The Relationship Between the SPS-Conferences and the Six Industrial Challenge Areas Within Produktion2030

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The Relationship Between the SPS-Conferences and the Six Industrial Challenge Areas Within Produktion2030

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Abstract.

In this paper, the 206 papers published at the Swedish Production Symposium (SPS) conferences in 2018, 2020, and 2022 have been analyzed, primarily focusing their relationship to the six industrial challenges identified by Produktion2030. Based on the analysis, ten in-depth interviews with representatives from the Swedish Production Academy (SPA) and industry have been done. These interviews have reflected on the analysis of the papers from the SPS conferences as well as progress during the years of the SPS conferences.

The emergence and implementation of the SPS conferences have a similar time span as the Vinnova program Produktion2030. The analysed papers indicate that the focus and development directions of the two have been similar, but not completely overlapping. The close collaboration between academia and industry in Swedish production research is clearly shown by the papers and indicated through an alignment with the industrial challenges indicated by Produktion2030. Of all the papers, 2/3 clearly state such collaboration, and the interviews indicate that the extent of the collaboration is even more extensive than that. The findings from the analysis also include the distribution of research funders involved, gender distribution among authors, and where they are from.

Two findings that stand out are the need to more clearly state funding bodies for the published research and to also state more clearly in the papers how, in what way, and with whom the researchers collaborated.

Keywords. Industrial challenge areas, Produktion2030, SPS-conference

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1. Introduction

The relationship between papers published at the Swedish Production Symposium (SPS) conferences in 2018, 2020, and 2022 and Produktion2030's six challenge areas has been investigated and analyzed in a Vinnova-funded project, SPS/2030. Based on an analysis of the papers, those responsible for a majority of all SPS conferences, i.e. seven members of the Swedish Production Academy (SPA), have been interviewed, as well as three representatives from industry. The interviews have reflected on findings from the analysis of the papers as well as progress during the years of the SPS conferences.

1.1. The Swedish Production Academy

The Swedish Production Academy is a national network bringing together researchers at Swedish universities, driving and developing production research and higher education. The network also supports and facilitates cooperation between industrial and academic stakeholders in the production area, both in research and education. To achieve this, SPA collaborates with, among others, Vinnova and Produktion2030 to influence the direction of Swedish production research. In this work, the Swedish Production Symposium (i.e. the SPS conferences) organized by SPA, is an important part.

1.2. Challenge areas within Produktion2030

Produktion2030 has identified six long-term challenges for the Swedish manufacturing industry. Within Produktion2030, industry, academia, and research institutes work together to address these challenges, aiming for the Swedish manufacturing industry to be sustainable and competitive. These challenges have been identified and prioritized in collaboration and dialogue with a large number of actors from industry, academia, and research institutes. The six industrial challenges identified by Produktion2030 are:

1. **Resource-efficient production** - Industrial challenge: To minimise the resource consumption and environmental impact of production systems and products.
2. **Flexible production** - Industrial challenge: To further develop manufacturing processes to keep pace with the products of the future.
3. **Virtual production development** - Industrial challenge: To convert information and data into knowledge and input for decision-making in virtual and physical production systems.
4. **Humans in the production system** - Industrial challenge: To strengthen cooperation between humans and automation in order to enhance people's performance and increase productivity and flexibility.
5. **Circular production systems and maintenance** - Industrial challenge: To develop competence and service-based products.
6. **Integrated product and production development** - Industrial challenge: To strengthen product development processes and tools for innovative product development.

2. Analysis of papers in SPS2018, 2020 & 2022

SPA is the organizer of the SPS conferences. The SPS conference was arranged for the first time in 2007, with Johan Stahre at Chalmers as host. Initially, the conference was organized every year, but since 2012 it is an bi-annual conference. The conference usually has around 150 participants and is held in close cooperation with industrial partners.

In 2018, the SPS conference was held in Stockholm with Lihui Wang at KTH as host. The theme of the conference was Sustainable production. SPS2018 was arranged in parallel with the conference CIRP-CMS 2018, which meant that the arrangement was extra extensive with many international participants compared to previous years. Proceedings from SPS2018 were published by Elsevier in Procedia Manufacturing 25 [1] and included 80 papers. These two co-located conferences had separate proceedings and only papers belonging to SPS2018 have been included in this analysis.

