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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 area Innovative and Sustainable Organizations.

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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. Research questions highlighted are: How could a manufacturing company be organized to develop the employees' competences in line with new technology? How to 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 in order to obtain long term sustainability?

Organizational aspects are essential for long-term development and success of competitive industries. Norwegian companies are in general recognized by highly competent and independent employees, factors considered as premises for advanced, innovative and sustainable manufacturing in high cost regions. In the coming 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. Manufacturers will need to deliver efficient and zero-defect production, accelerating on short term improvement actions, as well as more radical innovation. Organizational learning inside the companies and in interaction with other companies, schools and educational institutions, public bodies, research and academic institutes, locally, regionally and globally will become essential. To support the need of the manufacturing industry, this research area focuses on three main dimensions:

- Work and management systems: Identifying how extensive worker participation should be aligned with a systematic and cumulative approach to continuous improvement.
- Industrial clusters and learning systems: Co-creation of knowledge and innovation in industrial clusters are important for the innovation in each company.
- Innovation and product development: Exploring sustainable business development with regard to multi-materials and digitalisation.

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 work and management systems
- WP3.2 – Industrial cluster and learning systems
- WP3.3 – Innovation and product development

The research that will be presented during the upcoming workshop in Haugesund/Karmøy is described under the title 'Knowledge transfer in internal and external networks' and is aiming to reflect the organizational, managerial and learning elements related to innovations in WP3.1 and WP3.2.

Figure 1. RA3 workshop in Raufoss last year.

Knowledge transfer in internal and external networks

The creation and transfer of knowledge is pivotal for manufacturing companies' survival in environments characterized by rapid change and radical innovation. Companies should seek to identify, exploit and combine knowledge from their internal and external networks.

Knowledge transfer in internal networks

Companies learn to perform better through specialization. Individuals and departments focus on what they are good at, deepening their knowledge of specific processes and technologies. In large organizations, related specialist knowledge becomes dispersed across plants and geographic areas. R&D functions are set up to monitor and develop the technology of future operations.

When resolving complex operational problems or implementing new technologies, different bodies of theoretical and practical knowledge need to be brought together. Exactly whose knowledge is in demand may not be known in advance. The challenges for companies are to 'know what they know' and connect relevant expertise. The latter can be achieved through parallel organization structures, set up to facilitate knowledge exchange between different plants and between operations and R&D on a permanent basis. Hydro Aluminum's core team is an example of such a structure, which will be discussed during the upcoming SFI workshop.

Internal knowledge transfer was a research topic in the innovation project 'Step changes in mature production system' ending in 2017. You can read more about this project and its results in our online presentation: http://sprangforbedringer.bitballoon.com/

Knowledge transfer in external networks

Companies are also integrated in external networks. Some of these networks follow companies' supply chains, whereas others are within clusters. Knowledge development and learning processes are crucial for innovation and competitiveness. The concept of 'absorptive capacity' was originally defined as firms' ability to recognize the value of new information, to assimilate it, and to apply it to commercial ends. The organization should have some diversity and prior knowledge (e.g. some scientific, technical or practical expertise) related to the knowledge to be absorbed. Here we apply absorptive capacity at a cluster level, as something more than the sum of individual cluster firms' absorptive capacity. We pay attention to the role of knowledge brokers or intermediaries, which are organizations that operate as mediators between e.g. firms, universities and research institutes. These intermediaries function as an adhesive in a cluster, and binds the cluster to external knowledge sources and disseminate knowledge among cluster firms. We find this perspective productive as cluster firms are coping with disruptive technologies, in the face of a new technological revolution.

We analyse and compare two clusters' (Raufoss and Kongsberg) capacity to absorb and disseminate knowledge and prepare for technology upgrading among cluster firms. Currently, key firms and knowledge institutions in both clusters are adapting to a 'fourth industrial revolution' (Industry 4.0), by introducing advanced automation of manufacturing technologies, computerization and the introduction of novel combinations of materials. We evaluate recent strategies for upgrading technological capabilities and organizing for advanced technology platforms associated with Industry 4.0, with a particular focus on the role of intermediaries, and discuss implications for knowledge bases, for knowledge linkages within and external to the clusters.

Organization 4.0 (WP 3.1)

Automation and digitalization will increasingly challenge every company in terms of new needs connected to new competence areas and to having to make adjustments to the shop floor work systems. . Constantly, the manufacturing industry faces the challenging quest of automating more complex manufacturing processes. At the same time, the work connected to setting up, programming and controlling the manufacturing process work systems is becoming less complicated.

Work systems can be framed under the concepts 'team-based', 'lean production' or 'high-performance'. Contemporary work systems typically integrate those who perform direct work and improvement work, with 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. An example is the need for understanding systems that display fast amounts of data, acting on instant feedback systems, another example is 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, and it is available to everyone. Therefore, the ability to utilize the potential within the technology and productions systems is vital when aiming on strengthening a company's competitive advantage.

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. Furthermore, 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 lookat the clusters' 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.

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.

Figure 2. Raufoss and Kongsberg industry parks.

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 in Norway regarding 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. In additional, innovation in established manufacturing companies is more demanding than ever, with expectations of accelerated innovation (faster time to marked), use of complex sustainability multi-material products and advanced production technologies, resulting in an increasing number of requirements and demands to be fulfilled.

