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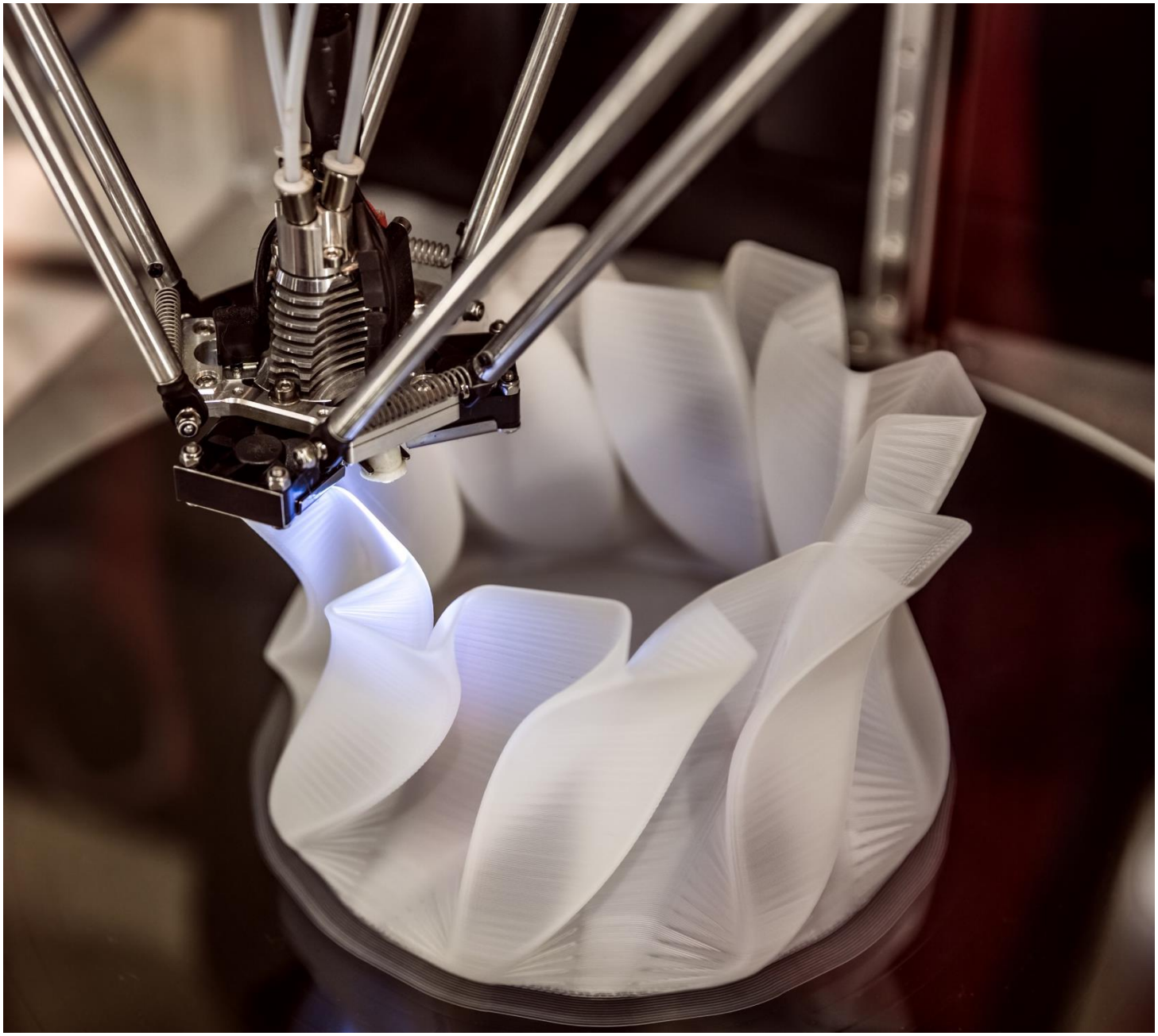
Ecosystems for Additive Manufacturing in Scandinavia

Study for the Interreg ÖKS pre-project ‘AM Nordic’



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Ecosystems for Additive Manufacturing in Scandinavia

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The Venn diagram is a stylistic representation of Oxford Research's efforts to combine competences in research, strategy and communication, to provide knowledge for a better society.

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1. Summary

The purpose of this study is to explore the potentials to strengthen ecosystems collaboration to promote the use of additive manufacturing (AM) in small and medium sized enterprises (SMEs) across Scandinavia. Danish AM Hub and Alfred Nobel Science Park have taken the initiative to conduct the analysis as part of the pre-project AM Nordic, financed by the Interreg Öresund-Kattegat-Skagerrak programme. The ambition of the pre-project is to develop the foundation for a cross-border cooperation project comprising more partners. The study has been carried out based on a combination of desk research and qualitative interviews with stakeholders of the national AM ecosystems. It provides insight into: 1) the organising of national/regional AM ecosystems of the Scandinavian countries, and 2) AM development issues in Scandinavia, concluding with recommendations for potentials to strengthen cross-border cooperation.

The study points to different positions of strength in materials use for AM, i.e. metals in Sweden and photopolymers in Denmark, and in the application of AM in different industries. In Denmark, the early adoption of AM technology took place in the hearing aid industry. In Norway, large players in the oil and gas industry were early to adopt, and in Sweden large industries, e.g. in the automotive industry were among the first to use to use the technology. Since then AM has spread to other niche industries such as aerospace and the defence industry in Norway, and especially in Denmark and Sweden to several large manufacturing companies. SMEs are increasingly adopting the technology in Denmark and Sweden, although according to interviewees it is happening slowly. There is also a development taking place in Norway, but the adoption of AM by Norwegian SMEs is still mainly at the stage of using AM for prototypes, and the general interest in the technology seems to be lower.

The AM ecosystems include public and private initiatives to promote AM in SMEs across Scandinavia, e.g. as part of R&D and innovation (RDI) programmes/initiatives that are focused on supporting the transition to Industry 4.0. In Denmark and Sweden, organisations and networks have been established to work specifically with the promotion of AM. The programmes and initiatives differ in their organisation, funding models, and scope, but there are some commonalities to be found. They can be categorised as follows: Industry 4.0 programmes/networks (DK, NO, SE), regional industry support organisations/networks (DK, NO, SE), research and technology organisations (DK, NO, SE), AM ecosystem hub (DK), AM interest/lobby association (SE), network to promote the AM research agenda (SE), and a joint venture, R&D company and large-scale 3D print facility (SE).

The review of the national ecosystems demonstrates that especially in Sweden, private industry has joined forces to push the AM agenda. The initiatives that have been established in Norway have been driven by publicly funded programmes. Denmark is found somewhere in the middle, where industry, e.g. represented through the Confederation of Danish Industry and the Danish Industry Foundation, has also been a key driver in establishing initiatives.

Key AM development issues and priorities with potentials for cross-border cooperation identified as part of the study include: changing mindsets and spreading awareness to SMEs, searching for new knowledge and partners to further innovate and develop strategies for AM, the link between AM and sustainable development, and finally, access to qualified labour.

