Global competitiveness of European surface technology. Part 2: challenges to and future development of the surface finishing sector

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ABSTRACT
Based on an analysis of the competitiveness of the European surface finishing industry, challenges are discussed and future directions for remaining competitive are recommended. The European surface finishing sector should prioritise advanced production technology for new high-tech and high added value products, and take advantage of disruptive changes in society and technology shifts where completely new areas of application of surface technology can arise. To be successful, surface finishers should meet expectations on price, quality, short lead time, innovation ability, complying with legislation, and brand equity. This should be accomplished by increased automation, closer cooperation within the value chain, and improved competence supply. Such a development is extra challenging for the many small-size sub-contractors in the sector. Basically, improved education and improved organisation between applied research, product development, production development and manufacturing are needed. Therefore, the need is strong for pan-European actions to coordinate and expand education on all levels. Higher competence leads to better reliability, quality, and cost-efficiency. Furthermore, the innovation capability will benefit from improved communication between the different actors in the value chain. Finally, coordinated actions are needed to market surface technology/finishing as an interesting and rewarding field in which to make a career. Europe has a strong tradition in surface finishing and the sector is characterised by a significant diversity. The right competence supply and organisation can make ‘cooperative diversity’ a European stronghold.

1. Introduction

This paper is the second and final part of an article based on a whitepaper report on the competitiveness of the European surface finishing industry prepared by the European Academy of Surface Technology (EAST) (Leisner et al.1). Part I (Leisner et al.2) presented an analysis of the competitiveness of the European manufacturing industry in general and the surface finishing sector in particular. In that it was emphasised that surface finishing is not a stand-alone industry, but an integrated part of the manufacturing chain for products, and that the surface finishing step follows the rest of the manufacturing if offshore. The drivers for outsourcing are changing, and increased automation is one of the parameters that makes offshoring less profitable. It was also concluded that the size of the European surface finishing sector approaches an annual turnover of US$ 114 Bn and 900 000 employees with an annual growth rate of 3.6%. Furthermore, surface finishing accounts for about 5% of all manufacturing of products with approximately 1/3 of the surface finishing done by sub-contractors and 2/3 in-house. The average size of European sub-contractors is small with the majority having less than 10 employees.

The aim of the present paper is to highlight the challenges the European surface finishing sector is facing, and to recommend future directions and actions for the sector to remain relevant and competitive.

The concept of this project came from a workshop on the topic held at the EAST 30 year anniversary meeting in Schwäbisch Gmünd, in October 2019.3

2. Challenges for the European surface finishing industry

Over several decades production has moved to low wage regions. The threat is that production continues to move away. In addition, European companies working in the field of surface technology are facing fundamental changes. Many applications especially in the traditionally strong industries such as automotive, mechanical, and electrical engineering are decreasing in volume or becoming obsolete due to technological changes. With less manufacturing in Europe, knowledge is lost and with this the innovation capability among practitioners and researchers will decrease over time. Knowledge loss, and transfer to others, leads to compromise of security of strategic industries like energy, military, and IT among others. To counteract this development three main actions can be emphasised:

1) Backshore production to Europe
2) Anticipate and avoid situations where existing European production is offshore
3) Develop new production in Europe

Even though we are experiencing a backshoring trend (Leisner et al.2), it is small compared to the amount of production that is offshore. It is probably

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not worth investing resources in an European strategy for backshoring surface finishing that is already established abroad and probably integrated with other production steps, and maybe even in proximity to the main market. Due to the ever-faster technology development, offshore production might often be considered as old and less attractive to bring back. In this sense, it is much more efficient to prioritise that production already established in Europe, stays in Europe. Finally, to have a long-term strong surface finishing sector in Europe, it is important to develop new production by being agile in adaptation of new technology and meeting new market demands. New products and new types of production driven by disruptive changes in society like Industry 4.0, AI, transition of the energy system (Paatsch et al., Nielsen et al., Melmen et al.), circular economy, regulations toward minimal environmental footprint and minimal consumption of strategic raw materials/ conflict minerals, and 100% traceability are all opportunities for Europe.