As the sum-up above indicates, finding a way to balance the demands in innovation and development will be important for successful manufacturing companies of the future. The organization of innovation and how development work is carried out, varies greatly among the industrial partners. Variations in strategies, organizations, approaches and tools have been mapped in the ongoing quantitative survey: SFI Manufacturing Maturity Mapping. One of the objectives of this maturity mapping is to map the companies' current situation and contribute to development of their innovation process to manufacture sustainable product solutions. Consequently, the results from each company will be followed up in the companies by reflection workshops discussing the results and develop ideas for the innovation processes, including the sustainability perspective.

The maturity mapping reveals that regarding to the companies' product and process development, the companies focus on both short-term improvements and strategic development projects, while there is less focus on ground research. In addition to these findings, the mapping also points at the challenge of increased complexity in product development of e.g. multi-material products, advanced production systems and sustainability. One of the conclusions drawn from the quantitative survey is that the development work is eased when the involved employees are working cooperatively. Today's product development often is a cooperative effort, with developers reaching out to colleagues, customers and suppliers collaborating to create a new product that meets the market demands. In the next coming months, the research results of the mapping will be further analyzed. Accordingly, we will organize follow-up workshops with the companies as well, and in 2019 a new survey will be distributed.

PhD progress reports

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

Eirik Bådsvik Hamre Korsen (WP 3.1)

I am Eirik and I started my PhD in January 2017. My research topics are alignment of performance management system across the organisation, and the link between strategy and operations. In organizations, we find numerous management tools and systems, such as Balanced Scorecard with KPI reporting, quality system with deviation reporting, budgets with financial reporting, and Lean with daily reporting of improvements initiatives. How well are these systems aligned and how do they together create value for the organization?

In 2017, I looked into how the management tools Balanced Scorecard and Hoshin Kanri together contribute to strategy implementation in collaboration with a SFI industrial partner. In 2018, I have started to explore how external audits for quality standards influence the organization's management system.

In the upcoming research, I seek to understand how management systems interact with the design of organizations, and their management and operational processes. I will also look at the how we define and use management information across the organization, and the impact of different ICT tools such as ERP and other reporting and analytical systems.

Henrik Brynthe Lund (WP 3.2)

My name is Henrik and I started my PhD in August 2016. During my PhD I will study how public and private actors collaborate, interact and engage in knowledge development and learning processes. The studies undertaken are focused on actors both within and outside the industrial clusters at Raufoss and Kongsberg.

One of my topics of research is vocational education institutions. Our research indicates that they are important elements of the regional innovation systems at Raufoss and Kongsberg. By offering educational programmes tailored to the knowledge needs posed by current technological upgrading, they contribute to the overall competitiveness of the manufacturing industry in these regions.

In the continuation of my thesis I will work on issues such as cluster absorptive capacity, i.e. how industrial clusters absorb, disseminate and utilize external knowledge. I will also study how local and regional capabilities in combination with new manufacturing technologies have enabled the reshoring of Norwegian manufacturing.

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/).

The past year I have focused on my literature review, investigating how application of life cycle thinking affects manufacturing companies' efforts towards sustainability. My first conference paper was also published in 2017, titled 'Improved Life Cycle Management by Product Communication'. The paper explores the potential use of sensor technology and product communication for the management of a product's life cycle environmental impacts.

My further work will focus on case work within manufacturing companies. I believe that life cycle assessments and other life cycle efforts can be utilized to develop tools that integrate environmental management into core business activities, and thereby prepare the manufacturing industry for the green shift, so in the next period, I will focus on this subject.

SISVI SUSTAINABLE INNOVATION AND SHARED VALUE CREATION IN NORWEGIAN INDUSTRY

NTNU SINTEF

Vetle Engesbak (WP 3.3)

Hi! I am Vetle and I started my PhD in April 2015. I explore how organizations with mature production systems may better organize to capture the value from step-change improvements. Industrial organizations need to continuously improve their production process in order to remain competitive. Improvements typically take the form of efficiency gains through cost reductions and increased production volumes. Local improvements from rationalization techniques such as Lean, TQM and Six Sigma are important, but organizations also need complex organizational learning from exploration activities in order to remain competitive.

In exploring how organizations may achieve this, I look at questions such as: What characterises organizational learning in process industries? How should expert divisions (for instance R&D) collaborate with the line organization to support implementation of new technology? Moreover, how does rationalizations efforts in the production process influence the organization's ability to innovate?

Ongoing projects

In particular, five Knowledge-building Projects for Industry (KPN) and two Innovation Projects for Industry (IPN) are important for research area 3. All these projects are described below.

KPN: 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?

KPN: 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.

KPN: 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 emphasizes 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.

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 together with the companies working on developing team based, are responsible and competent organizations for the future. Zero-defect manufacturing needs to be accompanied by a organizationally based zero-defect mindset.

IPN: SmartChain - Automation and Digitalization for Efficient Supply Chains

2017 - 2020. Partners: Kongsberg Maritime Subsea, Norautron, Oswo, Virinco, SINTEF Technology and Society, SINTEF Raufoss Manufacturing

Norwegian suppliers have had a significant competitiveness and growth potential related to knowledge-based production of highly advanced and innovative products with a high degree of customization. Over the years, we have positioned ourselves in the top of many premium market segments. However, when competition from low-cost competitors intensifies, can we also assert ourselves in the volume segments? The main goal of SmartChain is to develop methods and solutions that ensure efficient supply chains with a high degree of technology-enabled production, including planning and control.

KPN: V-ALU-E - Cross-Industry, Cross-Science Collaboration Strategies for Value Driven Aluminum 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 aluminum 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 aluminum product innovations and demonstrators in cooperation with aluminum users. The project team will be situated at NAPIC (NTNU Aluminum Product Innovation Centre), a transdisciplinary centre hosted by Department of Mechanical and Industrial Engineering.

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