In 2020, the SPS conference was held in Jönköping with Kristina Säfsten at Jönköping University as host. The theme of the conference was Knowledge-Intensive Product Realization in Co-operation for Future Sustainable Competitiveness. As this was in Corona times, the conference activities were all online. Proceedings from SPS2020 were published by IOS Press Ebooks in Advances in Transdisciplinary Engineering 13 [2] and included 57 papers.

In 2022, the tenth SPS conference was held. This time in Skövde with Amos Ng at the University of Skövde as host. The theme of the conference was Industry 5.0 Transformation – Towards a Sustainable, Human-Centric, and Resilient Production. Proceedings from SPS2022 were published by IOS Press Ebooks in Advances in Transdisciplinary Engineering 21 [3] and included 69 papers.

2.1. Cooperation with industry

During these three SPS conferences, a total of 206 papers were published. 62 of these papers listed co-authors from industry. In an additional 68 papers, it was stated, i.e. mentioned in "Acknowledgements" or clearly in running text, that cases at companies, experiments or similar were carried out in collaboration with companies. In the other 76 papers, collaboration was not stated clearly. In several of these 76 papers, it can be assumed that collaboration has taken place, but collaboration is not clearly indicated in the respective papers.

In the 62 papers with industrial-affiliated co-authors, a total of 30 different companies and organizations are represented. The five organizations having the most papers as co-authors are in descending order: RISE/Swerea, Scania, Volvo CE, Volvo Cars, and Träcentrum Nässjö. In the 76 articles where no clear industrial collaboration is indicated, a third are experiments done in a lab. A little less than a third of these papers are literature studies. The last third of these 76 papers describs development of algorithms, methods, and verifications. Included are also papers focusing on for example lifelong learning and future research studies. In several of these papers not clearly describing any industrial collaboration it is possible to assume, based on images and textual formulations, that some form of collaboration probably took place. However, since it is not clearly stated in the papers that this is the case, these have been sorted into "No clear collaboration".

2.2. Link to challenge areas within Produktion2030

The emergence and implementation of the SPS conferences have largely taken place in the same time span as the Vinnova program Produktion2030, which means that the current focus and development directions have been similar, but not completely overlapping. For each challenge area, Produktion2030 formulates an industrial challenge. During the analysis phase, it was assessed how clearly (in three stages - weak, medium, and strong) each article connects to the six formulated industry challenges **(Figure 1)**. A paper can have connections to several of the industrial challenges. The connections to the first five challenges are fairly evenly distributed in terms of the number of strong connections, but the sixth one stands out with a clearly lower number of connections. This deviation for the sixth area was one of two things that were frequently commented on in the interviews conducted in the project.

As shown in **Figure 1**, the total number of connections is few in comparison with the 206 papers included in the analysis. This is because 93 papers were considered not referring to the six industrial challenges. They were instead grouped into three additional areas. The first of these three areas was named: *Production technical details*. The 27 papers in this first area include for example research on cutting technology, and experiments with lasers and filaments for 3D printers. The second of these three additional areas was named: *Overall Concepts and Approaches*. The 45 papers referred to this area include leadership in production, general frameworks, and economic models. The third area, *Other*, gathered the remaining 21 papers including lifelong learning, national evaluations, identified future research areas, as well as papers with areas of application such as unloading ships and GPS control of drones.

