TOP ENGINEER

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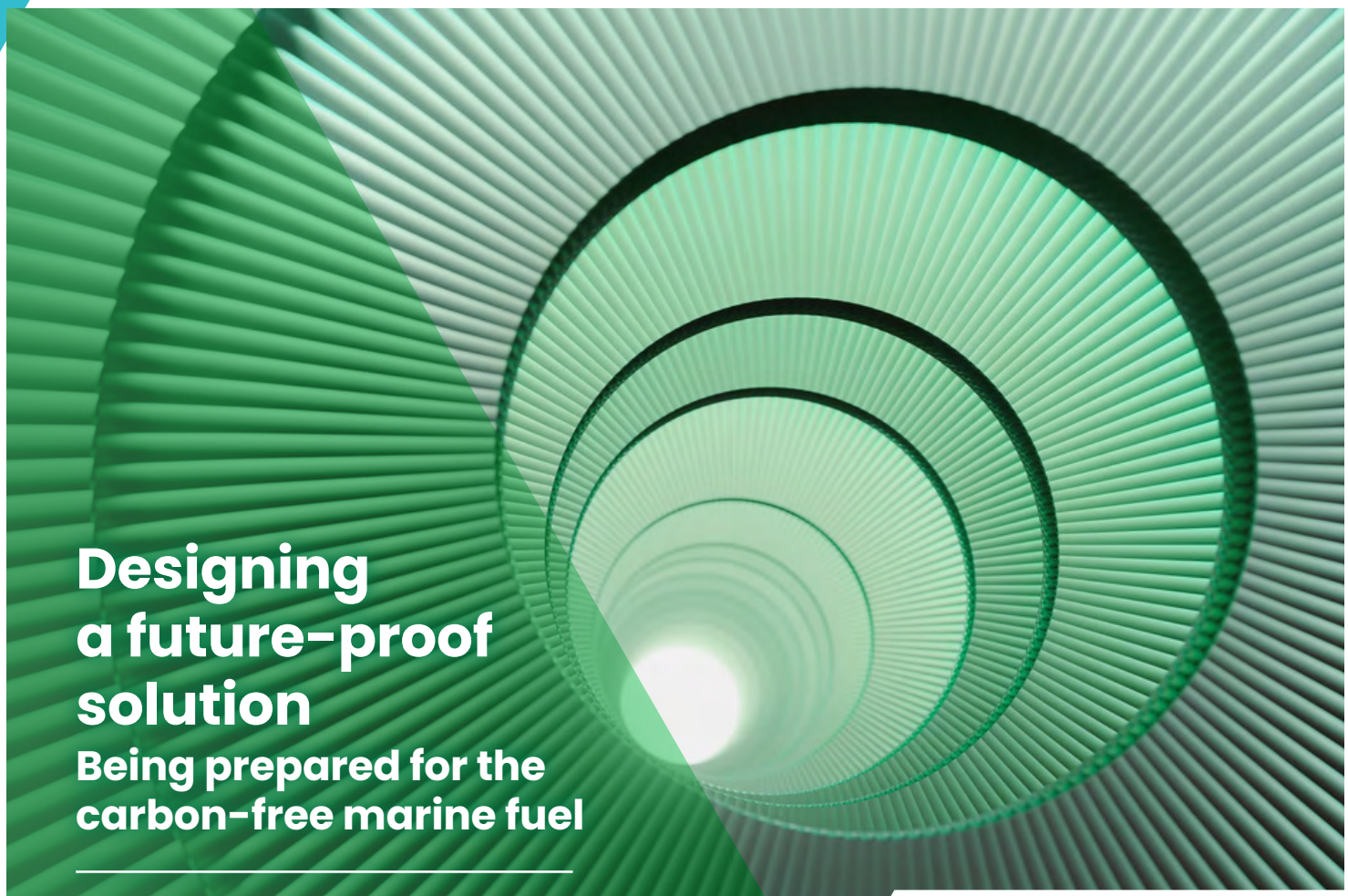
Consulting • Engineering • Green Transition • Innovation • Technical Solutions • Design



Designing a future-proof solution

Being prepared for the carbon-free marine fuel

Scaling up is not just for startups:

"Established operators need the same kind of thinking"

District heating – an advanced driver of the green transition

The circular economy is a game changer in the machinery industry

What should happen in the supply chain?

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A call to future-proof your business

In today's uncertain industrial landscape, one common challenge unites all industries: the urgent need to eliminate the use of fossil fuels. New solutions must be developed to achieve energy and material savings and empower businesses to become future-proof, as our world collectively strives toward a sustainable future.