Table 1 lists the most important selling points and their connected challenges for the European surface finishing industry. In the best case the industry should be able to turn one or more of these selling points into unique selling points (USPs) to differentiate the industry from competitors. The selling points are discussed in the following.

| Selling point | Challenge |
|---------------|-----------|
| Price | Be cost-effective in global competition. |
| Quality | Do right first time. Maintain high yield in production. |
| Lead time | Efficiency in communication, implementation of production of new products, and correction of problems. |
| Innovation ability | The development is faster than ever. If the innovation rate is too slow, product development and production are overtaken by others. Lack of enough technically and scientifically knowledgeable staff at practitioner sites. |
| Meeting legislation | Production outside Europe is mostly not complying with European regulations. |
| Brand equity | Production in Europe. Ethical and environmental responsibility. |

2.2. Quality and lead time

Quality and lead time are closely connected since customers expect deliveries to be both right and fast. Figure 1 illustrates the cumulative loss/profit during the innovation process starting from research followed by product development. Thereafter, production development is needed to be able to launch the product on the market. During these steps, investments are growing progressively. Launching the product on the market indicates the initiation of the commercialisation step. To begin with, production costs will still exceed income from sales. If the product becomes a success, sales will exceed production costs and start reducing the cumulative loss. Finally, when the cumulative loss has been turned into a cumulative profit, the product becomes a business success. The curve representing the cumulative loss in the figure is also known as the ‘death valley’ of product commercialisation. Any unexpected cost or time delay will make the valley bigger and jeopardise the product becoming a business success. It is likely that a delayed product launch might result in shorter time on the market for the product. Therefore it is important to have continuous control over the quality of the innovation process from the very beginning. This demands close cooperation between the different functions involved during the process (R&D, product development, production development, production, customer relations, sub-contractors, etc.). The subject of continuous risk reduction in the innovation process on the way to commercialisation in relation to surface technology is discussed further by Leisner and Johansson (Leisner and Johansson). An additional challenge related to creating innovation based on research results is that it is not easy to get risk funding for research on highTRL (technology readiness level), and product and production development. This results in prolongation of the time until product launch.

A general trend in manufacturing is that product generations are becoming shorter with reduction in quantity of specific parts. Instead more variation in product families is developed, resulting in more frequent reconfiguration of the production facilities. Everything else being equal, it is more difficult to maintain quality and agility in a cross-border supply chain. Companies want to have less interfaces between the different parts of the production chain.

2.3. Innovation ability

Europe has a strong tradition in surface finishing, and it is essential to keep the knowledge base in Europe to have a strong innovation ability. At present, there is a pronounced lack of enough technically and scientifically knowledgeable staff at practitioner sites. With the estimated 900 000 persons employed within the field of surface finishing in Europe, the number of...
new employees entering the field annually covering all types of functions is counted in tens of thousands. No matter if the employees are operators, experts, managers, etc., they need proper education for their function in the field to perform efficiently with quality in cooperation with colleagues holding complementary functions. The education in the field is on a national basis and very dispersed. Only a few dedicated technician and engineering programmes exist. Otherwise, surface finishing related teaching is limited to individual courses and lectures in engineering programmes. Complementary to this, several of the national professional associations throughout Europe, e.g. the IMF in the UK, offer additional training for professionals. Nevertheless, the sum of people taught in the diverse programmes and courses in Europe is far from the tens of thousands needed. Instead, most new employees in the field have to complement their existing skills with internal training in the company. An additional issue is that many of these are employed in small SMEs or similar sized manufacturing companies where the opportunity for getting internal training is limited. This accentuates the question on what is the critical mass and competence of companies to meet challenges with respect to automation, new technology implementation, quality, compliance with more and more demanding legislation? Can some of these requirements be deemed non-competitive at company level, and thus, open up the possibility of shared expertise? It is in any case, essential to have close cooperation between product development, design, and manufacturing when products and manufacturing processes are complex. This makes the demand for competence supply and multidisciplinary cooperation and trust between partners in the value chain more important than ever. There is a strong need for pan-European actions to coordinate and expand education and training offered by schools, universities, and professional associations across Europe.