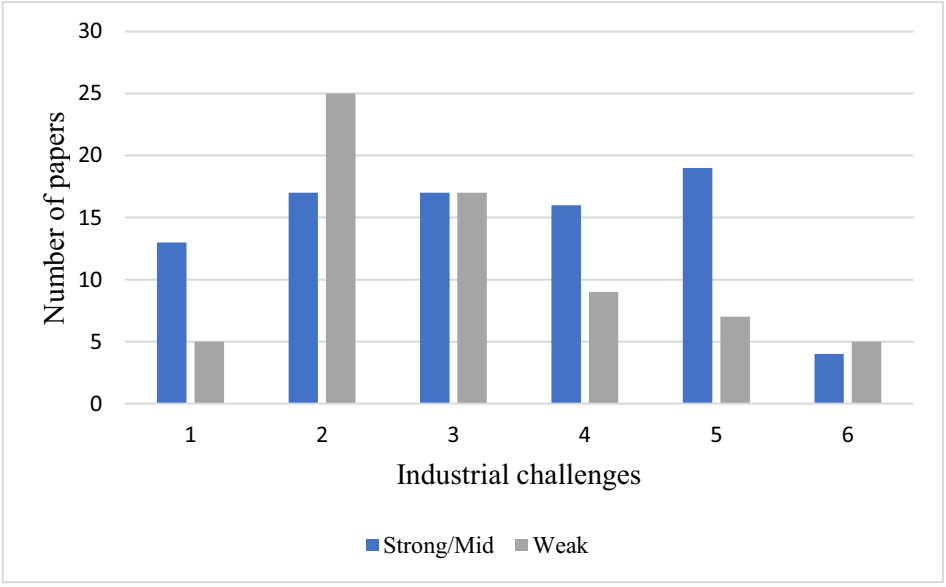

Figure 1. Number of papers from SPS2018, 2020 & 2022 related to the industrial challenges identified by Produktion2030

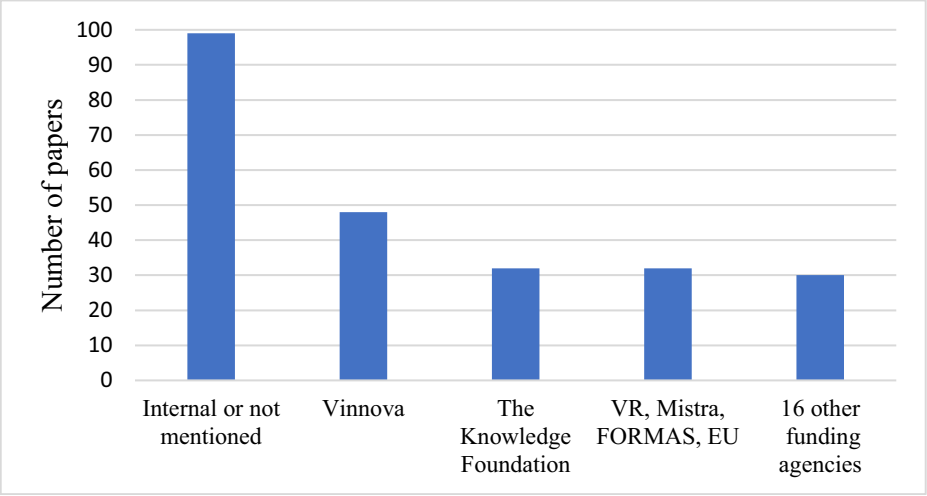

Figure 2. Indicated funding bodies for the analysed papers.

2.3. Research funding

Vinnova and the Knowledge Foundation are the two major external funding bodies of production research in Sweden and of papers presented at the three SPS conferences. Altogether, there are roughly twenty research funders acknowledged in the published papers. Despite this large number of stated research funders, in almost half of all 206 published papers (99 papers) no external funding is stated. Usually, nothing is mentioned at all about how the research described in the paper was funded or only internal funding is stated **(Figure 2)**. The fact that almost half of the papers do not indicate any external funding was in the top two of comments during the interviews following the analysis of the papers. As several funding bodies are stated in some papers, the total number of papers in **Figure 2** exceeds 206.

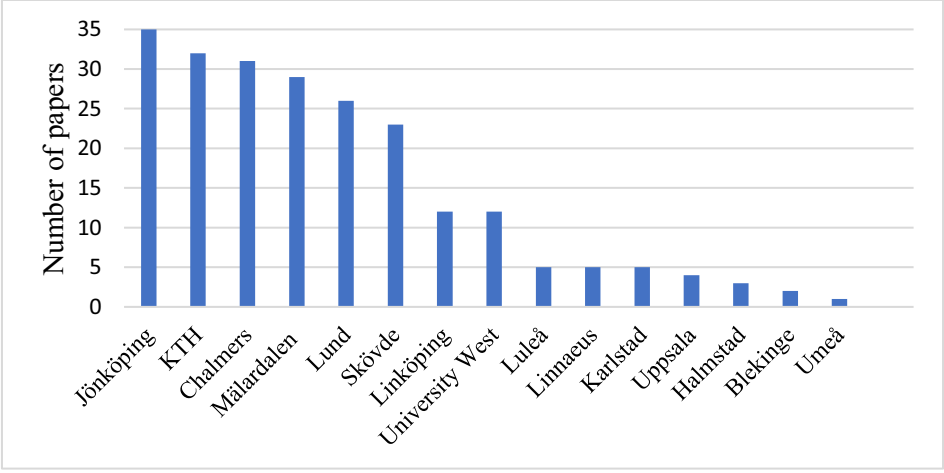

Figure 3. The number of papers with authors from Swedish universities.

