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Newsletter

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Research Area 3: Innovative and Sustainable Organizations

This newsletter is published prior to each workshop of SFI Manufacturing. The aim is to keep the community up to date with the current research that is being carried out within and related to the centre. This issue of the newsletter is focused on the research on Innovative and Sustainable Organizations.

In this issue:

- About the research area
- SFI Manufacturing Maturity Mapping
- Work package descriptions
- PhD progress reports
- Ongoing and new projects

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

SFI Manufacturing
A cross-disciplinary centre for research based innovation for competitive high value manufacturing in Norway

About the research area

The research area Sustainable and Innovative Organizations concerns the human and organizational aspects of advanced manufacturing companies. How should a manufacturing company be organized to develop the employees' competences in line with new technology? How should a company develop new product and production technology to stay competitive? How can sustainability issues be integrated into product and process development? How best to interact with other companies, educational institutions and research institutes for long term sustainability? These are important questions highlighted by companies and researches in research area 3.

In increasingly more competitive industries, the organizational aspects are essential for long-term development and success. Norwegian companies are in general recognized by highly competent and independent employees. These factors are considered overall advantages and a premise for advanced, innovative and sustainable manufacturing in a high cost country.

In the common future, manufacturing companies might face demands for more accelerated innovation with shorter time from idea to market on one hand, and increased focus on sustainability on the other hand. The companies must deliver efficient and zero-defect production, working on short term improvement actions as well as being able to succeed on more radical innovation. The advanced work systems inside the companies are developing and learning in interaction with other companies, schools and educational institutions, public bodies, research and academic institutes, locally, regionally and globally.

Two overall trends in society are digitalization and sustainability. Digitalization will influence the every-day life of employees and management in manufacturing companies: interaction with technology, how and who are making decisions, the ability to simulate changes in production technology before physically implementing these changes, and a large amount of generated data will influence the development of new products and services. Similarly, a greener business development will affect the entire organization: manufacturing, development of products and production technology, and co-creation with external bodies.

Overall objective and work packages

The overall objective of the research within this area is to develop knowledge and solutions for advanced work systems that are able to utilize new technology and flexible and automated processes to manufacture sustainable multi-material products. The work is organised into three work packages (WP's):

- WP3.1 – Organization 4.0
- WP3.2 – Industrial cluster and learning systems
- WP3.3 – Innovation and product development

So far, the work packages have had a large focus on developing the maturity mapping tool (the survey), to be able to reflect together with the SFI companies on their status and level of maturity, and hence point out potential organizational gaps that need attention. In addition, activities within these WP's also link to the two other research areas of SFI Manufacturing, i.e. RA1 and RA3.

SFI Manufacturing Maturity Mapping

How mature are manufacturing companies in Norway to meet the challenges and opportunities ahead: competitive production in a high cost country, digitalization and sustainable development of the society?

SFI Manufacturing Maturity Mapping will attempt to answer this question through a survey distributed to co-workers in the SFI Manufacturing companies and a series of follow-up workshops with each individual company. The survey was launched in May 2017 (and continues throughout the summer of 2017). Preliminary results such as overall trends will be presented during the workshop at Raufoss in June 2017. The follow up workshops will be initiated throughout the fall of 2017 and winter of 2018.

The mapping is grounded on organizational research on production and innovation, as well as the megatrends of digitalization and sustainability. By mapping the companies with respect to state of art and international trends on digitalization and sustainability, the mapping will provide an overall understanding of weaknesses and strengths, as well as characteristics of Norwegian manufacturing companies. The plan is to conduct the survey three times during the lifetime of the centre (2017, 2019 and 2022), to monitor and support the development or the maturity of the companies.

There is a threefold objective for conducting the maturity mapping in a research centre with industrial and academic partners. The survey allows for comparison between companies in the centre and between different departments or units within a company. Firstly, the mapping and the results should support organizational development and innovation processes in each company. The second objective is to develop a maturity model that will support the companies. The model will be based on the survey and the follow-up activities. The third goal is scientific publications, which is a key indicator for the research centre.

Participating in the maturity mapping should support learning and organizational development. The survey takes on the perspective of the individual co-worker and manager. By answering the survey, the co-workers will reflect on their own workday. The results from each company will be presented at company internal reflection workshops where co-workers and researchers will discuss the results and develop ideas for organizational development and innovation. The ideas can be the basis for company internal processes and action research case studies, or for research project applications for example.

The background for the mapping is presented on the following pages of this newsletter.

Figure 1. Mapping to support organizational learning and development.