The marine industry, in particular, faces the pressing concern of securing enough energy on board for long-haul transportation without relying on fossil fuels. Various alternatives to power vessels are being explored, such as hydrogen, methanol, methane, ammonia and e-fuels. In line with this development, we have designed a concept that allows ships to prepare for the future by switching from LNG to ammonia when available. By pioneering development in these areas, the maritime industry can achieve decarbonization and a more sustainable future.

Process industries also confront challenges in producing chemicals traditionally derived from fossil fuels, such as ammonia used in fertilizers. Biolan is leading the way by developing solutions for peat-free seedbeds. Their newly built biofiber plant utilizes wood-based side streams from the forestry industry, a great example of the growing role of the circular economy.

Future-proofing the machine industry calls for world-class process and mechanical engineering to join the circular economy to optimize resource utilization, minimize waste and enable the reuse of materials. What is more, innovating carbon-free products requires new competences, significant investments and societal acceptance.

In this landscape, companies need ways to scale up their technologies and support in managing complex projects. Elomatic is highly interested in developing sustainable solutions for a green future in all industrial sectors.

This will be my last editorial. I would like to thank all of our readers and warmly welcome our new CEO, Tom Lind. I look forward to seeing what the future holds for Elomatic and our customers.

Patrik Rautaheimo
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Designing a future-proof solution

Being prepared for the carbon-free marine fuel

Text: Antti Yrjänäinen
Images: Elomatic, iStock

One of the biggest races to cut greenhouse gas emissions is happening at sea. In light of the latest carbon dioxide emission regulations set by the International Maritime Organization (IMO), shipowners are actively seeking innovative ship concepts to transition to more eco-friendly fuels. Leading the way to zero emissions, Nippon Yusen Kabushiki Kaisha (NYK Line) and Elomatic have developed a concept that offers scalability for future deployments. When the post-LNG phase is properly considered in advance, conversion costs remain modest.

Japan's NYK is a forerunner in the market when it comes to transforming their fleets to greener technologies. Nearly 15 years ago, NYK selected Elomatic to conduct a technology study for a large container vessel presented as a futuristic ship concept. This fruitful collaboration continued with another project aimed at designing a future pure car carrier (PCC) for 2050.

Building on this success, NYK once again partnered with Elomatic approximately two years ago to develop a very specific future-proof vessel concept – the Ammonia-Ready LNG-Fueled Vessel. NYK's objective is to prepare for the post-fossil fuel era by exploring future fuel solutions now.

In search for a next-bridge solution

NYK tasked Elomatic to design two ship concepts closely resembling their current state-of-the-art vessels but operating on an alternative fuel source. This concept aimed at identifying the most viable green fuel as the industry makes concerted efforts to move away from hydrocarbon-based fuels.

The developed concept serves as a next-bridge solution to enable NYK to convert their existing LNG-powered vessels to ammonia at a minimum cost once green ammonia becomes commercially viable and ship engines are suitably engineered to utilize it. By considering the vessel's next phase in advance with tank and other component arrangements, the conversion to ammonia can then be easily done when the time is right.

LNG is serving as an effective interim solution, enabling shipping companies like NYK to significantly reduce their greenhouse gas emissions – but is not enough to meet future environmental requirements. With the concept, NYK can seamlessly convert their hydrocarbon-based vessels to run on green fuel, achieving complete decarbonization and compliance with upcoming legislation.

Green ammonia – best for deep-sea shipping

Elomatic studied the different future fuel alternatives. Among green fuels derived from hydrogen, carbon-free green ammonia has been projected to have the lowest production expenses – even with the technology we have today. For local transportation, vessels can use direct electricity with battery packs.

Methanol is another green option, and engines are already available. Hydrogen containers, either liquid or pressurized, have very limited opportunities in shipping due to the vast hydrogen volume requirement. Ammonia takes advantage of hydrogen's energy in a more convenient form. Therefore, ammonia is the optimal choice for deep-sea shipping.

Focus on climate change

Ammonia's energy density is much less than that of hydrocarbon-based marine fuels, such as heavy fuel oil (HFO) or marine gas oil (MGO). Earlier, HFO was the source of choice. Then starting from the Paris Agreement adopted in 2015 by nearly every nation to fight climate change, maritime emission regulations came into force.

Environmental pollution was the driver to cut back initially on sulfur oxides, and later toxicity was the driver to minimize NOx emissions. More recently, lowering CO_2 emissions has been the focus due to accelerating climate change.

A versatile concept for several vessel types

Elomatic began working with NYK and the Monohakobi Technology Institute (MTI), a member of the NYK Group, on two concurrent projects involving different vessel types.

The teams worked in parallel to deliver two concepts first, followed by two more.

The Finnish design group at Elomatic participated in regularly scheduled meetings with the MTI group, which was responsible for the larger technology scope. Elomatic's team members were involved in five different working groups with their Japanese counterparts.

