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SHARING IS CARING – FOR A DIGITAL FUTURE

Digital and sustainable transformation is essential for coatings companies in the new economy, but lies outside their comfort zone. Joining forces is a promising approach. By Dr Wolfram Keller, Wolfram Keller Professional Services, Dr Ulf Stalmach and Ralph Jan Wörheide, Orontec.

Society and industry, including the chemical and coatings industry, are experiencing major challenges, especially those of digitalisation and sustainability. Few small- or medium-size coatings enterprises (SMEs) have so far embraced sustainable digitalisation or digital sustainability [1]. They often lack the skills, experience and resources of large chemical companies that started doing so in the mid-2010s.

However, other industries are proceeding much quicker and are at a more advanced stage than the chemicals industry, of which the coatings industry is a part. The pioneers of digitalisation in Germany are the Information and communication technology (ICT) and automotive industries. Over the last three years, their digitalisation index [2] has consistently ranked far higher than that of the chemicals and coatings industries.

This implies that a great opportunity for the digitalisation approach adopted by coatings manufacturers awaits if they partner with companies that possess strengths in this area. Knowledge silos and a lack of willingness to collaborate are major hurdles to digitalisation in many coatings companies. Up to now, the mantra ("Holy Grail") has been the tacit knowledge of paint technicians and chemists, often acquired over decades, as well as top-secret formulations. Cautious protection of know-how, time-consuming, labour- and cost-intensive processes, and a reluctance to introduce technologies proven in other industries lead to operational inefficiencies. Both the chemicals and the coatings industries are classic manufacturing and processing industries, that represent the product-centric "old economy".

"NEW ECONOMY" AND DIGITALISATION EVOLVING RAPIDLY SINCE THE 1990S

One difference between the "new economy" and its predecessor is the shift in value creation. The production and sale of physical products are increasingly being replaced by virtually produced and applied products and services. Another difference is their clock speed [3], which is the speed at which a company can adjust to changes and is determined by the intensity of competition and the speed of development of key technologies, e.g. digitalisation.

The evolution of ICT, as measured by total data volume per year, is dramatic. The volume of worldwide data is doubling approx. every

RESULTS AT A GLANCE

➞ Coatings companies need to update their successful, yet dated, product-centric, "old economy" business models in light of the increasingly data-based "new and circular economy".

➞ However, coatings companies are lagging far behind when it comes to digitalisation.

➞ The development or acquisition of digital and sustainable solutions along the entire coatings value chain requires access to digital resources and competences that are currently lacking.