Organization 4.0 (WP 3.1)

Automatization and digitalization will increasingly challenge every company in terms of competence needed and making adjustments to the shop floor work systems. The manufacturing industry constantly faces the diversity of automating more complex manufacturing processes. At the same time, the complexity of setting up, programming and controlling the manufacturing process work systems are getting lower.

Work systems can be framed under 'team-based', 'lean production' or 'high-performance'. Contemporary work systems typically integrate those who perform direct work, improvement work, technical experts and managers. High-performance work systems aim to achieve superior performance through increased employee involvement and commitment.

With increased digitalisation in advanced manufacturing, the interaction between humans and technology is changing, for example by the need for understanding systems that display fast amounts of data, acting on instant feedback systems, or in direct co-creation with robots. More complex production systems also expand the skills and knowledge base of workers.

Supplementing manual skills and tacit knowledge, future workers are required to have a deeper theoretical understanding of the transformation processes, and perform tasks such as machine set-up and programming, which until now is mainly carried out by technicians and engineers. Therefore, there is a need to rethink the role of skilled workers in future manufacturing. Though we have been working on the concept of 'technological enhanced work', technology is still an important and crucial enabler, but it is available for everyone. Therefore, the ability to utilize the potential within the technology and productions system is hard to copy and strengthens the competitive advantage.

Innovation and product development (WP 3.3)

The development and implementation of new products and advanced production technologies is a premise for successful manufacturing in Norway. Nevertheless, there are large differences among the industrial partners in SFI Manufacturing with regard to strategies for product and process development. Some companies manufacture based on blue print, others develop advanced products in close cooperation with external partners. Other companies manufacture parts for larger, complex products, e.g. cars, ships or planes, while others again manufacture products for end user markets.

As a result, the organization of innovation and how development work is carried out, varies greatly among the industrial partners. Variations in strategies, organizations, approaches and tools will be mapped in the ongoing survey SFI Manufacturing Maturity Mapping, with expectations of uncovering best practices to develop the company itself and for others to learn from. Meanwhile, innovation in established manufacturing companies are more demanding than ever, with expectations of accelerated innovation (faster time to market), use of complex multi-material products and advanced production technologies, resulting in an increasing number of requirements and demands to be fulfilled.

Digitalization and sustainability demands will add to this complexity. The Norwegian government has stated a national goal of minimum 40% reduction of greenhouse gas emissions by 2030, compared to the level in 1990. For manufacturing companies, tracking of products or parts after its initial use stage can be a viable solution to support prolonged lifetime and a more circular economy. Nevertheless, there are potential negative environmental effects from the sensors. Similarly, multi-material solutions may contribute to lighter products, but may also cause difficulties in separating material fractions after the primary use stage. Finding a way to balance the demands in innovation and development will be important for successful manufacturing companies of the future.

Industrial cluster and learning systems (WP 3.2)

Industries and the innovation systems they are part of, are associated with knowledge bases defining generic and specific competencies, and the innovative capacity of firms is contingent to their ability to develop inhouse knowledge and exploit different external sources of knowledge.

Our point of departure is that companies are embedded in specific regional worlds of production (clusters), as well as in wider (potentially global) networks. Cluster firms ought to be exposed to external impulses and knowledge sources in order to avoid situations of lock-in to specific technological trajectories. Interesting clusters seem to develop differently, even in quite similar cultural and business contexts. With this in mind, we have started research on how to understand the development of two important Norwegian clusters, namely Raufoss and Kongsberg.

To more profoundly understand the historical trajectories of both Raufoss and Kongsberg, it is important to create an understanding of the development of both clusters. It is important as well to look at the cluster's innovative capacities: how can we understand their cooperation between schools, businesses, public services and industry? Are there differences between Raufoss and Kongsberg in how they develop knowledge and stimulate to cooperation between actors?

Another important issue is the role of gatekeepers in developing (or hindering) linkages to complementary knowledge sources. Many firms rely on regional support for relevant education and training (access to skilled labor), but also on firms outside the region (collaborators, suppliers, customers), R&D institutions and so on. Geographical diversity adds complexity, but can be both an asset and a challenge for learning and innovation.

Figure 2. Raufoss and Kongsberg Industry Park.

In studying and understanding how industrial networks operate and how learnings systems are effectively constructed and developed, distance and proximity are important figures. The insights from the study is that the firm's and clusters' knowledge bases and linkages to innovation systems with companies, schools, universities and authorities are changing. New collaborations across different sectors and clusters will be crucial to succeed in preparing for a new industrial future.

What will happen when digitalization and the Industry 4.0 concept are increasingly making its way into the industrial clusters? Digitalization will change organizations, alter patterns of interaction between firms and other organizational entities, and change the demands for knowledge and competence. Research on this topic will contribute with novel insights on how firms are learning and co-creating in internal and external networks.