Changing mindsets and spreading awareness to SMEs

A challenge across Scandinavia is that too few SMEs are exploiting the opportunities of AM. Consequently, there continues to be a need for changing mindsets and spreading awareness to SMEs. Initiatives are already being implemented by business support/network organisations across Scandinavia. A key learning point and identified need for companies to sufficiently consider the opportunities of AM is to introduce it not only to engineers and designers, but also to the management. This way there is a stronger focus on the business case and the link between AM and the overall strategic direction of the company. Organisations across the region host events and seminars focused on AM, which combine initiatives for promoting awareness through cases and contributing with knowledge on AM. SMEs that are not yet using AM or are at an early stage of development will often prefer to attend events and competence development activities locally.

Oxford Research recommends that cross-border cooperation focuses on sharing knowledge, experiences, and tools between business support organisations, e.g. including the catapult centres in Norway, the IUC – industrial development centres in Sweden, Centre for Industry in Denmark, and similar organisations. Business support/network organisations can develop stronger offers to SMEs by:

- Developing a mutual programme and/or a shared toolbox.
- Coordinating and sharing good practices in place today to promote awareness and competence development on AM in SMEs. For example, tools that are used in Denmark may be of use for organisations in Norway and Sweden: the opportunity to borrow a 3D printer combined with strategic advice (CFI in cooperation with Danish AM Hub) and a mentoring programme, where a less experienced SME is paired with a company that has more experience in the use of AM (Confederation of Danish Industry in cooperation with Danish AM Hub).
- Activities can be implemented in parallel by the organisations, or partly through shared events, where SMEs are invited to participate cross-border (e.g. to present good cases).

Access to knowledge and partners

The needs and challenges of SMEs and larger companies that have gained experience and are working strategically with AM in their production are generally centred on getting access to knowledge and partners. Development needs are often centred on materials use, and although depending on the company, the interest in materials use will vary, there is currently a mutual focus across Scandinavia on increasing the industrial use of AM in metals. Some companies express an interest in meeting with other companies that are working with similar materials to exchange experiences. A key point in this regard is that companies and other ecosystem actors see themselves as part of an international AM ecosystem. They are therefore also interested in sourcing knowledge from strong AM centres outside Scandinavia.

Oxford Research recommends that cross-border cooperation focuses on facilitating company innovation processes on AM in metals through peer-to-peer learning. This can be facilitated by business support/network organisations and research and technology organisations (RTOs). Importantly, it should focus on facilitating concrete change for the companies involved, and a cooperation project will be stronger from building links to the international AM ecosystem. The focus of cross-border cooperation can include the following:

- Matching companies cross-border where there is a win-win opportunity for the involved parties from sharing knowledge in their on-going innovation process. RTOs, Danish AM Hub, Alfred Nobel Science Park and others involved can help the companies identify one or two project partners. The companies can also benefit from the organising of study visits. This will take place between the companies that are matched, but in addition a project could kick-off with a study trip for the participating companies, e.g. to AMEXCI in Sweden to serve as inspiration and to set the framework for the coming cooperation.
- Consider involving partners and/or knowledge from leading international environments for industrial use of AM in metals. This can be done from the onset identifying partners, e.g. in Germany and/or the UK, aiming for a European rather than a Nordic project. It might also be part of a Nordic project, where partners (e.g. RTOs, business support/network organisations) establish links with leading test and demonstration facilities and/or companies abroad to organise study visits for the participating companies.

AM as a tool for sustainable development

AM is not a part of the sustainability strategy of most of the interviewed companies. However, they generally hope that it can be a side effect in the future. Sustainability opportunities linked to AM are centred on the topics of smarter production through utilising the unique opportunities of the technology, which offer the potential of only adding the material that is needed to realise different types of construction. It enables companies to produce more specialised on-demand products. It also allows for more local production, reducing the emissions from transport. Finally, there is a potential for AM to enhance the circularity of products, both by increasing the repair options and by reusing materials.

The policy agenda internationally and not least in the Scandinavian countries is increasingly focused on sustainability. The RTOs and business support/network organisations can play an important facilitating role in defining and promoting this agenda and creating awareness on the links between AM and sustainability. Oxford Research recommends that considerations are made for incorporating a focus on sustainability, e.g. in a cooperation project focusing on facilitating innovation processes for the industrial use of AM of metals.

Access to qualified labour

Access to qualified labour is a challenge, and a lacking focus on AM as part of engineering education programmes is highlighted as an issue across the region. In addition to engineering, the study has also pointed to the need for an understanding of AM in management and design.

Although education policy is a national matter, there may be potentials for better coordination on the development of AM in education programmes across the Scandinavian countries. Danish AM Hub will be commissioning a needs analysis for AM in education in Denmark. In the short term, Oxford Research recommends that Danish AM Hub shares the results of the needs analysis with other organisations such as SVEAT in Sweden that may be interested in following the results of the analysis and process of involving stakeholders in discussions on education needs. In the longer term, cooperation on AM in education can potentially become more structured between key stakeholders in the national ecosystems.

2. Introduction

Danish AM Hub and Alfred Nobel Science Park, with funding from the Interreg Öresund-Kattegat-Skagerrak programme, have taken the initiative to conduct an analysis as part of the pre-project, AM Nordic. The purpose of this study, carried out by Oxford Research, is to explore the potentials to strengthen ecosystems collaboration to promote the use of additive manufacturing (AM) in small and medium sized enterprises (SMEs) across Scandinavia. The ambition of the pre-project is to develop the foundation for a cross-border cooperation project comprising more partners.

AM and 3D print technologies are among the revolutionising technologies that are foreseen by experts to greatly impact the way in which manufacturing will develop in the future. AM involves the process of joining materials to make objects from 3D model data, usually layer upon layer, which is different from subtractive manufacturing methodologies. It is part of the umbrella concept 'Industry 4.0', which refers to the ongoing shift towards smart manufacturing through digital and technological solutions in robotics, automation, IT, and sensors. The technologies comprise virtual reality, augmented reality, artificial intelligence, simulation and advanced data analysis such as machine learning, big data and Internet of Things (IoT)[1].

The United States and Germany are global leaders in the use of AM technology, followed by South Korea, Italy and the United Kingdom. They all have strong industrial manufacturing traditions and have generally been at the forefront of developments in Industry 4.0. They have also initiated strategic national efforts to establish frameworks for the practical implementation of Industry 4.0, including new education and training programmes, addressing regulatory barriers, and developing incentives for companies to leverage AM and other digital technologies in their production processes[2]. The Scandinavian countries are not found among the global AM leaders. There is an increasing uptake of AM technology taking place by manufacturing companies, however there are concerns that it is happening too slowly, and that the AM ecosystem might be stronger if more integrated across the region.

The analysis is centred on generating:

1. Insight into the national/regional AM ecosystems of the Scandinavian countries. The focus is on, but not restricted to, the Interreg programme geography.
    a. What is the state-of-play of AM in the Scandinavian countries, e.g. are there specific positions of strength in the ecosystems?
    b. What are the similarities and differences of the public and private initiatives in place to promote the application of AM in SMEs?
2. Insight into AM development issues in Scandinavia.
    a. What are the potentials for cross-border cooperation?

[1] Blichfeldt, H. et al. (2019). Udbredelsen af 3D print og Additive Manufacturing i dansk industri. Syddansk Universitet.
[2] A.T. Kearney (2018). 3D Printing: ensuring manufacturing leadership in the 21st century: Public/private partnerships pave the way to become the next global design and manufacturing leader.

