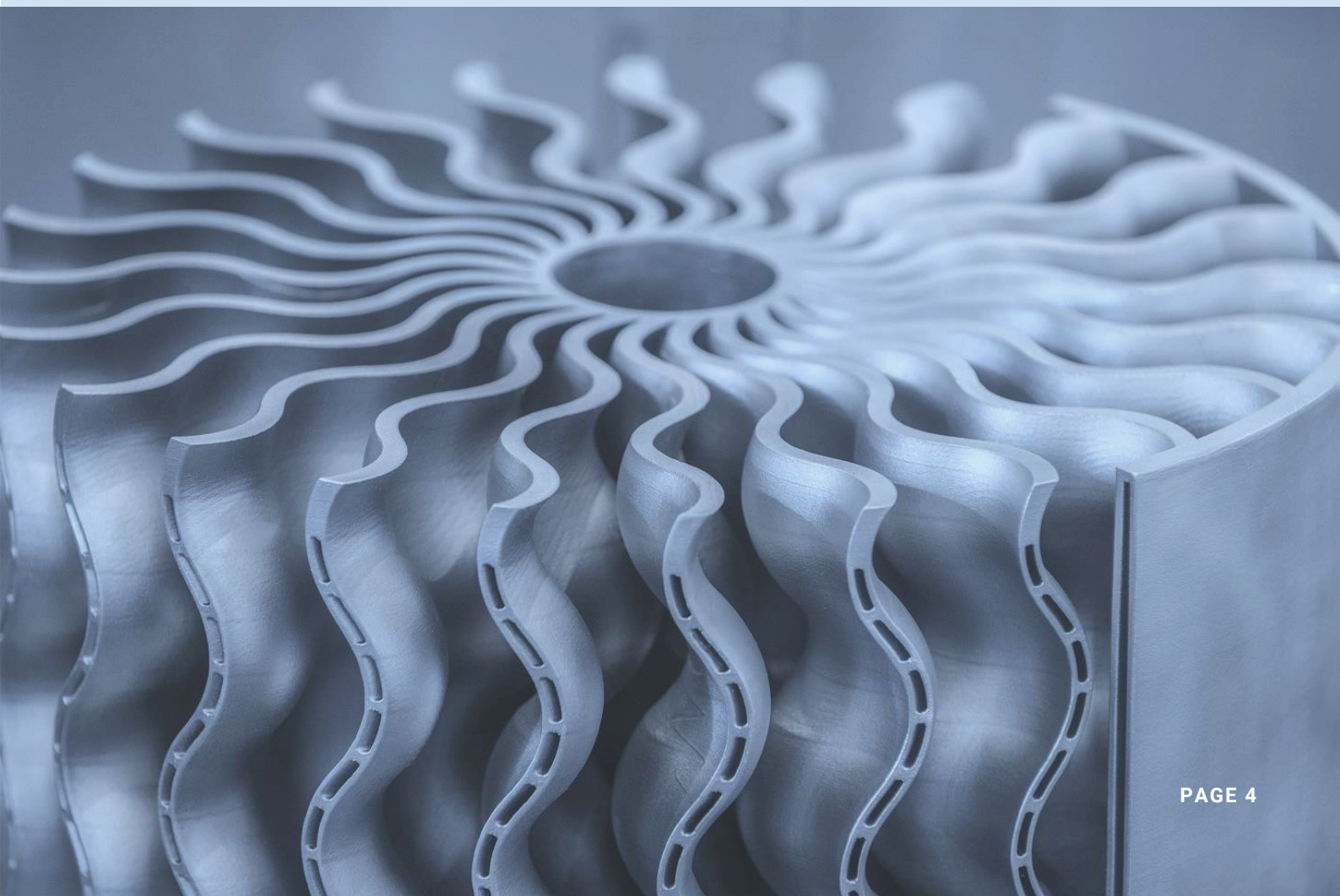
# Tentative **workshop plan** for 2022

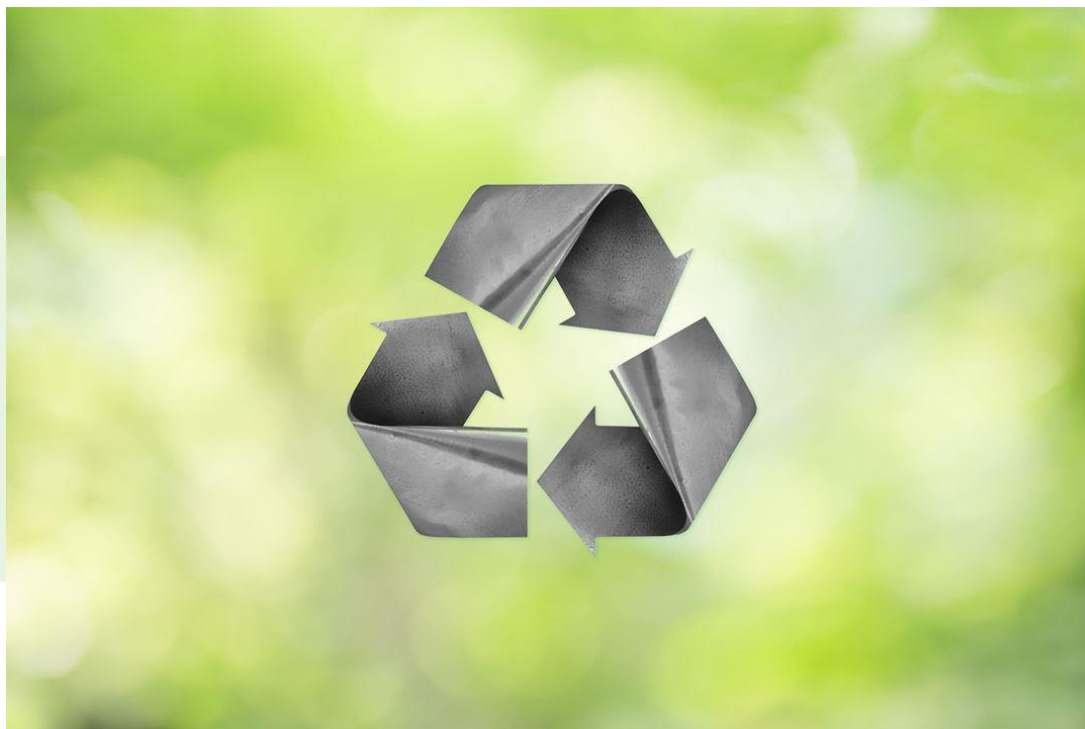
A physical gathering as the one in October clearly showed how new project ideas and opportunities arise when people talk together and not just "meet" at Teams and webinars!

In 2022, we will hold four industrial workshops in SFI Manufacturing.

Our plan is to hold them as physical meetings, and we cross our fingers that it will stay that way.

Time	Date	Industri partner	Location	Topic(s)	RAs
Q1	Apr 4-5	Hapro	Sanner Hotell, Hadeland	Flexible/adaptive robot assembly, ... Planning and logistics in global supply chains, ...	RA2 RA3
Q2	Jun 13-14 or Jun 20-21	Plasto	Åndalsnes	Sustainable/recyclable materials/products, ... Circular manufacturing and business models, ...	RA3 RA1
Q3	Sep 26-27	Kongsberg Innovasjon og GKN	Kongsberg	Multi-material additive manufacturing, ... Robotics in support op's, digitalization/digital twins, ...	RA1 RA2
Q4	Dec 5-6	Benteler	Raufoss	Material choice/development for products/processes, ... Adaptive, sensor-assisted automated processing, ... Homeshoring for sustainable operations/products, ...	RA1 RA2 RA3



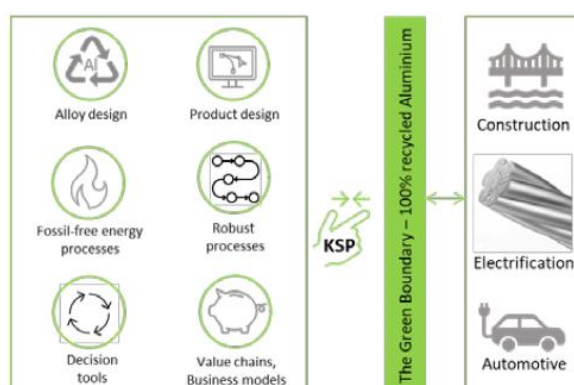


## New project: **AluGreen**

Project website: <https://www.sintef.no/prosjekter/alugreen/>

One of the Green Platform Initiative-projects that were granted this autumn were "AluGreen", which is led by Norsk Hydro. The main goal of this is to develop knowledge and demonstrate industrial pilots for circular and sustainable solutions for products in aluminum.

The project will include the use of aluminum for electrification as in submarine cables and engines in electric cars, automotive parts such as. battery boxes for electric cars, aluminum in larger constructions such as bridges and aluminum as reinforcement for low-Ph lime-based concrete



In addition to Hydro, the SFI-Manufacturing partners Benteler, SINTEF Industri, SINTEF Manufacturing and NTNU participate in this platform.

In addition to this, Manufacturing Technology, Metalco, Nexans, Oshaug Metall, Norcable, Leirvik, Dr. Techn. Olav Olsen, Kodyna, Christie & Opsal, Overhalla Betongbygg, Ocean Sun, Nordic Office of Architecture, Corvus Energy and Prodtex participate in the green platform project. The project also has an associated Competence and Cooperation Project (KSP) led by SINTEF Industri.