To date, Elomatic has designed concepts for an ammonia-ready car carrier, a post-Panamax bulk carrier, a capesize bulk carrier and a very large crude carrier (VLCC). In the next project phase, Elomatic aims to work with shipyards and marine equipment manufacturers on the actual design based on the concept work.

Studies show that if the post-LNG phase is properly considered in advance, conversion costs stay at a moderate level, making the ammonia-ready ship concept a cost-efficient way to transition to the use of ammonia, regardless of the type of vessel.

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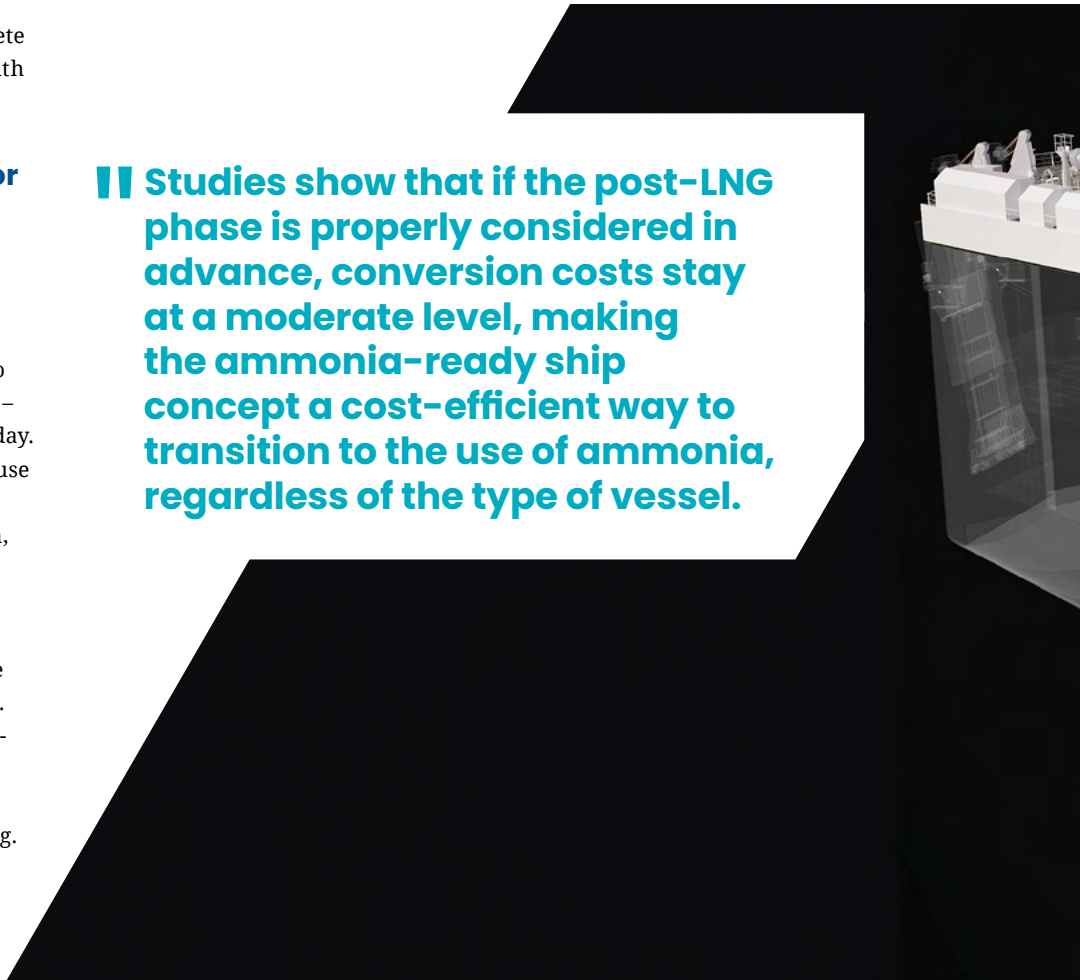

Designing for as-yet-unknown technology

Elomatic used NYK's existing state-of-the-art vessels of a similar size and type as a reference for future-proof ammonia-fueled vessels. But since the technology is not yet available, the teams needed to prepare for solutions that would be coming, perhaps even many years ahead. One issue was how to store the fuel; another was that there are no ammonia engines on the market yet.

Extensive discussions were held with engine manufacturers to get a better understanding of the potential changes needed or retrofitting requirements. Other key considerations included the fuel supply system, bunkering procedures and managing ammonia's high toxicity.