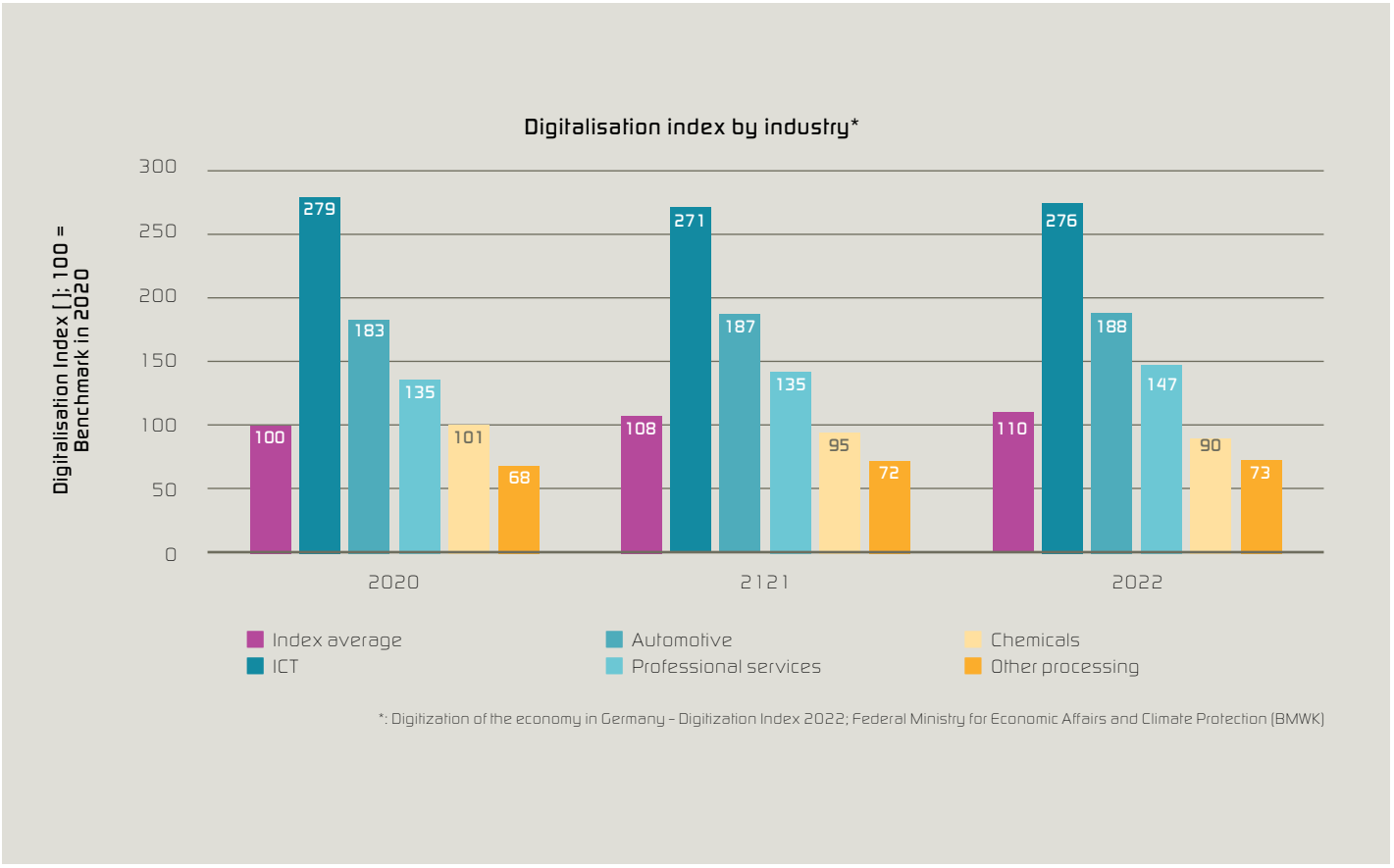
➞ A current lack of willingness to collaborate and a reluctance to share data need to be overcome, e. g. by joining a secure network of experts.

2 years. The zettabyte (1021 bytes) era began around 2010, reached 80 ZB by 2020, and is expected to be approx. 175 ZB by 2025 [4]. The annual data volume will be measured in yottabytes (1024 bytes), if not in brontobytes (1027 bytes), as early as 2030.
The cycles in the coatings industry are several times longer than those in the ICT industry. The greater and faster the progress being made in automation and digitalisation, the wider the gap is growing between companies in the "old economy" and those companies in the "new economy" that deploy digital, data-driven, and data-centric business models. Coatings manufacturers' product-centric business models were the method of choice in the "old economy". The massive growth in data and an increased need to share it with suppliers, customers, and the periphery will facilitate faster and economically superior product development and delivery.

DIGITALISATION IS A BIG CHALLENGE, BUT OFFERS SOLUTIONS, TOO

All industries, including coatings and its periphery, are currently contending with various challenges, e.g. raw materials shortages, the Green Deal, new supply chain transparency law, and a shortage of skilled labour. Solutions will change coatings companies' value chains and ecosystems in several ways. Product development, sourcing, formulation, application, and recycling will become much more trackable, traceable, and transparent. There is no way to stay sustainably competitive without appropriate automation and digitalisation in place.
On top of that, transparency and reporting requirements regarding supply chain, carbon footprint, and product safety are increasing, and skilled resources, e.g. lab technicians, data analysts and scientists, are

Figure 1: Position of the "chemicals industry" and "other processing industry", incl. coatings producers, relative to leaders in digitalisation between 2020 and 2022.



scarce. A single company is unlikely to master all these challenges on its own in good time. A valid option is to join forces. By sharing data, paint companies can establish continuous loops of information on products, services, and applications from the entire value chain. This is necessary for enabling advanced machine learning, models, and simulations.