Data collection for the study has been based on desk research, drawing on existing studies and reports on AM in the Scandinavian countries, and 8-10 interviews in each of the countries with ecosystem representatives, including: industry associations, business development organisations, knowledge institutions, large companies and SMEs.

3. The Scandinavian AM ecosystems

This chapter first sheds light on the state-of-play of AM technology adoption in the manufacturing industries of Denmark, Sweden and Norway. This points to different positions of strength in materials use for AM, i.e. metals in Sweden and photopolymers in Denmark, and in the application of AM in different industries. Second, this chapter provides an overview of the public and private actors and initiatives of the AM ecosystems. Including an outline of the differences and similarities between the three countries. The AM ecosystems include public and private initiatives to promote AM in SMEs across Scandinavia, e.g. as part of R&D and innovation (RDI) programmes/initiatives that are focused on supporting the transition to Industry 4.0. In Denmark and Sweden, organisations and networks have been established to work specifically with the promotion of AM.

3.1 State-of-play

Scandinavia, and the rest of the Nordic region including Finland and Iceland, is a part of an international ecosystem. For example, leading 3D print companies are mainly based in the "global AM leader countries", such as the US, Germany and the UK. These companies often perceive the Nordic region as one market, i.e. the countries individually are considered too small as separate markets, and therefore resellers and 3D print service companies are in many cases Nordic set up with offices in each or several of the countries. One of these is PLM Group, which is a reseller of industry 3D printers in the Nordic and Baltic region. The company monitors the development in the market. Their most recent annual survey sent to customers and other manufacturing companies in their network in the Nordic-Baltic region included 187 responses from companies in different industries. It indicates some of the overall development trends in the region[3]:

- **3D printers are now used in many different manufacturing industries**. All verticals from automotive to healthcare are now using 3D printers.
- **There is an increase in the number of companies using 3D printers.** 81% of the manufacturing companies have at least one inhouse 3D printer. The number was 63% in 2018. 20% have their own 3D printer and they also buy as a service. It indicates the share of companies that rely on service bureaus to outsource part of their 3D print production. Regardless of printer ownership, 26% buy 3D printing as a service, which is up from 15% in 2018.
- **FDM and composite FDM is the most used technology**. Compared to 2018, FDM usage has increased, indicating that more companies are moving to 3D printing, as FDM is a typical entry-level technology. Composite printing has picked up from 11 percentage points to 31 percentage points.

[3] PLM Group (2019). The current state of 3D printing in Nordics and Baltics 2019.

- **There is a modest rise in the use of metal**, Multi Jet Fusion (MJF), as well as Multi jet and Polyjet technology. On the other hand, SLS and SLA, have seen a slight dip between 2018 and 2019. It is still early, but there are indications that the metal printing numbers follow a global trend.
- **3D printing is used across the product lifecycle**. Looking at global figures, 3D printed end-use parts is the fastest growing area, followed by production tools (jigs, fixtures and robotic grippers). Prototypes holds its ground and spare parts is still an untapped area, where more traction is expected in the future. In the Nordic-Baltic region all applications are seeing an upward trend. Concept verification has seen the highest increase with 15 percentage points from 2018 to 2019. Production tools and end-use parts grew 11 and 12 percentage points. Spare parts also grew 12 percentage points.
- **Basic plastic is the most widely used material**. 91% of the respondents are using the material, up 7 percentage points from last year. High performance plastics is at a stable 29 percent, same as in 2018. It is still a high number, as these materials are mainly used for production tools and end-use parts. Metal materials have decreased from 35 to 12 percent, which can be explained in several ways. Firstly, metal 3D printing is mainly used for end-use parts. Secondly, with the growth in high performance plastics, many uses these as an alternative to metal.

Overall, although only based on a sample of manufacturing companies, the PLM survey provides an indication of a continuously wider adoption of AM and 3D print technology across the Nordic-Baltic region. However, in the three Scandinavian countries there are differences to be observed in the stages of AM development.

In Denmark, large manufacturing companies, such as Danfoss, Grundfos and The LEGO Group, have made strategic investments in AM and aim to also use it in the manufacturing of end-products[4]. The hearing aid industry was early to use AM in end-products. This has facilitated the building of knowledge on photopolymers. Today, developments are underway in companies in the pharma and food industries. According to a study conducted by University of Southern Denmark in 2019, approximately 25% of Danish manufacturing companies now use AM technologies, mainly for prototypes and in production. Some SMEs have also been exploring the opportunities presented by AM technology, especially in relation to smaller batches of custom-made products[5].

In Norway, the use of AM is mainly taking place in niche industries, e.g. in the oil and gas industry by the large company Equinor. DNV GL Group has also been established in Norway as an international certification company. Few examples are found of companies that have developed centred on AM technology, Norsk Titanium delivers structural titanium parts to the international aerospace industry, and Fieldmade uses AM to develop both technology and services for the energy and defence sectors. There is also a development taking place around regional industry clusters on lightweight materials and automated production. However, today few SMEs in Norway are using AM for more than prototype development.

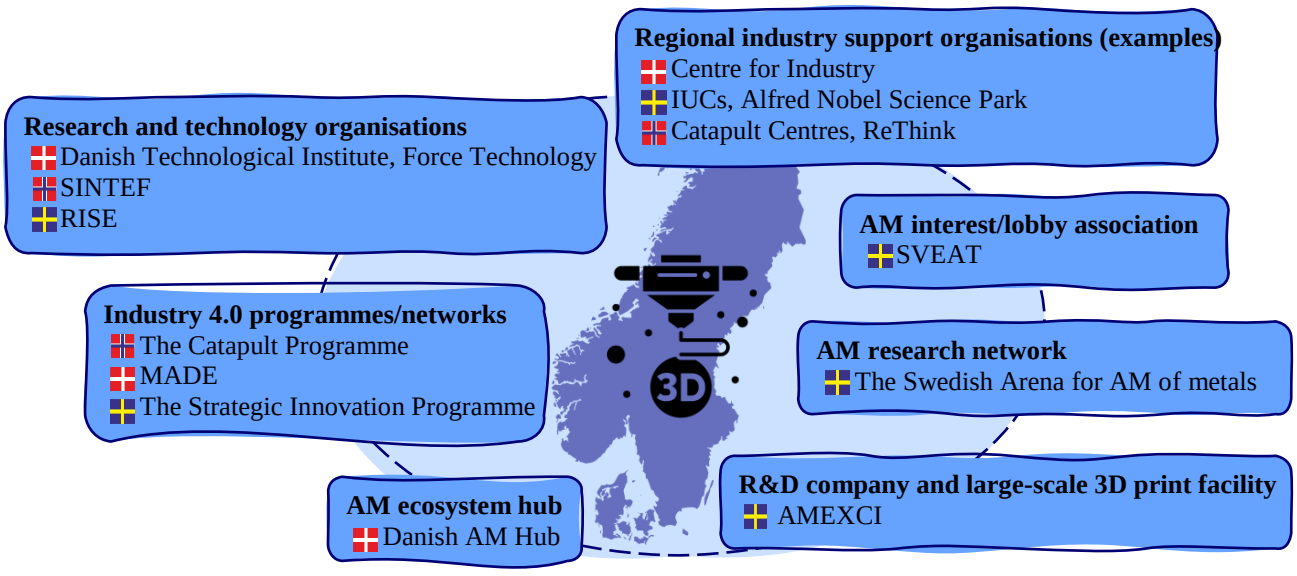
[4] Danish AM Hub (2020). AM Report 2020. https://am-hub.dk/rapport-2020/
[5] Blichfeldt, H. et al. (2019). Udbredelsen af 3D print og Additive Manufacturing i dansk industri. Syddansk Universitet.