Safety and reliability were paramount in every design decision. This encompassed engine modifications, safety systems, tank size and positioning, enclosed compartments, protective structures, the philosophy for containing toxic zones as well as compliance with emerging regulations. It was possible to implement certain rules and regulations with specific protocols regarding toxicity, although the actual rules are currently being defined by IMO and classification societies.

Tackling differences in current fuel usage

Ammonia and LNG have many similar technology considerations when it comes to rules and regulations. All fuel pipes are double-walled, and all spaces exposed to the gases must have proper ventilation. Ammonia is also very corrosive, which makes it essential to select the right materials for the tanks and fuel supply systems. Since ammonia has a lower energy density than conventional fuel, the ships also were designed with larger fuel tanks.

The concept solves the challenges of ammonia use, such as the fuel tank material and placement along with the hub durability and stability. All safety rules being developed for future ships powered with ammonia have also been considered.

Innovative process to match outcome

Elomatic used its facilitated innovation process as part of ship concept development to gather ideas, explore opportunities and address design challenges for the concept. The entire project needed a new approach to developing future-proof ship concepts that align with evolving industry needs. Repeating old ship designs no longer works.

In the first project with two distinct vessels, Elomatic proposed two unique solutions. For one vessel, the interior compartment was expanded, allowing for an increased deck area. The other vessel, a bulk carrier originally designed as an LNG vessel, was reconfigured to accommodate

Ammonia-Ready LNG-Fueled Vessel – Pure Car Carrier

Ammonia-Ready LNG-Fueled Vessel – Capesize Bulk Carrier

> **The entire project needed a new approach to developing future-proof ship concepts that align with evolving industry needs.**

ammonia usage by cutting the vessel to create space for an additional tank compartment. These customized solutions allow the existing vessels to meet the upcoming regulation changes.

The future-proof ship concepts cover various operational specifications, including load capacity, voyage distance, ship speed and fuel capacity.

When to switch to ammonia?

The time to switch to green fuels will come gradually. First, vessel engines that can operate on these fuels are needed. Those will be coming only in a couple of years. The big engine manufacturers are currently testing and fine-tuning their engine concepts for the market.

The new fuels need to be commercially available in every port where carbon-free ships operate. These fuels also need to be priced competitively in the market. Legislation, too, is needed for this transformation to proceed. A European emission trading system (ETS) is coming that will benefit carbon-free vessels in European waters. Or companies may request to use only green supply chains in the future, creating a demand-based driver by end customers.

The decision to switch to future-proof ship concepts will ultimately depend on operational costs. It is also essential to consider the vessels' operational profiles and optimize the tradeoff between range and energy density of low-density fuels, since these vessels have reduced payload due to larger tanks and limited space.

First-movers are ready for the future

One of the most satisfying parts of the project was the cooperation. The teams created new solutions together and were very involved in exchanging knowledge. Elomatic also provided visualization services and extensive technical support as part of the project scope.

Moreover, Elomatic brought a wealth of knowledge and experience of ammonia from land-based projects to the collaboration. Additionally, they could share experience from other new fuels, like methanol, for which engines are already available, and from retrofitting other LNG vessels. Still, the company predicts that ammonia will be more cost efficient in the long run.

Elomatic has a long history with NYK, and the projects have always been very forward-looking. For a company focusing on engineering solutions, projects involving game-changing technology are always the most fascinating. As a major shipowner, NYK has hundreds of vessels. They are open to testing different solutions to prepare for carbon-free future fuels.

Watch videos about the concept:

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Biofiber Factory produces ecological wood fiber to replace peat in substrate and bulking products

Finnish ecological gardening and environmental product company Biolan has invested in a new type of biomaterial processing plant in Eura, Finland. The new plant produces wood fiber from forest industry side streams that can be used to replace peat in its substrate and bulking products. Developing the advanced plant required not only solid design expertise but also a bold and open-minded approach to innovation.

Images: Biolan Group, iStock

Biolan has traditionally used white peat moss in its substrate and bulking products because it binds water and nutrients well and then releases them slowly to the plants. However, the supply of white peat moss has been impacted by the rising price of fuel peat due to increased taxation and the rising price of emission rights.

Biolan has been exploring alternatives to peat for a long time already. One of the most promising substitutes is wood. Wood fiber is an ecological and rapidly renewable raw material that provides substrate products with suitable airiness and an optimal structure for plant roots.

"With the help of wood fibers, we can move away from very slowly renewable peat to a rapidly renewable material," says Dr. **Petri Konttinen**, Technical Director at Biolan Group.

Multi-year research work behind the new Biofiber Factory

Biolan began researching wood fibers in 2018. Even though wood fibers that had been developed for substrates already existed at the time, Biolan saw room for improvement in their quality. The company also participated in a project exploring peat-free, climate-friendly substrates and bedding materials financed by Business Finland.