The concept of the smart paint factory focuses on data integration within and among companies. Stakeholders must be open to exchanging information and must organize fast and integrated data communications along the value chain.

Individual coatings companies cannot accomplish this alone. The number and intensity of collaborations with partners whose competences and resources complement those of the paint manufacturers will increase sharply. As a means of controlling the resulting flood of information and creating additional value, a smart paint factory is an attractive option, but it presupposes two things.

Firstly, companies must overcome their data mania. Today, internal, cross-functional sharing of data and information is a huge problem in many paint companies. The problem becomes visible when expert paint technicians or chemists retire and their tacit, unrecorded knowledge is lost with them. Cross-company exchange of data with suppliers and customers is today unfortunately hardly an option. Too much emphasis is placed on know-how as a unique selling point and maintaining person-dependent knowledge despite the availability of secure IT systems. Use of artificial intelligence (AI) is an attractive proposition, but its deep learning models need a high volume of reliable data. Very often, this critical amount of data cannot be collected by one company only.

Secondly, coatings companies must be willing to expand their mainly product-centric business model with key elements of digital business models [6]. New-economy companies' business depends heavily on applied information and communications technologies for value creation or revenue generation [5]. In data-driven business models, data is collected, structured, and analysed to serve as a basis for any kind of business decision, e.g. for optimisation of processes, new offerings, or strategic options. Data-centric business models define how new/different types of data can support the business and create new, primarily digital offerings. The benefits of data-centric business models outweigh those of the other business models, but such models are not applicable to coatings companies, which have a strong emphasis on physical products.

Each company must find its own hybrid business model, depending on how strong its physical core business, paints and coated surfaces shall remain and how much it shall be supported by automation and digitalisation. For e.g. the more a coatings company continues to deal with "haptic" or "pysical" products, the less business model modifications towards data-driven are required. The more "data-based", "IT-enabled" services will become part of the own vaklue chain, the more data-driven the business model will have to be. Each company will have to find its own, individual "balance".

WHAT WILL CHANGE IN THE SMART PAINT FACTORY?

Today, raw materials and paint-makers develop formulations based on their toolbox of well-known raw materials. These products are dedicated to one or two market segments and applications only. Customers then check whether the products fit the requirements. Especially in the case of global formulations, the products are often manufactured centrally for distribution all over the world. This configuration stems from the fact that raw materials are not usually available in the same quality across regions and the quality of products sourced from different production sites is often not identical.

Tomorrow, a customer will provide requirements profiles instead of product specifications only, thereby placing the emphasis on the desired coated surface effect. This requires a better understanding of the parameters of the application process, characteristics of the

Figure 2: Evolution of annual data volume as an indicator of the clock speed of the ICT industry and driver of digital, data-driven, and data-centric business models.