Sweden, which is the Scandinavian country with the largest manufacturing industry, is also the country with the most advanced adoption of AM of metals. A study from 2019 on AM of metals, indicates that some of the most advanced users of AM that are also having an impact internationally include Siemens Industrial Turbomachinery in Finspång, which is a flagship for metal AM throughout Siemens, and GKN Aerospace and Sandvik, which both have small-scale production of components. Many other Swedish manufacturing companies print themselves on a small scale or with the help from 3D print service providers. A bottleneck here is that the AM market in Sweden is small and that service agencies are in competition with large established international players[6]. Although, Sweden is in some ways an industry leader in the adoption of AM in Scandinavia, the perception among key stakeholders is that also Sweden is lagging in a global perspective. This is further elaborated in the following section focused on public and private initiatives in place to promote AM.

3.2 Promoting the use of AM in SMEs

This section provides insight into main actors of the AM ecosystems with a focus on introducing the public and private initiatives in place to promote R&D activity as well as awareness and wider application of AM in SMEs in each of the Scandinavian countries. The review includes key national initiatives, but it does not comprise all stakeholders, e.g. regional business support organisations promoting the AM agenda in each country. It provides indications on similarities and differences across the region. Especially in Sweden, private industry has joined forces to push the AM agenda. The initiatives that have been established in Norway have been driven by publicly funded programmes. Denmark is found somewhere in the middle, where industry, e.g. represented through the Confederation of Danish Industry and the Danish Industry Foundation, has also been a key driver in establishing initiatives.

The programmes and initiatives in place differ in their organisation, funding models and scope, but there are some commonalities to be found. They can be categorised as follows:



[6] Strondl,A., Nilsson-Åhman, H. (2019). Omvärldsanalys på temat material och AM i Uppsala. Rapportnummer: MEF19118, SWERIM.

Industry 4.0 programmes/networks: In Norway and Sweden, national authorities have developed RDI programmes to address the future challenges of industries of strategic national importance. These programmes also include the opportunities for funding Industry 4.0 initiatives, which incorporate AM as one of the technologies. In Norway this involves the previous Norwegian Centres of Excellence (NCE) programme which has supported regional cluster initiatives and the Catapult Centres programme currently running. In Sweden, it is possible for clusters or consortia of industry and R&D actors to apply for funds from the Strategic Innovation Programmes. In Denmark, MADE is the national 4.0. initiative. It is not a programme, but a public private country-wide partnership conducting RDI activities and implementing strategic programmes, co-financed by national public funds.

Regional industry support organisations/networks: Examples of these include Centre for Industry in Denmark, the IUC – Industrial Development Centres in Sweden, and the Catapult Centres and ReThink in Norway (the organisations in Norway differ by being closer linked to R&D environments and offering test facilities). These organisations provide advisory services, information, and competence development to promote AM to manufacturing SMEs.

Research and technology organisations: Danish Technological Institute, Force Technology, SINTEF, and RISE operate in similar ways and are all involved in RDI activities to support the application of AM in companies. Furthermore, they have cooperated on European R&D projects, through which they have also established links to each other and to RTOs across Europe.

AM ecosystem hub: Danish AM Hub has been established to bring together the national ecosystem and to promote AM to manufacturing SMEs.

AM interest/lobby association: SVEAT has been established by industry and today also comprises members from knowledge institutions and universities.

Network to promote the AM research agenda: The Swedish Arena for AM of metals has been initiated by knowledge institutions but also comprise industry members.

R&D company and large-scale 3D print facility: AMEXCI is a unique entity in Scandinavia established entirely with the use of private funds.

3.2.1 Nordic AM Group

Some of the organisations that will be highlighted below in a presentation of the national AM ecosystems are part of the Nordic network, Nordic AM Group, which has been established with the overall ambition to promote and develop the knowledge, cooperation and openness of the Nordic AM ecosystem to attract international talent, investments and growth to the region.

Nordic AM Group has a role to play in creating a focus on the strengths of the Nordic region in AM, as well as to connect SMEs with knowledge institutions within and outside the region. Through a shared LinkedIn site and through sharing of information between the members of the network, the members promote their events to encourage participation cross-border and they share good practice cases.

Nordic AM Group was established in 2018. The initiative does not have funding to develop or promote activities, which in part explains why cooperation activities have so far been limited. This study, and the Interreg ØKS pre-project which it is a part of, can however help contribute to how the network or its members might expand cooperation. In addition to Danish AM Hub and Alfred Nobel Science Park, partners of Nordic AM Group include AMEXCI, Sandvik, Danish Technological Institute, and from Finland: Ideascout, VTT, 3D Step, and LUT University.

3.2.2 Denmark

In Denmark, key R&D environments include the Technical University of Denmark (DTU) and Aarhus University, and the research and technology organisations (RTOs) Danish Technological Institute (DTI) and Force Technology. These are the knowledge institutions that have the strongest focus on materials research and industrial application, including in metals. Some R&D activity in materials development is also taking place at Aalborg University. Furthermore, R&D with a focus on AM in supply chain and operations management and business models is conducted, mainly at University of Southern Denmark and Aalborg University[7].

The initiatives to promote the use of AM in Denmark have been driven from the side of industry, not least with the industry association, the Confederation of Danish Industry (DI) as an initiator and co-financier. Innovation Fund Denmark also contributes with substantial funds to the development of AM as part of Industry 4.0, e.g. co-financing activities within the framework of MADE. MADE, the Danish national innovation and research platform for the manufacturing industry, was established in 2014 as a response to the negative spiral observed by industry of the increasing relocation of production outside the country. The public-private partnership was established to promote the development of Industry 4.0 in Denmark. In 2018, Danish AM Hub was established with funding and on the initiative of the Danish Industry Foundation in order to specifically promote awareness on AM to Danish SMEs and to bring together the national ecosystem to further push the agenda. In addition to these network organisations, initiatives to promote AM in SMEs is mainly implemented by the RTOs and by regional network organisations, one of which is introduced below.

MADE - Manufacturing Academy of Denmark

MADE is the national innovation and research platform for the manufacturing industry. It was launched as an independent association in 2014 by Danish companies, universities, RTOs (DTI, Force Technology, the Alexandra Institute), various associations and public and private funds. MADE aims to facilitate the development of innovative manufacturing solutions in Danish industry, enabling Denmark to compete globally and create employment within Denmark. MADE is appointed the Danish Industry 4.0 initiative, and the organisation also leads the national innovation network for advanced manufacturing. AM is incorporated as part of the activities of Industry 4.0.