2.4. Legislation
Surface finishing plants in Europe must comply with many European, national, and local regulations. The basic purpose of the regulations is to improve the protection of human health and the environment, and harmonise the European market. It is becoming an increasingly complex process for surface finishers to understand and meet the demands of regulations, especially for SMEs that often cannot afford a specialised function for the purpose.

The European Chemicals Agency (ECHA) under the European Union is promoting a strategy for substitution of hazardous substances in European production. Unfortunately, the strategy does not suggest actions prohibiting import of products produced using the same hazardous substance in third countries (ZVO). This will result in unfair competition for European surface finishers that have to give up established process chemicals like chromate and cyanide and instead turn to more expensive processing and challenges concerning process stability. At the same time, the health and environmental problems are not solved, just relocated to third countries which most likely have less control than in Europe. Therefore, European regulations for production should be valid for all products sold in Europe, independent of where they have been produced. Otherwise regulations lose their legitimacy. In a situation with equal regulatory demands on production, experience in meeting REACh could conform as a possible niche advantage for European surface finishers.

2.5. Brand equity
It is becoming increasingly important for companies to show that in addition to attaining good financial results they are taking societal responsibility e.g. by publishing annual sustainability reports relating to the UN Sustainable Development Goals. The driving force in this matter could be within the company or coming from different groups of stakeholders, since it is risky for well-established brands to be connected to poor working conditions and environmental scandals as well, even when the
responsibility formally is on a subcontractor, for example.

3. The future development of European surface technology

European strength is cooperative diversity. Europe has a common ground in culture and legislation, but still with a tradition of diversity that stimulates creativity and mutual inspiration.

The diversity in processing throughout Europe as seen in Part I (Leisner et al.) can create added value by benefiting from specialist competence originating from regional unicity e.g. the Swiss watch industry (Figure 2).

For European companies it is more valuable to prioritise new high-tech and high added value products (high quality) and advanced (automated, digitalised, RMS) production technology than fighting to get ‘old’ high volume production back by backshoring. This will demand increased focus on specialisation, e.g. in nanotechnology, environmentally friendly technology, products with high degree of customisation, e.g. implants and just-in-time production of essential spare parts. The industry should be ready to take advantage of disruptive changes in society and technology shifts where completely new areas of application of surface technology can arise, e.g. 3D-printed components needing specially adapted surface treatment (Figure 3). This is particularly the case in the area of new and alternative energy systems. New coating processes can be used, for example, for the deposition of catalytic materials and protective layers for fuel cells or to produce three-dimensional electrode structures for applications in new battery systems by use of electroforming processes.

Another advantage of companies in the field of surface technologies is that they have special competence in the application of chemical processes and they are able to create completely new business in the field of the generation and storage of alternative energy such as hydrogen electrolysis or energy storage by means of redox-flow cells. These are just a few examples of the fact that, even during technological changes, new opportunities for a successful alignment of the company strategy can arise.

Furthermore, Mulone et al. propose a sustainable approach in development of electroplating processes (Figure 4) with the strategy to avoid critical raw materials (EU11) and substances of very high concern (ECHA12). Finally, the metals should be recyclable when used as coatings. Circular economic solutions could be a USP demanding competence and probably ‘support’ by tough EU legislation.

Education on all levels related to surface technology complemented by continued training programmes for professionals should be better coordinated to meet the needs in content and volume of the industry.