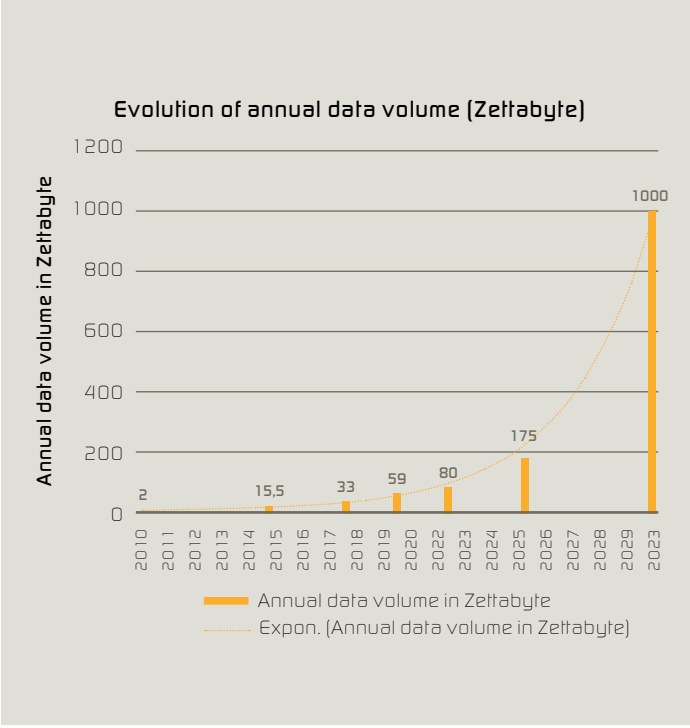
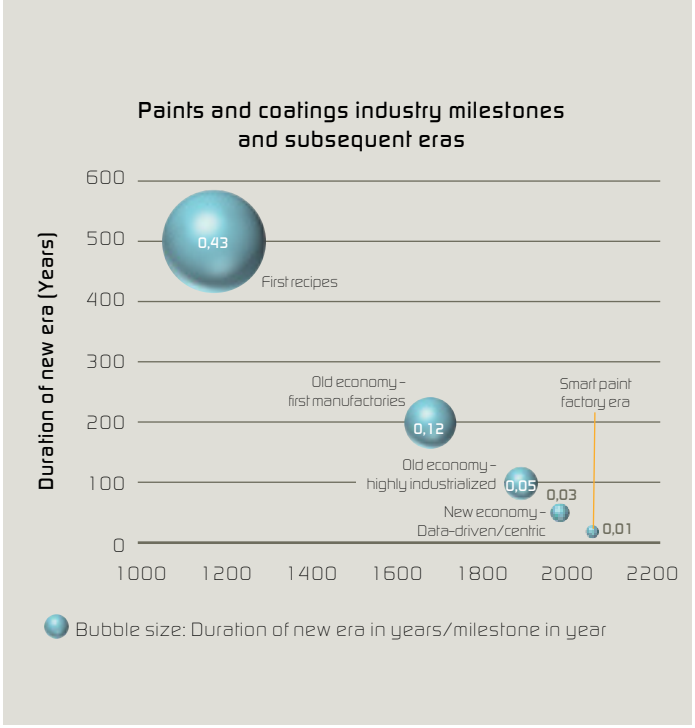


Figure 3: Schematic representation of the coatings industry's clock speed; eras have shortened from centuries to decades up to the new economy.



coating manufacturer's product and its underlying manufacturing attributes and material features.
AI can potentially be used to propose several alternative options that will meet the customer's requirements profile. These options build on an ever-growing repository of data on raw materials origin, quality, specified and as yet unknown or unspecified attributes, and their impact on the manufacturing process, equipment, and application.
All the data relevant for these purposes needs to cover the entire value chain, from raw materials supplier via coatings manufacturer and customer to recycling company – and vice versa. Only data loops ensure that AI, machine learning, and deep learning are fed with sufficient and valuable data that will enable them to generate valid prognoses.
Coatings producers will increasingly use all kinds of technical, commercial, and regulatory information to define and refine products, production site and carbon footprint, and total cost of ownership. What is currently inconceivable in the coatings industry is already the norm in data-driven and data-centric companies today. It will be the rule in the smart paint factories of tomorrow, too.
Combining AI-driven prediction, simulations and design of experiments 2.0, can dramatically shorten product development cycles and customer requirements fulfilment. Operations will benefit from shorter delivery times, lower total cost of ownership, reduced resource consumption, smaller carbon footprint, and greater customer satisfaction, e.g. through the decentralising of raw materials sourcing and production.