"We tested different biomaterials and their combinations to see how plants grow with each mixture. Ultimately, we found the wood fiber which worked best," explains Konttinen.

According to Konttinen, wood fiber can be used in substrate products for professional cultivation, bedding for livestock production, and mulch products for gardeners.

State funding awarded for important project

Based on the results of its research, Biolan submitted a funding application to the Ministry of Agriculture and Forestry's nutrient recycling pilot program. The company wanted to invest in a biofiber factory that could utilize, for example, waste wood chips from sawmills to produce compostable biofiber.

The application yielded results, and Biolan's plant project was able to start in 2021 under the management of the South Ostrobothnia Centre for Economic Development, Transport and the Environment.

"Wood fiber is a raw material for us whose production chain we wanted to keep in our own hands," Konttinen explains.

Project begins with bold innovation

Consulting and engineering partner Elomatic was involved right from the outset having previously helped Biolan with other plant projects. It was already known at this stage that the wood chips had to be processed without using additives and that there would be two end products: pure wood fiber and a mixture of wood fiber and rapidly renewable peat biomass.

"We needed a partner to consider, for example, how the equipment should be placed to make plant operations as cost-effective as possible and what kind of material and energy flows should be taken into account," explains Konttinen.

According to **Pasi Leimu**, Project Manager at Elomatic, their work began by brainstorming ideas on how the plant could be implemented, as well as evaluating the suitability of the

equipment suppliers identified by Biolan for its production needs.

"Usually, it is my role to produce innovative ideas that could achieve the objective. In this case, it was rewarding to develop the process together with an expert customer," Leimu says.

Rapid progress after investment decision

Once the parameters for the pre-planning phase began to take shape, a budget and schedule were drawn up for the project and planning could begin.

"Elomatic was responsible for plant, process and electrical design and ensuring that everything at the plant works together in the best possible way," Leimu says, explaining the role of Elomatic.

Construction work was completed in September 2022. Production is now running in three shifts, and the new peat-free product is already being delivered to retailers.

Test cultivations demonstrate quality of Biolan's wood fibers

It is Biolan's practice to test all product lots under standardized conditions. These test cultivations have demonstrated that the end products produced by the new plant maintain growth better or at least as well as other wood fibers purchased on the European market. This is due to the advanced process through which several benefits have been obtained.

"We experiment with different combinations to find the best recipe for each plant. We have learnt how to use peat, and in the same way we need to learn how to use wood fiber and a mixture of wood fiber and bog biomass," Konttinen confirms.

"In addition, we take customer feedback into account in our development work," he adds.

Plans to expand production

Biolan's new plant is the first in Finland to produce wood fiber for substrate and bulking products.