Overall competence and better theoretical understanding leads to better reliability, quality, and cost-efficiency. It becomes easier to communicate between the different actors in the value chain stimulating efficient technology transfer from academia to supply house and practitioner in industry and increase innovation support to speed up the innovation rate. An unexpected side effect of the ongoing pandemic could be that it becomes much easier to realise on-line education of high quality that can be given on demand and be accessible from anywhere in Europe. This type of joint European training will also generate cross-border connections and strengthen the European dimension of the surface finishing sector. Possibly,
European support actions, for example like the Marie Skłodowska-Curie programme could be used to catalyse such pan-European training and education. Nevertheless, offering educational programmes and industrial training does not automatically solve the problem. Students must be attracted to choose an education and career related to surface technology even though the field is less visible, since it is not a branch of industry with its own separate products like e.g. automotive. Coordinated actions are needed to market surface technology/finishing as an interesting and rewarding field with direct impact on daily life and essential for the future development of society. Its importance in impacting and adding value to the great majority of manufactured components and products needs to be emphasised again and again, with strong examples of the properties conveyed to substrates by surface finishing e.g. corrosion resistant, high conductivity coating on electronic components in aerospace stopping aircraft falling out of the sky, etc. In addition, surface finishing is thought soon to become, if not here already, a trillion-dollar industry globally\textsuperscript{13}, not the biggest, perhaps, but with a major influence everywhere.

To accomplish the suggested development of the European surface finishing sector there is a strong need for ensuring that the firms have critical size and access to the needed critical competence. Small firms need to grow bigger and smarter, and be able to invest in new technology, or it should be attained through acquisition/merging/alliances that result in critical mass and access to strategic competence. It should be noted here that many such sub-contract surface finishing firms are owner managed, and issues of control are likely to be important. Perhaps this can be resolved in developing closer supply chain management relationships/partnerships, as with the older established Japanese style Keiretsu partnerships in which the larger technologically stronger firm (often the customer) takes on a responsibility to aid its suppliers in e.g. adoption of new technology of mutual benefit to both, shared information technology and databases (Ellram and Cooper\textsuperscript{14}; Lee et al.\textsuperscript{15}; Birasnav and Bienstock\textsuperscript{16}).

A stronger common communication about surface technology as an enabling technology with proven high added value together with stronger cooperation/alliances in the value chain should pave the way for easier access to capital for investments in product development and new production technology.
From a pan-European point of view, relocation of production within Europe, most often from the West to the East, is a natural part of the European ideal of free movement of people, goods, and services. It could add stimulation to the development of low-wage regions in Europe, which in the long run should be beneficial for Europe in general. However, the existing structure of many very small sized sub-contractors with the need of competence development to cope with future demands and lacking in resources to invest in new production technology, could hinder the evolution toward a more balanced and competitive intra-European structure of surface finishing providers. Bachtler et al.\(^{17}\) recommend spreading innovations throughout the European economy to avoid spatial gaps in competence, cost-efficiency, and capacity in entrepreneurship.

4. Summary

European surface finishing is not a stand-alone industry, but an integrated part of the manufacturing chain for products, which is challenged by global competition.

It is recommended that the European surface finishing sector prioritises advanced production technology for new high-tech and high added value products, and takes advantage of disruptive changes in society and technology shifts where completely new areas of application of surface technology can arise.

To be successful, surface finishers should meet expectations to the following selling points: Price, quality, short lead time, innovation ability, legislation compliance, and brand equity. This is challenging, especially for the many small-sized sub-contractors in the field, and should be obtained by increased automation, close cooperation between all functions and partners in the value chain, and secured and improved competence supply for all functions involved.

Basically, the solution can be described as improved education and improved organisation between applied research, product development, production development and manufacturing. Each year, tens of thousands of new employees are entering the surface finishing sector to cover many different functions, but the present education and training programmes do not offer the needed capacity. There is a strong need for pan-European actions to coordinate and expand education and training offered by schools, universities, and professional associations across Europe.

Students must be attracted to choose an education and career related to surface technology even though the field is less visible, since it is not a branch of industry with its own separate products. Coordinated actions are needed to market surface technology/finishing as an interesting field with direct impact on daily life and essential for the future development of society.

Europe has a strong tradition in surface finishing and the sector is characterised by a significant diversity (specialisation). The right competence supply and organisation can make ‘cooperative diversity’ a European stronghold.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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