THE SMART PAINT FACTORY ALLIANCE: JOINING FORCES AND COMBINING COMPETENCES

The index of digitalisation by company size reveals a clear gap between small, medium, and big companies [2] for the reasons explained earlier. Full digital and sustainable transformation entails overcoming a large number of challenges and significant changes. "You'll never walk alone" is the idea behind The Smart Paint Factory Alliance. The SPFA was established in 2022 to pursue a collaborative approach for coatings companies wishing to evolve into a smart paint factory.
Instead of a big-bang approach, the SPFA suggests taking things step by step. This approach triggers motivation to continue and expand, due to proven progress and tangible results, and increases trust in the coatings industry that digitalisation works, generates benefits and is applicable to the company.
Successful collaborations require the selection of partners that have the right attitude and competences for developing pilot applications and solutions in a trusting, neutral environment. The SPFA is a community of individual experts and companies drawn from the coatings industry and its periphery, and its mission is to develop and provide digitally sustainable solutions to coatings companies and industry.
The joint planning and execution of projects limited in terms of scope and objectives ensures timely delivery of tangible results, e.g. digitally enhanced methods, equipment, products, and services. Every solution marks a milestone on a company's roadmap towards its future data-supported or data-driven hybrid business model. The ultimate objective is to become a smart paint factory or a smart paint company that operates several plants in different regions.

EXAMPLES OF CROSS-COMPANY COLLABORATION IN THE SPFA

As mentioned earlier, the proposed step-by-step approach triggers motivation to continue and expand, due to proven progress and tangible results. This establishes trust in the coatings industry that digitalisation works, generates benefits and is applicable to the own company.
One example of a cross-company SPFA project is "Colour match of uni-colours". The partners, a university, AI experts, paint manufactur-

Figure 4: Evolution of increasingly data-based business models during the coatings companies' transition from "old economy" to "new economy".