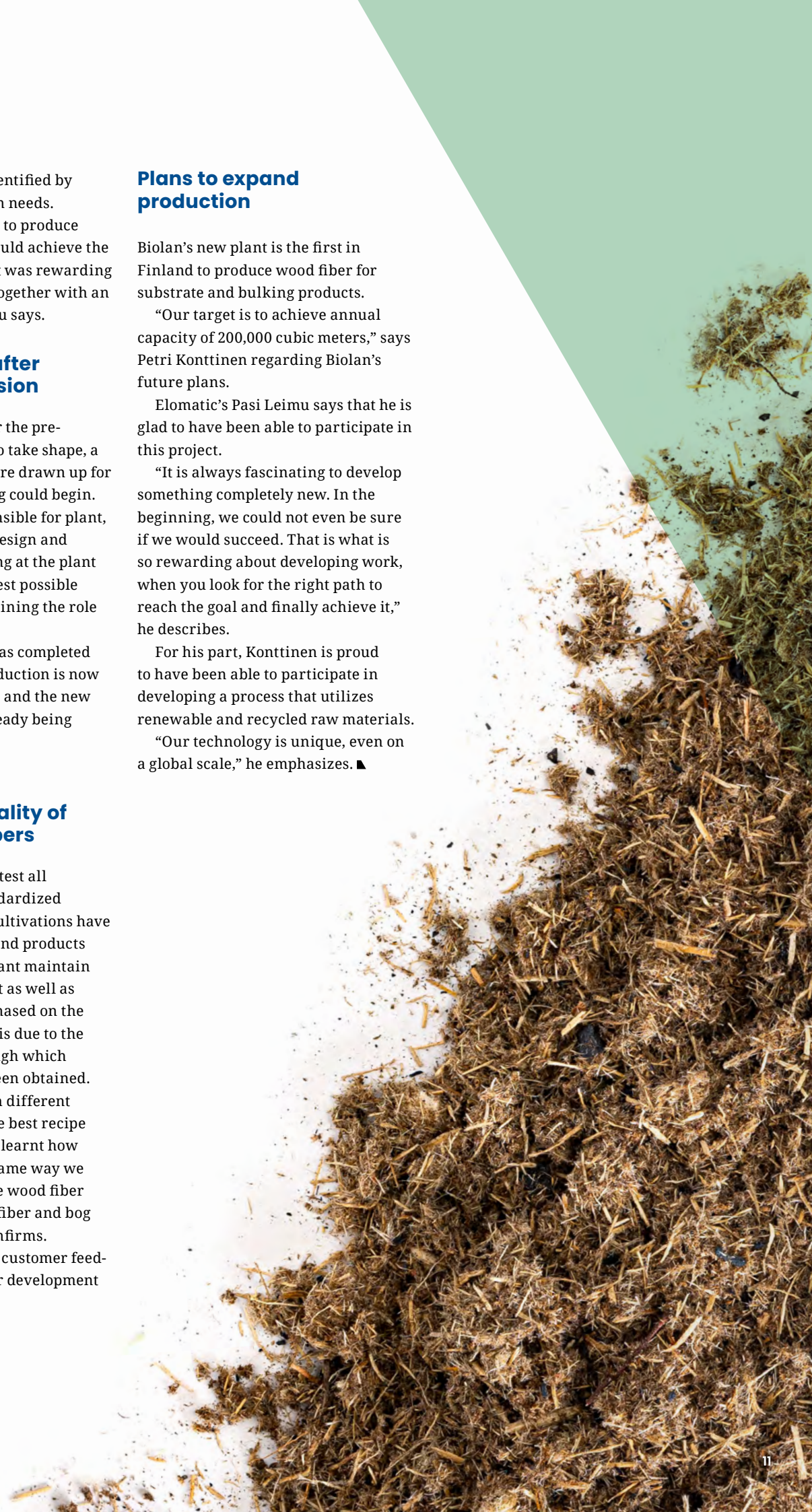
"Our target is to achieve annual capacity of 200,000 cubic meters," says Petri Konttinen regarding Biolan's future plans.

Elomatic's Pasi Leimu says that he is glad to have been able to participate in this project.

"It is always fascinating to develop something completely new. In the beginning, we could not even be sure if we would succeed. That is what is so rewarding about developing work, when you look for the right path to reach the goal and finally achieve it," he describes.

For his part, Konttinen is proud to have been able to participate in developing a process that utilizes renewable and recycled raw materials.

"Our technology is unique, even on a global scale," he emphasizes.



The circular economy is a game changer in the machinery industry

What should happen in the supply chain?

Text: Mika Patrakka
Images: Elomatic, GettyImages

The circular economy is a key model for reforming the economy and a necessity for solving the major climate, natural resource and other sustainability goals globally. Today, the circular economy is more than just an opportunity: technological know-how has taken giant steps forward, and the willingness of customers, consumers and governments to promote circular economy solutions is more significant than ever before.

The circular economy provides the keys to the solution to combating climate change and the loss of biological diversity. It allows us to grow and share wealth while reducing greenhouse gas emissions, waste and pollution.[1] By transitioning to a circular economy, companies and governments can not only reduce waste and environmental impacts but also create new economic opportunities and improve the productivity of resources. Only 7.2% of the world's economy is part of the circular economy[2], so there is plenty to do for everyone.

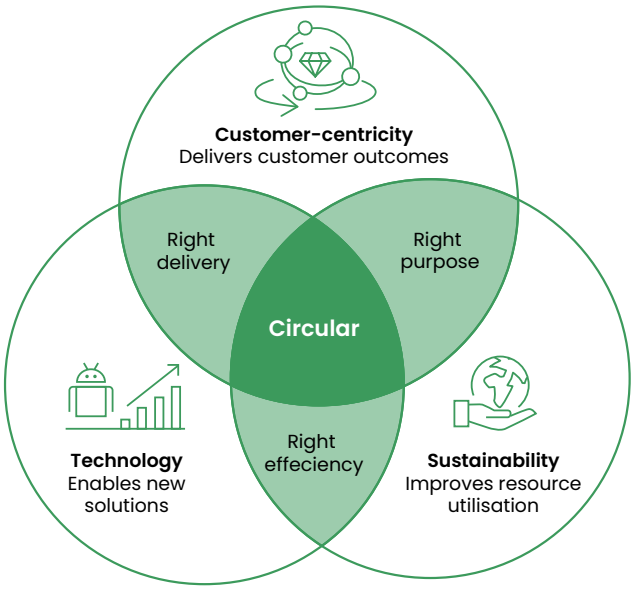
The three main themes of the circular economy are technology, customer-centricity and sustainability. Sustainability rests on four so-called pillars of sustainability: human and

cultural sustainability, environmental sustainability, economic sustainability and social sustainability.