# Report from RA1: WP1.1 + WP1.2

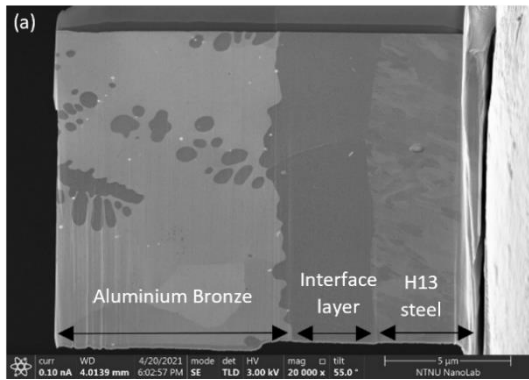
**PhD student Håkon Linga** and **Postdoc Ding Peng** have been working on additively manufactured multi-material component.

The emphasis so far has been on the material combination of H13 tool steel and aluminium bronze, where the aluminium bronze is deposited onto the tool steel and vice versa.

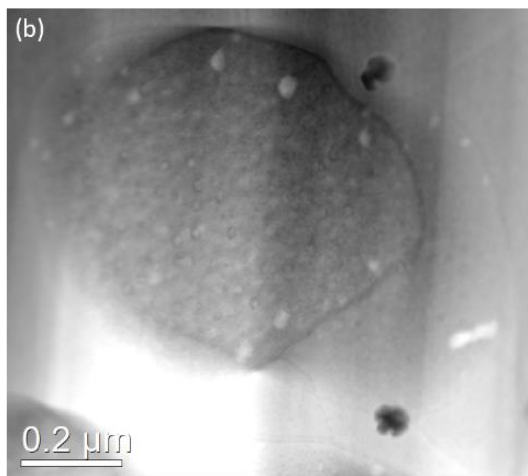
The intention of this is to combine the thermal properties of the bronze with the wear resistance of the tool steel in one part. In the boundary between the two materials a mixing zone is formed, and although the emphasis has been on characterizing this area, the mechanical properties of the surrounding material are also heavily affected.

You can see examples of Ding's work on the left (Electron microscopy images of additive manufacturing tooling alloy).

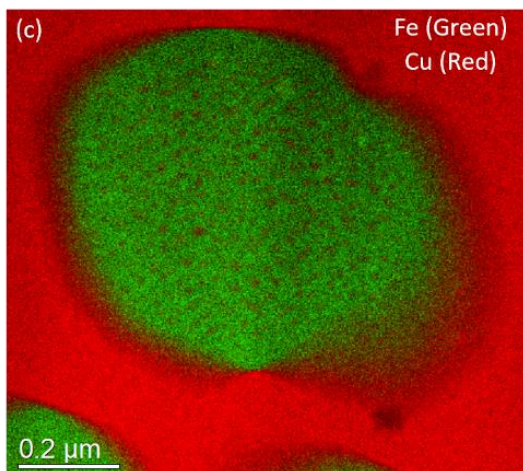
Håkon's work is shown on the next page.



(a) Electron micrograph of scanning electron microscopy investigated of focused-ion-beam (FIB) sample, showing the microstructure of the interface joining H13 steel with laser-melted aluminium bronze.

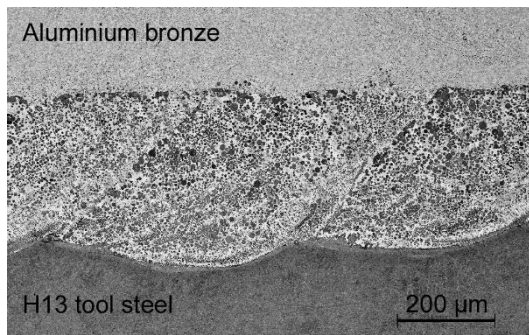


(b) Transmission electron microscopy (TEM) investigation of iron-rich intermetallic phase close to the interface layer.



(c) Elemental mapping of the iron-rich phase in figure b by energy-dispersive X-ray spectroscopy (EDS), which reveals the dispersion of nano-sized copper-rich  $\epsilon$  particles within the iron-rich pool.





(a) Backscatter electron image of mixing zone between H13 and aluminium bronze



(b) Inverse pole figure of steel in the mixing zone, red:  $\langle 001 \rangle$ , green:  $\langle 101 \rangle$ , blue:  $\langle 111 \rangle$ .

In Manulab, a 16 kW fiber laser station coupled with Fronius CMT welding system has been installed. The system can perform both laser and hybrid laser-arc welding.

In SFI Manufacturing, we are interested in using the laser system for joining of dissimilar materials. A review paper on laser-assisted joining of aluminium alloys to other metals has been accepted for publication in Metals journal.

Recently, we also initiated an activity to use laser for cladding of stainless scrap metal on carbon steel substrate. Good results have been obtained, which will be published very soon.

# Contact us

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