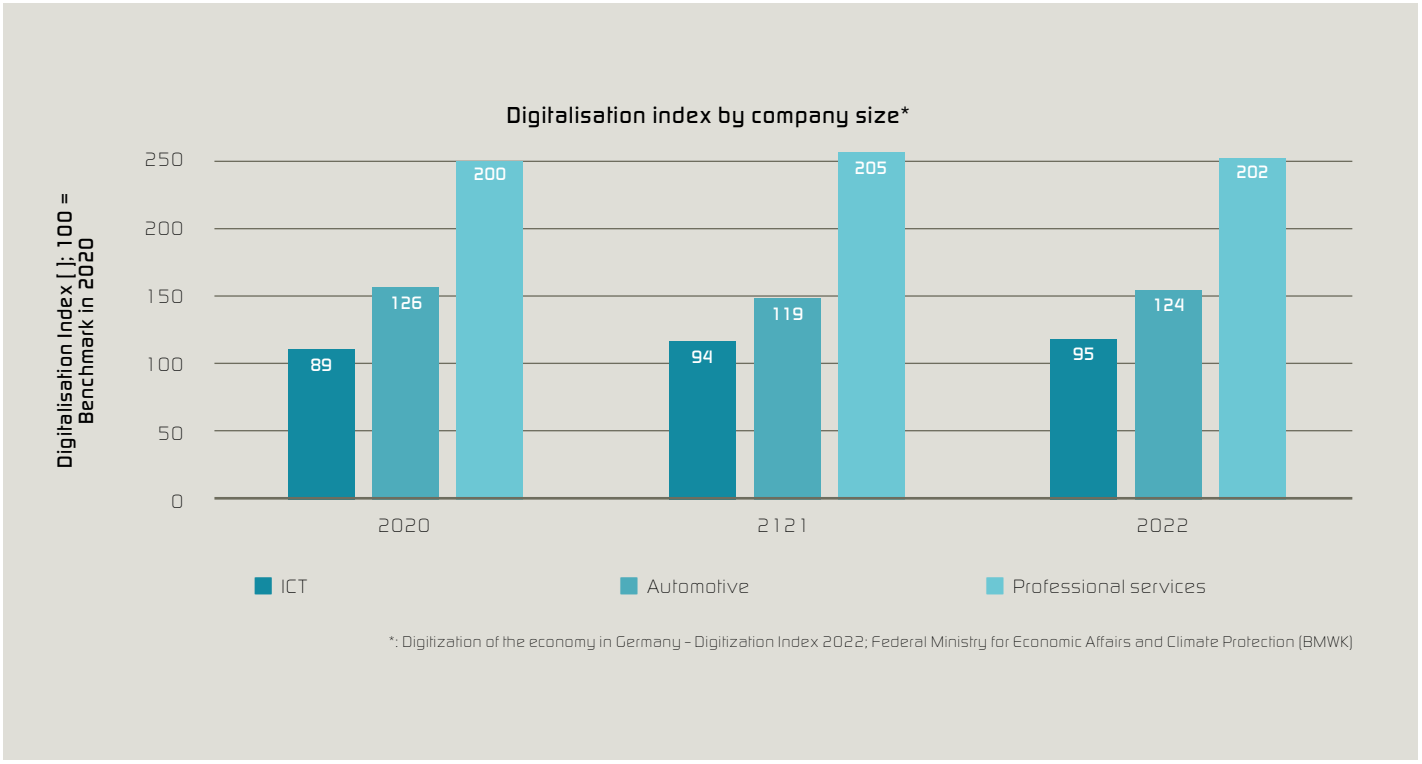


Figure 5: Centralised, AI and simulation methods product development loops allowing shorter time to market and decentralised production leading to the desired global effect.