PhD progress reports

PhD candidates are essential resources within SFI Manufacturing. Marit, Vetle, Eirik and Henrik are connected to research area 3.

Marit Moe Bjørnbet (WP 3.3)

Hi, I am Marit and I started my PhD in August 2016. The main topic of my PhD is life cycle assessments (LCA) and how they can help facilitate the transition towards a green economy by focusing on circular thinking. My PhD is co-financed by the competence project SISVI - Sustainable Innovation and Shared Value Creation in Norwegian Industry (https://sisvi.no/)

I believe that life cycle assessments can be utilized to develop tools that integrates environmental management into core business activities, and thereby prepare the manufacturing industry for the green shift. This spring has been busy, with presentations, courses, seminars and workshops, but also with writing papers and abstracts for next autumn's conferences.

Right now, I am in the process of finalizing a life cycle assessment comparing different materials for one specific product for one of the partners of SFI Manufacturing. The rest of the spring will be used for literature review that hopefully will lead to my first journal paper.

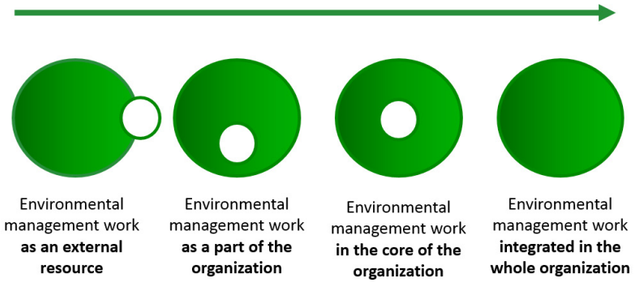

Figure 3. Towards green competitiveness.

Vetle Engesbak (WP 3.3)

I am Vetle and I started my PhD in April 2015. During my PhD I will focus on how organizations with mature production systems may better organize to capture the value from step-change improvements. My PhD is co-financed by the project Sprangvise (http://sprangforbedringer.bitballoon.com).

I will assess how Scandinavian industry should organize to be able to gain the most from explorative activities. I will look at questions such as: What characterises organizational learning in process industries? How should expert divisions (like R&D) collaborate with the line organization to support implementation of new technology? And how do rationalization efforts in the production process impact the organizations ability to innovate?

Eirik Bådsvik Hamre Korsen (WP 3.1)

My name is Eirik and I have a master degree from Norges Handelshøyskole and Queensland University of Technology in Australia. After 14 years working as a consultant, I joined NTNU in Gjøvik in 2013. I started my PhD in January this year.

During my PhD I will study how manufacturing companies align their performance management across the organization to linking the strategy to operation. Many organizations have systems for operations, accounting and quality, but what are their roles, how are they used and do they contribute to manage the organization?

By observations and assistance based research, I will analyse the different management systems in companies to understand how it supports the organizations design, the management processes, the use of information and the impact off different tools and techniques such as ERP and analytical systems.

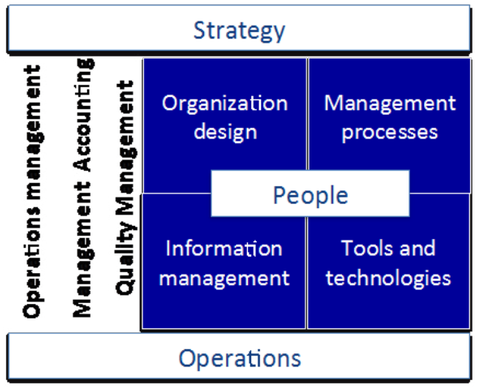

Figure 4. Are your performance management system and tools alligned and supporting your operations?

Henrik Brynthe Lund (WP 3.2)

My name is Henrik and I started my PhD in August 2016. During my PhD I will look at how the industrial clusters at Raufoss and Kongsberg plan to cope with the challenges posed by technological change. Furthermore, how do they work with actors on all levels, from local to global, to appropriate the knowledge needed in order to stay competitive and innovative?

I am currently working on an article on how skilled workers, meaning workers with a trade certificate, vocational training and education, and vocational colleges are important parts of the regional innovation systems of Kongsberg and Raufoss.

Vocational high schools and colleges are previously underresearched knowledge institutions in relation to innovation. Our research indicates that they are important elements in the overall competitiveness of the Norwegian manufacturing industry as they offer educational programs tailored to the knowledge needs that technological change entails.

Ongoing and new projects

In particular, four Knowledge-building Projects for Industry (KPI) and one Innovation Project for Industry (IPN) are important for research area 3. All these projects are described below. A description of the project V-ALU-E, which is a new project, is given as well.