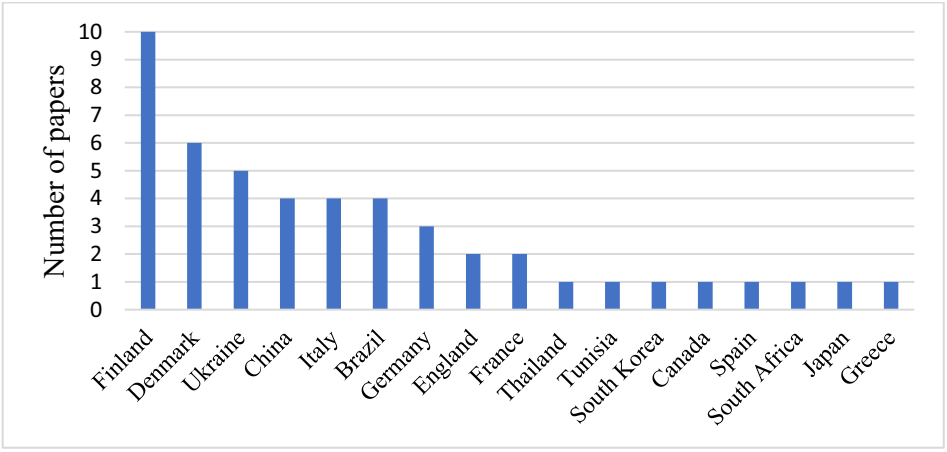

Figure 4. Authors at SPS2018, 2020 & 2022 from outside Sweden.

2.4. Who has published?

As previously mentioned, almost a third of the papers at SPS2018, 2020 & 2022 have co-authors from industry and external organizations, but the majority of the authors are based at Swedish universities. The six academies that account for most of the papers are Jönköping University, with the highest number of papers followed by KTH, Chalmers, Mälardalen University, Lund University, and the University of Skövde. In addition to these six, a further nine Swedish universities have authors at the three SPS conferences **(Figure 3)**. In total, 328 authors were included in the papers at the three analysed SPS conferences. The distribution between men and women at the three conferences is shown in Table 1.

The SPS conferences were founded as a national conference, but the number of international participants has gradually increased. During the three SPS conferences in 2018, 2020 & 2022, barely a quarter of the papers had co-authors from outside Sweden, and in total these represent 17 different countries (Figure 4).

Table 1. Gender distribution of authors at SPS2018, 2020 & 2022.

	Male	Female
SPS2018	99	19
SPS2020	54	21
SPS2022	99	35

3. Interviews

Following the analysis of the papers, seven interviews were done with professors from SPA, chair persons for 8 of the 10 SPS conferences. In addition, three people from industry with long experience of research collaboration have also been interviewed. When invited to these semi-structured interviews the analysis was presented as previously described in this paper. The quotes from the interviews are translated from Swedish and presented in italics in the following text.

3.1. Collaboration with industry

Regarding how industrial collaboration is indicated, the number of papers with no clear collaboration got much interest during the SPA interviews. A majority stated that the research on which the SPS papers are based is likely to have a higher degree of industrial collaboration than two-thirds.

"Most of the research we do is externally funded."

"Within our field, collaboration is necessary."

"I think there are more. The paper is based on collaboration with industry, that is behind it. "

A possible explanation that emerged during the interviews was that many PhD students publish at the conference and they may not have the whole picture of how the research they are part of is structured and funded. For example, it may be that an experiment done in the lab is based on research questions emerging from industry. It was also considered that it might not be relevant to state collaboration in specific cases. Most interviewees state that industrial research partners are in most cases involved in research, for production research it is usually a requirement to have industrial collaboration.

Of the interviewees from the industry, two out of three believed that there are probably higher numbers for collaboration than actually indicated. It may be that the PhD students fail to mention actual collaboration. One of them stated that in many cases it may be that you may have consulted your partners in industry during research but failed to address this in the paper or neglected the origin of the data used in the research. The industrial interviewees also address that when it comes to collaboration and publication with SMEs they often lack experience and momentum of scientific publications.