MADE coordinates two large, national research and innovation programmes, MADE SPIR and MADE Digital, which together comprise more than 100 R&D projects on, e.g. 3D printing, robotics, and digital supply chains. In projects, typically 10-15 companies work on “open book” R&D activities in cooperation with university researchers. In addition to the R&D activities, each year up to 15 innovation conferences are organised with participant numbers ranging between 70-130. The

[7] Oxford Research (2018). Additive manufacturing i Danmark: Kortlægning af AM-iværksætter- og uddannelsesmiljøet.

conferences are typically organised by the RTOs, and they are always organised on a specific theme. As part of the innovation conferences knowledge from the R&D projects is shared.

Danish AM Hub

Danish AM Hub was established on the initiative of the Danish Industry Foundation, which established the "core group" comprising industry representatives, knowledge and education institutions and the Danish Business Authority. After a series of meetings in the core group, a project plan for the period 2018-2021 was developed and Danish AM Hub was granted funding from the Danish Industry Foundation. The purpose of the organisation is to serve as a national hub, bringing together the AM ecosystem, and to promote the use of AM by more SMEs. The SME activities have a focus on AM in the development of new business models.

Core activities of Danish AM Hub include advisory and innovation activities and programmes, which are developed and implemented in cooperation with ecosystem partners. These are tailormade and offered to SMEs at different AM development stages. Danish AM Hub has a focus on communications activities to disseminate knowledge on AM and to bring together the national ecosystem. The annual AM Summit, which in both 2018 and 2019 have attracted more than 150 participants, is a key event. It brings together industry and expert speakers from Denmark and abroad, and it also hosts an exhibition where companies can showcase their products and meet potential clients and partners.

AM Line 4.0

DTI is leading the project AM-Line 4.0, which aims to ensure that Danish industrial companies receive the necessary knowledge to exploit the potential of 3D print production of metal items. A new demonstration and knowledge centre for industrial 3D printing in metals is being developed at DTI, and it will be open to SMEs at the end of the four-year project period (01/2018-12/2021). DTU, Danfoss, Grundfos and MADE - Manufacturing Academy of Denmark are among the partners of this initiative, which is co-financed by Innovation Fund Denmark.

AM Link

AM Link is a network initiative established and managed by FORCE Technology, which comprises public and private partners with specialist competences in AM and 3D print, including e.g. re-sellers and service providers. The purpose of the network is to solve any production issues related to AM for companies considering using 3D printing for their application manufacturing. The companies contact AM Link through FORCE Technology with their idea, and the RTO assesses the idea in cooperation with the company. In some cases, the conclusion is that AM is not a suitable solution. In cases where there is found to be potential, the relevant FORCE Technology project manager, that is specialized in material science or production technology, sets a job solving team that often include several network partners.

Centre for industry

Centre for Industry has been established to promote the development of industrial manufacturing companies. Based in Viborg in mid-Jutland it offers a startup and incubator environment, and the organisation also offers advisory support for manufacturing SMEs. In cooperation with Danish AM Hub, Centre for Industry offers the so-called 3DP tryout programme to SMEs that are interested but not yet working with AM. The participating companies can borrow a simple FDM printer free of charge for one month. Combined with advisory support from Centre for Industry this has been a

starting point for several SMEs that have continued after having the opportunity to try out the technology.

3.2.3 Norway

In Norway, the research and technology organisation (RTO) SINTEF, present across the country, has several divisions working with R&D in AM. The focus on AM was enforced in 2017 when funds were allocated to internal coordination where AM became one of five strategic initiatives in SINTEF. Today, the divisions that mainly work with AM include SINTEF Manufacturing focusing on polymer materials, SINTEF Industry focusing on metals, and SINTEF Digital focusing on interoperability. Other R&D environments focusing on AM include NTNU: Norwegian University of Science and Technology in Gjøvik and Trondheim, University of Agder, University of Stavanger, and the research institute Norce in Bergen. It is possible for companies to get access to industrial 3D printers on several locations in Norway, e.g. at SINTEF, NTNU, and the Norwegian Defence Research Establishment (FFI).

Some of the main initiatives to promote AM have been developed with support from the Norwegian Centre of Expertise's cluster development programme (NCE). The programme was established in cooperation between the state-owned business development organisation SIVA, the Norwegian Research Council, and Innovation Norway. The purpose of the programme was to promote the development of strong regional clusters in cooperation between industry, research and higher education, and public authorities. In 2006, six clusters were given the status of NCE and thereby co-financing for a period of 10 years. These included the NCE for lightweight materials and automated production (the Raufoss cluster) and the NCE for systems engineering (the Kongsberg cluster).

In 2017, SIVA, the Norwegian Research Council, and Innovation Norway introduced the Catapult Centre programme. This was done with inspiration from the UK where a similar programme has existed since 2010. The programme co-finances national centres that offers facilities, equipment, competences and network in business areas of relevance for the future of Norwegian industry. The catapult centres will make it easier for innovative small and medium-sized companies to develop prototypes, test and visualise for ideas to develop faster with less risk involved. Two catapult centres have been launched with relevance for the promotion of AM technology, Manufacturing Technology Norwegian Catapult Centre as part of NCE Raufoss and Future Materials as part of Mechatronics Innovation Lab. The catapult centres are used by the supporting partners for research and for business who have project ideas they want to test.

None of the initiatives in Norway are focused exclusively on promoting AM, rather AM is part of wider Industry 4.0 initiatives.

Manufacturing Technology Norwegian Catapult Centre – a part of NCE Raufoss

The Manufacturing Technology Norwegian Catapult Centre (MTNC) has been established to facilitate the NCE Raufoss cluster for lightweight materials and automated production based in the South-eastern part of Norway. The cluster has 17 companies and the established network of collaborating aluminium related companies named TotAl-gruppen as a partner. The main markets for the cluster companies are the global automotive industry, the defence markets and B2B electronics, and niches within water and gas distribution, gas tanks, aluminium profiles, mobility aids, etc. The cluster has

established cooperation with NTNU, which has led to the development of education programmes at bachelor and master's level.

One of the main pillars of NCE Raufoss is innovation through research and development. SINTEF Raufoss Manufacturing AS (owned by SINTEF, the industry, and SIVA) plays an essential part in this work. SINTEF Raufoss Manufacturing AS manages the MTNC, which offers advisory services and facilities in the form of seven "mini factories" to develop manufacturing technology. One of these factories is focused on additive manufacturing. MTNC offers companies premises, equipment such as onsite 3D printers, and competence for testing, simulate or visualise ideas. The purpose is to help companies, especially SMEs, to faster, cheaper and better be able to develop ideas from the concept stage to market introduction. They are mainly used for production of prototypes. SINTEF Raufoss Manufacturing also owns, together with other businesses located in Raufoss, the start-up company Nordic Additive Manufacturing (NAM). NAM is a local initiative that aims to establish AM on an industrial scale.

Future Materials Catapult Centre - a part of Mechatronics Innovation Lab

Mechatronics Innovation Lab AS (MIL) is a national centre for innovation, piloting and technology qualification in mechatronics and other related disciplines, including 3D printing. It is based in Grimstad in the southern part of Norway, in proximity to its main owners, the University of Agder and the research institute Norce that both focus on higher education and research in the field of mechatronics. Due to its status as a national centre, Mechatronics Innovation Lab has received substantial funding from the state budget to invest in test equipment, including 3D printers before it was given the status of catapult centre.