KPI: Lean-Management

2015 - 2019. Partners: Benteler Aluminium Systems Norway, Kongsberg Automotive, Kongsberg Maritim, Nammo, Ernst & Young, NTNU, SINTEF Raufoss Manufacturing

The project's primary goal is to understand, model, verify and demonstrate lean management roles, responsibilities and practices at all organizational levels and across organizational boundaries, to develop knowledge in order to increase competitiveness in the Norwegian manufacturing industry.

The project has gained an in-depth understanding of what characterizes excellent lean management within the Scandinavian working life. It goes beyond the application of well-known tools in a relentless pursuit of learning and continuous improvement at the shop floor, and across the organization's wider value streams. This leads to a question we are currently working on: how to educate and train current and prospective managers so that they build the required competencies?

KPI: ManuNet 4.0 - Manufacturing Network 4.0

2015 - 2019. Partners: Pipelife Norge, Brunvoll, Ekornes, Kleven Verft, Norwegian Rooms, Ikuben, SINTEF

Global sourcing of production, increased international competition and financial crisis call for a new level of excellence in manufacturing. Knowledge-based innovation, cost reduction and creating company specific value chains and manufacturing networks with a global supplier base, are essential strategies to face these challenges.

ManuNet 4.0 aims to develop a knowledge base and methodology for the dynamic design of manufacturing networks, innovation and knowledge sharing, and next generation manufacturing operations, to achieve sustainable growth and competitiveness. The project concerns how networks are able to capture innovation and value in distant networking, and particularly how the configuration and design of global supply network will affect knowledge sharing and innovativeness in those networks.

The project will develop knowledge on the connection between location and innovativeness, as well as knowledge on how to assure effective knowledge exchange in a given network configuration. This involves an in-depth study of value co-creation in manufacturing networks, and research on how this can be improved.

KPI: SISVI - Sustainable Innovation and Shared Value Creation in Norwegian Industry

2014 - 2018. Partners: Hexagon Ragasco, Plasto, Raufoss Water & Gas, Wonderland, åkp, Forsvarsbygg, NTNU, SINTEF Raufoss Manufacturing

Based on the concept of sustainability, SISVI will support Norwegian industrial firms in developing their own unique competitive strategy with respect to internationalization, innovation and interactions in networks. The project emphesizes environmental and green aspects as drivers for innovation and value creation, and the development of sustainable business models is an important topic within the project.

KPI: Step-changes in Mature Production Systems

2014 - 2017. Partners: Hydro Aluminium, Trioving (Assa Abloy), Kongsberg Automotive, SWEREA, NTNU, SINTEF Raufoss Manufacturing

Scandinavian manufacturers constantly work to perfect their production systems. But as more and more organizations find that they are caught up with these practices, a new set of problems arises: Can we effectively innovate while standardizing our production? And how do we implement new technology? The project Step-changes in Mature Production Systems tries to answer these questions.

Throughout the project, several independent pieces of work have illuminated these topics. For example, structural factors likely to influence step-change success, such as internal mobility in the organization, contact points between departments, centralized roles that govern technology implementation and incentive systems. Further reading: http://sprangforbedringer.bitballoon.com

IPN: NAP - Zero-Defect Manufacturing for Autonomous Production Systems

2015 - 2019. Partners: GKN Aerospace Norway, Nammo, Benteler Aluminium Systems Norway, SINTEF, SINTEF Raufoss Manufacturing

The project NAP develops technology for zero-defect manufacturing within the field of automation and autonomy. Radical new production technology demands changes in the ways we are working. Competence changes, organizational changes and responsibility models will be developed in-line with the technological development, thus ensuring that the resulting pay-off from the project work is increased.

This project is a collaboration between researchers from RA3 and RA2, who are together with the companies working on developing team based, responsible and competent organizations for the future. Zero-defect manufacturing needs to be accompanied by a organizationally based zero-defect mindset.

KPI: V-ALU-E - Cross-Industry, Cross-Science Collaboration Strategies for Value Driven Aluminium Product Development

2017 - 2021

The primary goal of V-ALU-E is to develop new insights, models and capabilities for accelerated, value-driven innovation of aluminium products, tested and verified in a research environment that enhances collaboration between academia and industry, as well as industry sectors.

Besides developing knowledge on scrum-based product development methodology, cross-project learning in companies and co-creation between industry and academia, the project is expected to contribute to a series of aluminium product innovations and demonstrators in cooperation with aluminium users. The project team will be situated at NAPIC (NTNU Aluminium Product Innovation Centre), a transdisciplinary centre hosted by Department of Mechanical and Industrial Engineering.

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