When asked how cooperation can be strengthened, one of the representatives of the industry believes that it is about continuity, building long-term relationships, and getting to know each other. It then becomes easier in the next step to shape projects, anchoring them at both parties. Another interviewee believed that there is a general problem in the application phase, often the industry is activated too late in the process having less or no chance to influence the focus of the application. Companies may want different focuses leading to late compromises, which in turn risks reducing both industrial and academic relevance of the application. The industrial interviewees also state that many SMEs lack experience of academic collaboration, a high threshold for even starting to collaborate.

3.2. Link to challenge areas within Produktion2030

Most of the SPA interviewees agree that the distribution of papers addressing the industrial challenges identified by Produktion2030 **(Figure 1)** is in accordance with how they would imagine the papers to be distributed. However, the interviews revolve more around area #6 compared to the other areas. Not everyone agrees, but several interviewees note that there has not been as much focus on product development at the SPS conferences in recent years. However, one of the interviewees thought that the interpretation of area #6 were very narrow and that several of the papers classified within the overall area should be referred to area #6.

"Those in product development publish elsewhere. They focus on product development from a production perspective, but they publish elsewhere."

"In the 6th... There is not much there. We are not organized in such a way in our universities that we can work with product development for high sustainability. I am not at all surprised."

"I think the result is reasonable. The 6th area may be more related to product design."

"It's a little surprising that there are so few in the 6th area."

When talking about the challenge areas, it was also emphasized that the additional area, *Overall Concepts and Approaches,* is an area in which SPA-interviewees were considering increasing their research and that this area is a prerequisite, not least, for challenge areas #1 and #2. Several of the interviewees also state that it is reasonable that there is not such clear connection between the challenge areas of Produktion2030 and the papers at the SPS conferences:

"It's not Produktion2030's conference"

3.3. Research funding

Regarding how the papers presented at the three SPS conferences were funded, most agree that the data behind Figure 2 does not tell the "truth", as most of the research has external funding. One explanation mentioned is that PhD students, and especially the new ones, may not always be aware that they receive external funding. Several also believe that it may be carelessness, or that the PhD student in question has not yet been linked to a specific project and funder. One of the interviewees from the industry points out, however, that it is not always so easy for the individual to know who is funding and that industrial PhD students are funded by the company.

"I think it is careless not to specify."

"It is partly due to carelessness and partly due to the fact that they are relatively new PhD students who may be using internal funding or have not yet been dedicated to a project. There is not that much money in the academic system."

"Perhaps you are a little off target with funders, sometimes there are several projects that contribute to the research."

3.4. Who has published?

Many of the interviewees, both from SPA and the industry, are positively surprised that so many companies and organizations are among the authors and express that these are good numbers. A general opinion is that companies often do not prioritize the time required to be a co-author. It is difficult to get them to participate in writing and often a tradition of publication does not exist in industry.

"These are good numbers. It is good for Sweden that industry and academia collaborate in this way"

"I would guess that there are actually more, it is common that companies do not want to be mentioned."

4. Other reflections from the interviews

During the interviews, reflections were also made beyond the analysis based on papers published at the three SPS conferences.

4.1. Collaboration

During the interviews, the representatives from the industry address what they see as good collaboration and the challenges of collaboration. They discuss the problem of finding and formulating jointly interesting research questions for a project. Success in jointly formulation research questions would lead to much more value for all participants in the project. Not least smaller companies generally need more knowledge about what it means for them to participate in a research project and what the company can gain. The interviewees also agree and express, like the representatives from SPA, that the collaboration must be based on long-term relationships that do not end just because the end of a specific project is reached. This is important not least to retain, implement, and use the results and knowledge from the project.

"For example, there can be 3-year projects that produce fantastic results that end up in the drawer. It should be a dissemination project/continuation project. It is perhaps something that Produktion2030 can look into so that results can be spread."

The interviewees also address a perceived problem that research projects sometimes have to include too many perspectives. As an example, it was given that there is not always a reasonable sustainability perspective in the research question or that there will be directives that wood should be used when concrete and insulation must be used. During the interviews, it is also highlighted that a good research idea has not received funding as there were no female professors in the field. An experience is expressed that the benefit of a project is not always weighed against the shortcomings of the above examples in terms of the many different perspectives.