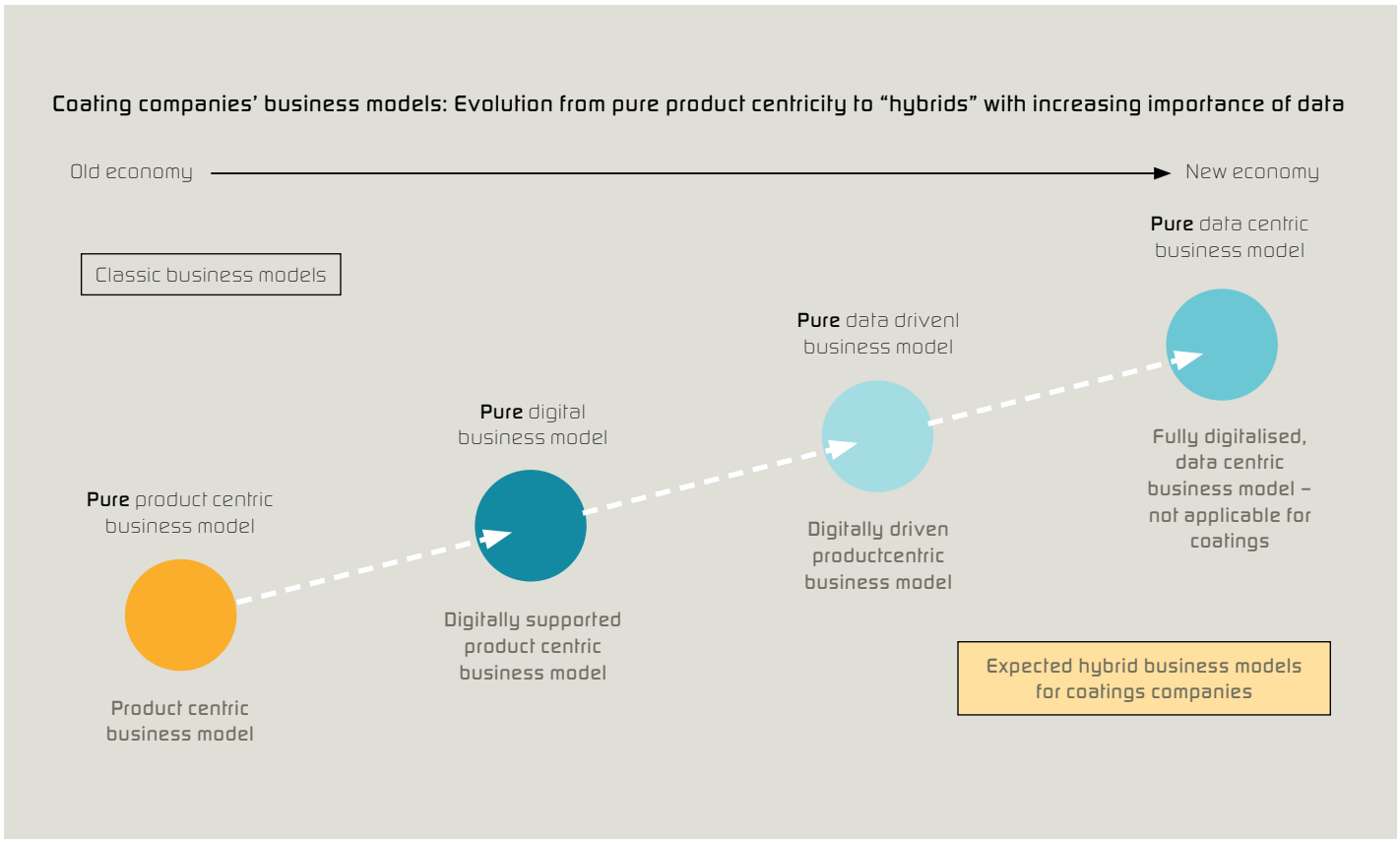
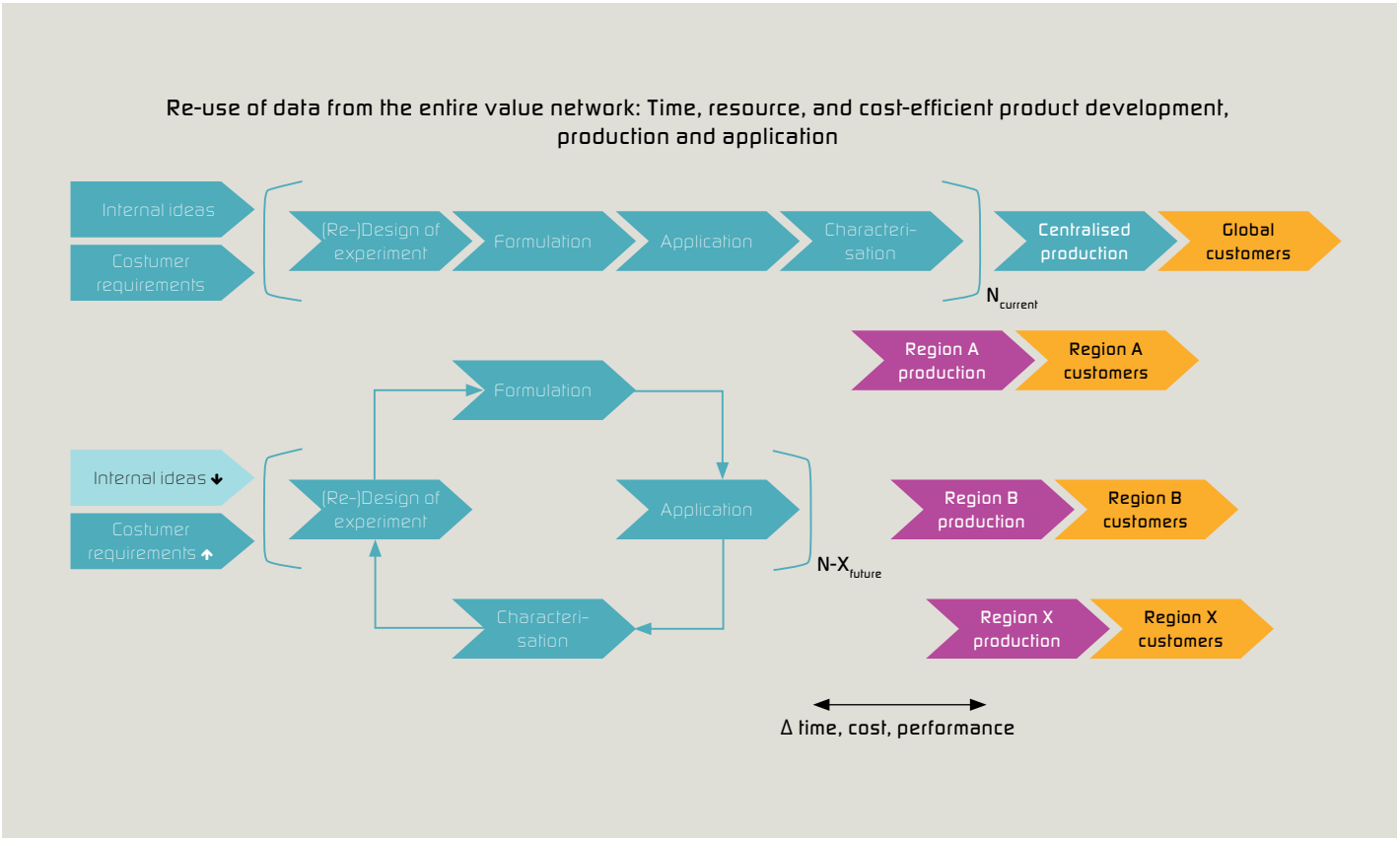