The catapult centre Future Materials focus on material development and is a national development and testing centre for materials. The centre is supported by locally connected business such as Arendal Fossekompani and Elkem, and research centres such as Norner and University of Agder. At the catapult centre companies can use the facilities to conduct small-scale pilot tests before introducing the technology and investing in 3D printing in their production. Future Materials have 3D-printers for polymers, nylon, composites and metals. The lab is mainly used for testing prototypes. Mechatronics Innovation Lab also offers advisory services where they visit companies and they offer competence development courses in using AM technologies and 3D printing. They also arrange workshops and seminars.

ReThink, Norwegian Advanced Design and Innovation Centre – a part of NCE Kongsberg

ReThink, Norwegian Advanced Design and Innovation Centre is based in Kongsberg in the Southeastern part of Norway. It is part of the NCE Kongsberg cluster with core competences in systems engineering. The cluster comprises several high-technology companies with global market positions in different industries, including aerospace and automotive. The focus of ReThink is to develop design tools for the Kongsberg cluster, but the ReThink centre also offers test and competence development for small and medium-sized companies with a focus on designing for AM and simulation-driven design. The focus is on design and process, and less on technology. ReThink does not have the same industrial 3D printing equipment available as is the case for the catapult centres.

3.2.4 Sweden

Across Sweden, 15 research environments are active in research and development on AM of metals[8]. In the ÖKS programme geography, Chalmers University of Technology, the Centre for additive manufacture – Metal (CAM2), and Lund University are examples of knowledge environments active in R&D in AM. RISE Research Institutes of Sweden, the network of research and technology organisations (RTOs), wholly or partly owned by the Swedish state, are also included in the list. RISE help companies of all sizes to take the step from concept to finished product and have expert knowledge on AM.

The development of initiatives to promote AM first gained momentum in 2014, when Umeå University coordinated the Swedish agenda for research and innovation in AM and 3D printing[9]. The process to develop the national agenda was funded by Vinnova – the Swedish Innovation Agency. Vinnova has since then been the coordinator of the research agenda through the Strategic Innovation Programmes. Vinnova, the Swedish Energy Agency and the Swedish research council Formas jointly finance a total of 17 strategic innovation programmes[10]. Businesses, academia and organisations join forces under the umbrella of these programmes to develop the sustainable products and services of the future in areas of strategic importance to Sweden. While none of the programmes are specifically focused on AM, it is embedded in some of the activities financed by the programmes, e.g. the Production2030 programme.

In Sweden, the industry and R&D environments have been key drivers behind initiatives to promote AM. Thus, the industry association SVEAT has been established specifically to push the agenda towards policy and industry. The network Swedish Arena for AM of metals has been established by R&D actors. Several large-scale industry-backed regional business support initiatives have also been launched. For example, AMEXCI which is a key initiative for test and demonstration in AM of metals, backed by private funds. 3DTC Group is another association started by five complementary companies working together to market AM opportunities, in collaboration with amongst others Alfred Nobel Science Park. Initiatives are also in place to support SMEs at early development stages, e.g. located at the IUC – Industrial Development Centres.

SVEAT - the industry association for Swedish additive manufacturing

One of the recommendations of the research and innovation agenda was to establish an industry association to promote AM. SVEAT was formed in 2014 by suppliers of machinery and services to increase awareness of AM. Today the organisation has around 40 members, mainly representing industry but also comprising knowledge institutions and universities. The purpose of SVEAT is to push prioritised issues and thereby represent the interests of AM for the members of the association in societal and policy debates. SVEAT also disseminates information and knowledge about the development of AM in Sweden and internationally.

[8] For detailed list and mapping of competences, see: Strondl, A., Nilsson-Åhman, H. (2019). Omvärldsanalys på temat material och AM i Uppsala. Rapportnummer: MEF19118, SWERIM. Pp.15-16.
[9] Vinnova (2014). Coming together to lead the way. https://www.vinnova.se/globalassets/mikrosajter/strategiska-innovationsprogram/agendor/additiv-tillverkning.pdf
[10] For a list of ongoing innovation programmes: https://www.vinnova.se/m/strategiska-innovationsprogram

Swedish Arena for Additive Manufacturing of Metals

The Swedish Arena for AM of metals was initiated by Chalmers, Högskolan Väst and Swerea (now Swerim and RISE) in 2016 and has about 30 members from both industry and academia. The first initiative of the network was to create a roadmap for research and innovation to industrialise AM of metals in Sweden[11]. It is managed by a board with the majority from industry and it has also attracted 11 universities that network around education and research.

AMEXCI

In 2017, Marcus Wallenberg took the initiative to bring together key industrial stakeholders with the purpose of establishing collaboration in order to speed up application of AM. AMEXCI AB, based in Karlskoga, is a joint venture, R&D company, founded by eleven large companies and with financial backing from Wallenberg funds[12]. The company manages R&D programmes, education programmes and provide large-scale 3D print facilities for its owners. The goal is to accelerate the industrial use of AM by raising awareness of the technology and supporting the companies and their customers in their journey to adopt AM and increase their competitive advantage. In addition to supporting its owners, AMEXCI hosts lectures and participates in public-private funded initiatives for SMEs in order to develop their products and people.

IUC – Industrial Development Centres

The IUCs comprise a network of regional industrial business development centres, which coordinate knowledge development, advisory services, and competence development to manufacturing SMEs. The centres are established as membership organisations and funded by public and private funds. The IUCs have also introduced initiatives to promote awareness and wider use of AM by SMEs. As an example, they give lectures and seminars to the members in order to explain how to use AM as an enabler for higher performance and sustainable future production.

4. AM development priorities and potentials for cross-border cooperation

This chapter places focus on the AM development issues and priorities, which have been derived from the interviews. Key AM development issues and priorities with potentials for cross-border cooperation identified as part of the study include: changing mindsets and spreading awareness to SMEs; searching for new knowledge and partners to further innovate and develop strategies for AM; the link between AM and sustainable development; and finally, access to qualified labour.

[11] https://www.swerim.se/en/collaboration/networks/swedish-arena-for-additive-manufacturing-of-metals
[12] https://www.wallenberg.org/en

4.1 Changing mindsets and spreading awareness to SMEs

Across the three countries, stakeholders highlight the challenge that too few SMEs are using AM or have considered the opportunities the technology has to offer. The main reason is that there is a lack of knowledge and awareness about AM. This has also been highlighted in a previous study, which indicates that reasons why many Danish companies still do not use AM technology is not because AM is not or could not be relevant to them, but rather that they lack knowledge, either about how the technology can support the business foundation, or fundamentally about what AM technologies can actually do today[13]. This calls for a potential role of business support organisations to spread awareness on AM to SMEs that have not yet considered the potentials of AM.