4.2. Results presented in papers

During the analysis of the various publications, the results presented in the papers were catagorized. It turned out to be a difficult task as many of the papers did not have clearly described results. Several of the SPA interviewees stated that one of the main purposes of the SPS conferences is to allow the PhD students to enter the stage early during their time as PhD students. It was also emphasized that many of the PhD students publish initial results and that several publications have the character of "What to do in the future". There is also partly an image that the authors do not want to "burn" their material at the SPS conferences, instead they "save" it for scientific journals. Others believe that the most important purpose of the conference is to meet and build your network.

"It is primarily a way to test your wings. You get to be in a realistic situation without it being super important."

"We wanted to have a forum where PhD students don't feel like they're missing out. That they don't go home afterward and want to buy a rope…"

"Everyone is aware that it is a way to primarily meet and allow PhD students to enter the stage. They are not always ripe."

When asked what good results are for industry, one person stated that projects often are too ambitious when they are set, leading to too high expectations at companies. As a consequence expected results of the project not are reached. The interviewee thought it would be better to have more realistic goals and allow yourself to adjust them when reviewing the progress of the project.

"Now we don't solve all the world's problems, but this detail. Then I think the companies will be more satisfied."

One reflection stated that good research results are when project outcomes are comprehensible, concrete, and can be introduced into industry. Another good outcome stated were contacts and networks, also insights of gained new knowledge were seen as a sign of good results. Also, the importance of adjusting the project and its goals along the way was raised during interviews.

"A good result is if a company is satisfied with the research project's effort. But in general - that they gain greater knowledge."

"If you allow yourself to adjust the goals when you review the project halfway through and communicate that, I think the companies will be more satisfied."

4.3. Summary of the years with SPS conferences and Produktion2030

There was a consensus in all SPA interviews that the years with the SPS conferences have been important in several ways. The conferences are seen as an important arena for the PhD students, a meeting place, and an opportunity for professional feedback and collaboration.

> *"SPS is an important network. It was created to provide an arena for the PhD students, it is a meeting place. I hope it will continue."*

> *"This thing about providing an arena for younger researchers, it has worked well. "*

The SPS conferences are also seen as important for production research in Sweden in general. Also that Produktion2030 has provided stability, with long-term perspective and continuity in research funding.

> *"To have received support as a production researcher, it has been incredibly important!"*

> *"Long-termism and continuity have been important. In the past, we have not been able to predict, the long-time strategy has provided stability."*

> *"It's a small conference you look forward to."*

5. Conclusions

As indicated for both production research, as it is reflected in the papers at the SPS conferences, as well as for Produktion2030, is collaboration between academia and industry active and broad. This is indicated in the analysis of the papers, where 2/3 have a clearly stated collaboration. During the interviews, several of the members of SPA argue that this collaboration has probably been even more extensive than it appears from the analyzed papers.

The first SPS conference was held in 2007 as a national conference with occasional visiting authors from Norway and England. Since then, the conference has grown both in scope and distribution. At the SPS conferences in 2018, 2020 & 2022, in total 17 countries besides Sweden are represented among the authors, and barely a quarter of the papers have authors who are domiciled in a country other than Sweden.

During the analysis of the papers and the interviews, two things have emerged above other findings. These two are:

- The need to more clearly indicate funding bodies for the published research and also to,
- The need to state more clearly in papers how, in what way, and with whom the researchers have collaborated.

During the interviews with SPA, regarding upcoming SPS conferences, the need to emphasize the importance of including "Acknowledgments" in the papers has been clearly stated. This is to meet this lack of clarity regarding research funding and collaboration partners that emerged during the project.

It has been very interesting and rewarding to carry out this analysis and interviews. We have met several people who are deeply committed to Swedish production research and who are not only passionate about their own research but also about building a national environment with good conditions where new students, PhD students, lecturers, and professors can find interesting challenges, work, and research questions. Through the papers, we have taken part in a cross-section of Swedish production research and encountered great breadth and depth.

It has been very rewarding during the interviews to have the opportunity to listen to those who told about the development that production research has undergone in the last 25-30 years. In conclusion, we would like to give a quote from an interview with a person from SPA that vividly describes this development:

"We have had a fantastic time! Production technology has gone from the basement to the penthouse."

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