Circular economy keeps resources in use for as long as possible

In a circular economy, waste and pollution are minimized. This is based on the principles of reducing, reusing and recycling materials and resources, rather than the traditional linear model of resource recovery, use and disposal.

One of the circulation systems of the circular economy is a closed-loop system in which resources are used efficiently and sustainably and no waste is generated; instead, resources



Factors guiding the circular economy[3]

Circular economy business models compared to the linear economy model [3,6,7]

Circular economy business models	Circular economy strategies	What does this mean in the circular economy?	Linear business models	What does this mean in a linear business model?
Circular Inputs	1. **Sustainable product design and circular supplies** 2. **ReGenerate** 3. **ReFuse**	**Sustainable product design:** Design products according to cycles and sustainability goals. **Circular supplies:** Utilize side flows generated from the processes of other operators or refuse to use unsustainable solutions. **Regenerate:** Create operations that conform to natural cycles in the ecosystem and give more than is taken. **Refuse:** There is no need for the product or it can be completely replaced by another product.	Taking resources	Procure virgin materials and other production inputs.
Sharing Platform	4. **Share** 5. **Rethink**	Utilize new models of the sharing economy and think of the product as a new kind of solution that increases utilization.	Design, manufacturing, distribution	Products are designed for single use, and distribution solutions are mostly global supply chains.
Product As a Service	6. **Product as a Service** 7. **Performance as a Service**	**Product as a Service:** Offer customers use of the product for a subscription fee or usage-based payments instead of ownership. **Performance as a Service:** Offer customers a predetermined solution as a service and commit to guaranteeing the quality level and outcome.	Use and consumption	The owned product is used until it breaks down or is no longer used for other reasons.
Product Lifecycle Extension	8. **Reuse** 9. **Repair** 10. **Refurbish** 11. **Remanufacturing** 12. **Repurpose** 13. **Reduce**	**Reuse:** The use of a product in good condition by another user for the same purpose **Repair:** Repair, service and maintenance that enables the continued use of the product for the same purpose **Refurbish:** Refurbishing an old and defective product for today's needs **Remanufacturing:** Utilization of an end-of-life product or its components for the same purpose **Repurpose:** Utilization of an end-of-life product or its components for a different purpose **Reduce:** Making production or usage more efficient by reducing the use of natural resources and materials		
Resource recovery	14. **Recycle** 15. **Recovery**	**Recycle:** Processing materials to obtain the same (= high value) or lower (= low value) quality **Recovery:** Incineration of materials and recovery for energy use	**Landfil:** Discarding as waste and energy	The product as such or its components are discarded and will not be reused in any way. The resource is disposed of by incinerating it into energy.

are always recycled again and again. Narrowing loops approach means that less energy, water and raw materials are used in the manufacturing of a product, meaning the business is resource efficient. Slowing loops refers to the extension of the product's lifespan by means of service and maintenance.

The aim of these cycles is to create a unique approach to different starting points and goals that can help reduce the negative environmental effects of economic activity and thereby improve resource efficiency.

What does the circular economy mean in practice?

The circular economy offers a concrete approach to achieving sustainable growth. Products are designed to be long-lasting, durable and easy to repair or recycle, and materials are reused or recycled to create new products. This helps to reduce the amount of waste generated and increase the resources needed to manufacture new products. In this way, new economic opportunities are created when new business models and value chains are developed.

The circular economy can be implemented in several different ways:

- Designing products and systems that can be easily repaired, refurbished or recycled
- Developing business models that encourage the use of shared or rented resources
- Investing in infrastructure and technology that enable the recovery and reuse of materials
- Recovering as energy – this is the last option that should be considered, because then the resource is no longer available for solutions with a higher value added

The circular economy highlights interdependencies between different organizations and companies. The importance of the role of users and consumers is also emphasized.

> **"Product design can determine up to 80 percent of the environmental impact during the product's entire life cycle. The role of product design, in other words, is very significant.**

Is the circular economy profitable?

Many actors may face impediments to growth and profitability during the transition. At the same time, however, it is also possible to create new business that is both sustainable and profitable.

In terms of overall impact, the manufacturing cycle alone can generate net material cost savings of up to USD 630 billion per year in the EU alone, according to an estimate by Goldman Sachs.[4] It has also been calculated that product design can determine up to 80 percent of the environmental impact during the product's entire life cycle.[5] The role of product design, in other words, is very significant.