> *"There is a huge potential, but it is complex. Those who produce the products of today are raised in a different tradition. They do not necessarily have the knowledge about this technology. We need a sort of information campaign towards manufacturing industry to highlight the opportunities."*
>
> Emma Østerbø, Katapult Raufoss

Mainly in Denmark, actors from the business support system highlight that they made the mistake of creating a hype around what the technology was able to do too early in the technology maturity process and thereby raised unrealistic expectations. They therefore see that they have a role in "grounding" the technology and addressing both how individual SMEs might benefit from using AM and help them identify where it is not useful for them. This also involves who to include in discussions on AM potentials in the individual SME. The engineers are not the only relevant actors. Business support actors in Norway and Sweden, also highlight a need to focus on the business side, and that it is a challenge that engineers do not always possess the needed skills to develop the business case. As an example, one of the SMEs indicates that they would be interested in more targeted advisory support on how to develop a strategy for AM, which incorporates business strategy, technology and design thinking. It requires an investment for SMEs to introduce an AM strategy.

> *"What is important is to realise the opportunities of the AM technology for business purposes. I think that we made a mistake by starting out introducing AM to engineers, and not to the business strategists. We have a role to play in teaching the engineers how to develop a business case."*
>
> Henrik Larson, Centre for Industry

[13] Blichfeldt, H. et al. (2019). Udbredelsen af 3D print og Additive Manufacturing i dansk industri. Syddansk Universitet.

Large international manufacturing companies located in Scandinavia have made significant investments to introduce AM. Initially, these investments have to a high extent involved effort to implement a change in mindset and to introduce competence development initiatives to employees with a focus on developing new skills within engineering, design and organisational strategy. For most of the companies included in this study, change management within their own organisation is still a challenge to be addressed. Furthermore, large companies highlight that it is important that more SMEs start introducing AM to the Scandinavian manufacturing industries to remain internationally competitive.

> *"We keep the hype down and the interest up, focusing on what AM can and cannot do. We communicate what changes the company need to make. It is not the same structure and work procedures as with traditional manufacturing. It is a tough pill to swallow for many. Companies should not underestimate how much processes mean - people, competences and skills."*
>
> Ronen Hadar, The LEGO Group

It is common for SMEs to source knowledge themselves through online searches about how to use AM. However, a direct connection to utilise the opportunities in the business support system may facilitate a more targeted and successful introduction of the technology. In order to address the challenge of creating awareness and changing mindsets of SMEs on AM, potential actions, targeting not only engineers and production technologists, but also designers, and significantly the business strategists/management of SMEs, can be identified as:

- Information and knowledge, e.g. through the dissemination of cases that communicate easily accessible knowledge about the application of AM by other manufacturing SMEs. The sharing of experiences by SMEs that have gained experience and overcome barriers to introducing AM and the benefits it has created for them can impact and contribute to spreading awareness and pushing the adoption of AM.
- Competence development, e.g. through programmes that give SMEs the opportunity to receive tailored advice and develop their ideas for introducing AM.

4.1.1 Potentials for cross-border cooperation

Organisations across the region host events and seminars focused on AM, which combine initiatives for promoting awareness through cases and contributing with knowledge on AM. Part of the purpose of Nordic AM Group has been to share cases, e.g. through LinkedIn and to encourage cross-border participation in events. This is however only being implemented to a small extent today. SMEs that are not yet using AM or are at an early stage of development will often prefer to attend events and competence development activities locally. The opportunities for cross-border cooperation points towards sharing knowledge, experiences, and tools between business support organisations, e.g. including the catapult centres in Norway, the IUC – industrial development centres in Sweden, Centre for Industry in Denmark and similar organisations. Business support/network organisations can develop stronger offers to SMEs by:

- Developing a mutual programme and/or a shared toolbox.

- Coordinating and sharing good practices in place today to promote awareness and competence development on AM in SMEs. For example, tools that are used in Denmark may be of use for organisations in Norway and Sweden: the opportunity to borrow a 3D printer combined with strategic advice (CFI in cooperation with Danish AM Hub) and a mentoring programme, where a less experienced SME is paired with a company more experienced in the use of AM (Confederation of Danish Industry in cooperation with Danish AM Hub).
- Activities can be implemented in parallel by the organisations, or partly through shared events, where SMEs are invited to participate cross-border (e.g. to present good cases).

4.2 Access to knowledge and partners

This section focuses on the needs and challenges of manufacturing SMEs, as well as the larger companies that have gained experience and are working strategically with AM in their production. This is centred on challenges to source knowledge and find partners in Scandinavia and beyond. A key point in this regard is that companies and other ecosystem actors see themselves as part of an international AM ecosystem.

Except for a few suppliers in Sweden, the Scandinavian industry is dependent on industrial 3D print manufacturers based abroad. It is a challenge for companies that the 3D printers are sold in a closed system with a set of specific materials available. This also makes it more expensive and it can become a barrier for companies to invest in industrial 3D printers. In Norway and Denmark, it is highlighted that the number of companies that have invested in industrial metal 3D printers is very limited. Some of the universities, RTOs and the large-scale test facilities such as AMEXCI in Sweden have the equipment to experiment with and develop materials. Norwegian and Danish respondents highlight that the Swedish ecosystem is stronger in the application of metals in AM. Broadly polymer materials have reached high maturity levels, and efforts in R&D are today becoming more focused on metals also in Norway and Denmark.

Currently, based on the interviews conducted for this study, there is not much cooperation between manufacturing companies on AM in the Scandinavian countries. One of the reasons is that suppliers of materials and 3D printers are found outside Scandinavia. The large companies often develop direct relations with these companies rather than the resellers based in Scandinavia. Furthermore, the large companies and some of the SMEs that have a R&D focus and, e.g. are active in EU Horizon 2020 projects, have also developed cooperation with knowledge institutions with strong AM profiles, e.g. in Germany and the UK. Among industry and others in the ecosystems, ideas are raised of potentials to learn from each other especially on R&D in materials and to establish cooperation between AM centres/R&D environments across the countries. Some companies express an interest in meeting with other large companies that are working with similar materials to exchange experiences.

Although potentials are found for Nordic cooperation on AM to gain access to knowledge and partners, many stakeholders interviewed for this study highlight that it is more relevant to seek cooperation outside of the Nordic region in order to tap the potentials of the international AM ecosystem. Especially the UK and Germany are pointed out as countries of interest. However, it may hold potential for RTOs and/or business support actors in Scandinavia to join forces to build networks both inside and outside the region.

> *"We are good at printing in titanium. Other producers might be stronger in aluminum. There could be potentials to develop a close cooperation on manufacturing. I think that to make it happen SINTEF and similar organisations need to join forces and invite the industry."*
>
> Nils Elsrud, Tronrud Engineering AS

4.2.1 Potentials for cross-border cooperation

Companies that are already using AM but need further knowledge and inspiration in order to implement their plans are more likely to be interested in participating in cross-border cooperation projects, notably if they see a direct benefit for their company. The industrial use of metals AM is a development trend, which is a priority for industry across Scandinavia. From the side of Norway and Denmark, stakeholders point to Sweden as generally having the strongest knowledge environments, especially the test and demonstration facilities and the organising of cooperation between the companies at AMEXCI are highlighted. Cross-border cooperation can centre on the facilitation of company innovation processes on AM in metals through peer-to-peer learning. This can be facilitated by business support/network organisations and research and technology organisations (RTOs). The opportunities include:

- Matching companies cross-border where there is a win-win opportunity for the involved parties from sharing knowledge in their on-going innovation process. RTOs, Danish AM Hub, Alfred Nobel Science Park and others involved can help the companies identify one or two project partners. The companies can also benefit from the organising of study visits. This will take place between the companies that are matched, but in addition a project could kick-off with a study trip for the participating companies, e.g. to AMEXCI in Sweden to serve as inspiration and to set the framework for the coming cooperation.
- Involving partners and/or knowledge from leading international environments for industrial use of AM in metals. This can be done from the onset identifying partners, e.g. in Germany and/or the UK, aiming for a European rather than Nordic project. It might also be part of a Nordic project, where partners (e.g. RTOs, business support/network organisations) establish links with leading test and demonstration facilities and/or companies abroad to organise study visits for the participating companies.