Figure 6: Coatings SMEs' digitalisation index relative to that of bigger companies.



ers, and a digital service provider, are seeking to improve the currently limited understanding of – in some cases not even objectively measurable – physical parameters concerning the final colour. They want to complement predominantly empirical, human-intelligence-based colour matching with artificial intelligence methods. By proving the applicability of machine-learning algorithms to physical properties and their interdependencies, they are hoping to get into a position to make accurate predictions about the final colour.

Another example is the "Prediction of metallic/pearlescent effects" initiative. This collaboration by seven partners seeks to increase their understanding of the impact of raw materials, such as special additives, binders, rheology modifiers, on the metallic/pearlescent effect. The ultimate goal is to be able to design these desired effects on the basis of simulations rather than series of lab experiments. Project partners include measurements methodology experts, AI experts, and coatings manufacturers to generate data for the model.

The main advantage of taking a consortium approach to projects like these is the bundling of competences and capabilities. Leveraging of swarm intelligence facilitates advanced design of experiments and reduces the number of experiments to a minimum. In this connection, energy, material, manpower, and time-to-market savings are significant. Any player operating on its own would have to run a classic, sequential, trial-and-error based development approach, instead, because

- A single raw materials supplier has no access to real formulation data
- A stand-alone simulation software company has no real-life data,
- An applicator has no insight into the chemistry of the raw materials used
- A typical SME coatings producer cannot afford the high-throughput experimentation (HTE) of a university

Multiple systematic variations of the formulations using HTE in a fraction of the previous time requires help with the identification, capture, calculation, and evaluation of the complexity of the mutual interactions of all components in the system with the target, i.e. a specified coated surface. Systematic "data-use and re-use" or "data circularity" builds on a simple principle: once generated, all relevant data is fed into models to simulate future outcomes. Compared with sequential experiments in the lab, these data-based predictions lead to new colours' being developed and produced faster and in a more sustainable way.

CONCLUSION

For several reasons, digitalisation and the coatings industry still do not go hand in hand. To blame this on a lack of resources, competences, and the "touch and feel" of virtual digitalisation and the current, rapidly-changing world is not helpful.

Instead, a clear vision, a sound cost/benefit analysis, and a step-by-step roadmap for becoming a smart paint factory will secure coatings companies and the industry's medium- and long-term competitiveness. The Smart Paint Factory Alliance is orchestrating the development and roll-out of collaborative and partnership-based digital and sustainable solutions. Any company along the coatings value chain and its periphery can benefit from these solutions, provided it is willing to collaborate and securely share data in its rapidly changing ecosystem as required.

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