4.3 AM as a tool for sustainable development

Additive Manufacturing has been predicted to give manufacturing industries a leap towards more sustainable production. As part of the study we have asked respondents how they see the link between AM and sustainable development. Despite general agreement on the potentials, the analysis points to some challenges in the AM technologies sustainability profile.

The potential for AM to provide a more sustainable way of production is largely based on three points:

1) Smarter production
2) Local production
3) Circularity of products

First, the AM technology with digital, printable designs allows the production to be smarter. AM has the potential of only adding the amount of material, that is needed, unlike carving and casting in traditional manufacturing. This has a sustainability potential of using less materials and creating lighter products. AM also gives the opportunity to realise different types of construction than with casting and carving. There is a potential to print shapes and structures into the product, that cannot be made with traditional production methods. These possibilities can be utilised to create a more energy efficient product or a stronger product, that lasts longer. Another advantage of AM is that it can be used for production of smaller batches of a product, which makes it profitable. AM does not require special carving tools or casts made for individual products, but print based on a digital design. Therefore, the start-up costs of a new product in AM will often be much smaller than in traditional production. This enables companies to produce more specialised on-demand products, instead of keeping stock of standardised products.

> *"An application I worked on weighs 7.5 kg in metal. We used 9 kg to produce it with 3D-printing. Traditionally, one would mill it out of 220 kg of metal."*
>
> Peter Tommy Nielsen, Force Technology

Second, AM has a potential to move production closer to the costumers. Rising wages has moved much production out of the Scandinavian countries. By printing the products closer to the demand, the emissions from transportation can be reduced.

Third, there is a potential for AM to enhance the circularity of products, both by increasing the repair options and by reusing materials. For example, quick on-demand printing of spare parts for tools, robotics, etc. can make it more cost-effective to repair these, than to buy new ones. New research works with recycling of the materials used for printing. Some challenges remain concerning a lack of recycling plants for different AM polymer and metal/waste dust. It has also been noted that there is a lack of research on work environment regarding production and handling of waste. However, if this potential is realised old products can be separated in different materials, the materials can be grinded and used as filaments for new products using AM. Common to these circular potentials is, that they are at an early development stage.

> *"Just being able to repair things, instead of scrapping an entire module. They can scan the defect part and its surroundings. From this a replacement part, possibly with improved performance, can be designed and produced, and the rest is perfectly fine, so it may have an extra life."*
>
> Tor Dokken, SINTEF Digital

Despite the above-mentioned benefits, AM is not broadly recognized as a sustainable production method in the short term. Several respondents from knowledge institutions point out that AM today is energy intensive, as both melting and cooling of products demands a lot of energy compared to other production methods. This energy use is often not outweighed by the positive impacts mentioned above. A sustainable integration of AM as the technology is now mostly seen when used for products that, as mentioned above, by their smarter design can decrease energy consumption in the lifespan of the printed product.

> *"Sustainability is a large part of our business because we supply packaging. It is hard to see the link between AM and sustainability right now. Our sustainability profile is driven by material consumption. I think there is potential, but we don't know yet."*
>
> Bastian Fietje, PlusPack

Additive manufacturing is not a part of the sustainability strategy amongst most of the interviewed companies. However, most of them hope that it can be a side effect in the future, and some larger companies are also making the link today. Internationally there is also a growing focus, e.g. with the establishing of the association AMGTA of which Danish AM Hub and AMEXCI are members.

4.3.1 Potentials for cross-border cooperation

The policy agenda internationally, and not least in the Scandinavian countries, is increasingly focused on sustainability. The RTOs and business support/network organisations can play an important, facilitating role in defining and promoting this agenda and creating awareness on the links between AM and sustainability. It can be relevant to consider incorporating a focus on sustainability, e.g. in a cooperation project focusing on facilitating innovation processes for the industrial use of AM of metals.

4.4 Access to qualified labour

Across the three countries, stakeholders highlight a lacking focus on AM as part of engineering education programmes as a key challenge. Access to qualified labour is a challenge especially for large companies that often cannot find the AM competences they need from national candidates and therefore recruit internationally, often from universities in the UK and Germany. To a high extent, it also links to the challenges of raising awareness and changing the mindset of manufacturing SMEs towards the potentials of AM. While some education programmes do integrate AM as part of the curriculum, and stakeholders in all three countries point out that there is a development taking place, some universities have still not updated their engineering education programmes and/or AM is only a minor focus. In addition to engineering, the study has also pointed to the need for an understanding of AM in management and design, which implies a need to include the Industry 4.0 and AM focus more strongly also in education programmes outside engineering.

> *"Education for AM is a challenge on a national level, understanding the role of AM as part of Industry 4.0 and the benefits that comes from AM when all the processes are digital. I'll assume that to this point there is just a few of the universities that promotes AM as an engineering major. There is also a lot of reskilling needed amongst company engineers."*
>
> Anna Sannö, Volvo CE

4.4.1 Potentials for cross-border cooperation

The Nordic region has a long-standing tradition for promoting both student and labour mobility. Although education policy is a national matter, there may be potentials for better coordination on the development of AM in education programmes across the Scandinavian countries. Danish AM Hub will be commissioning a needs analysis for AM in education in Denmark. In the short term, Danish AM Hub can share the results of the needs analysis with other organisations such as SVEAT in Sweden that may be interested in following the results of the analysis and process of involving stakeholders in discussions on education needs. In the longer term, cooperation on AM in education can potentially become more structured between key stakeholders in the national ecosystems.

5. List of interviewees

Denmark:

- Peter Tommy Nielsen, Force Technology
- Henrik Larson, Centre for Industry
- Nigel Edmondson, MADE
- David Bue, Technical University of Denmark
- Jacob Kjeldsen, Confederation of Danish Industry
- Werner Stapela, Danfoss
- Thorsten Brorson Otte, Grundfos
- Ronen Hadar, The LEGO Group
- Bastian Fietje, PlusPack
- Anders Johnsen, Carmo

Norway:

- Tor Dokken, SINTEF Digital
- Klas Boivie, SINTEF Manufacturing
- Erik Andreassen, SINTEF Industri
- Emma Østerbø, Katapult Raufoss
- Morten Kollerup, Mechatronics Innovation Lab
- Lars Lyshaug, ReThink Kongsberg
- Svein Hjelmtveit, Fieldmade
- Nils Elsrud, Tronrud Engineering AS
- Odd Terje Lium and Hilde Løken Larsen, Norsk Titanium

Sweden:

- Marcus Engqvist, IUC Syd
- Jan Andersson, IUC Sjuhärad
- Mats Falk, SVEAT
- Göran Backlund, SAAB
- Anna Sannö, Volvo CE
- Axel Månsson, Odigo Consulting

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