Circular economy requires a new type of technology

If industrial business wants to make full use of circular economy business models and strategies, Industry 4.0 and Industry 5.0 solutions such as artificial intelligence, IoT (Internet of Things) and automation must be utilized. These solutions enable smart and flexible management and production optimization in the operations of plants and processes. This offers an opportunity to improve the efficient utilization of manufacturing, materials and resources, as well as to reduce waste and environmental damage.

Industry 5.0, materials and resources are used as efficiently as possible according to the principles of the circular economy and sustainability, and processes can be planned by promoting resource wisdom. The purpose of technology in Industry 5.0 is to improve people's quality of life and achieve sustainability. Industry is a significant user of raw materials and other resources. The development and implementation of new technologies is therefore essential.

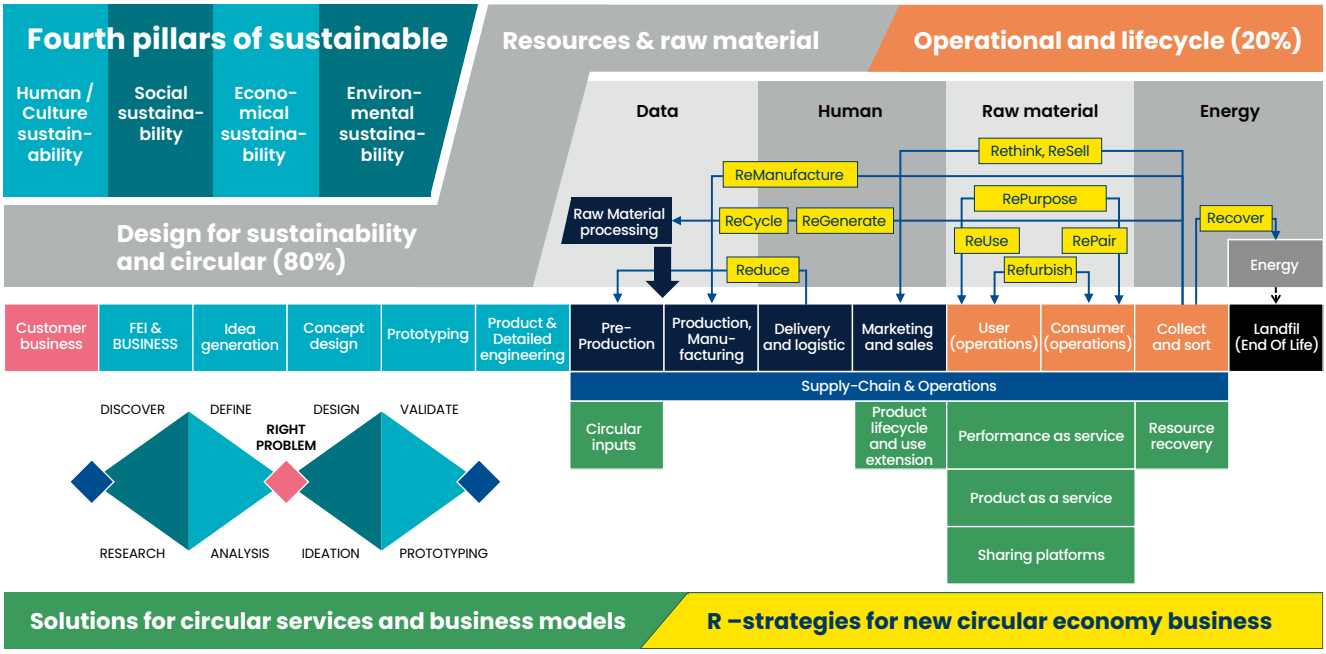
Manufacturing for circular economy

An interesting perspective is provided by resource-wise manufacturing technologies, such as additive manufacturing (3D printing) and smart manufacturing with their numerous applications. New manufacturing methods and processes can be used to improve material and energy efficiency and to operate in circular economy value chains in a new way.

In smart manufacturing in a circular economy, the production processes adapt to changes in the market by utilizing smart technologies, procuring raw materials and automating production capacity. Monitoring material flows in different stages of the chain and risk management are also emphasized in terms of availability. Consequently, special attention in the circular economy must be paid to managing the logistics of value creation chains, utilizing resources more efficiently and developing production processes with the help of digitization and manufacturing technologies.

New competence needs

The challenges and requirements of design increase substantially in a circular economy, but at the same time,



Circular economy product development, order-delivery process and business models[8]

design becomes even more relevant. Processes must be developed to correspond to circular economy business and ecosystem models, and the demand for new skills also increases.

The new competence needs highlight knowledge of value chains and materials, as well as of serviceability and repairability considerations. Both the special properties of recycled raw materials and a product's recyclability must be taken into account in design and technology development. Competence in these properties will also be emphasized in the production stage of the products.

Challenges of transitioning to a circular economy model

Although we see significant advantages and opportunities in the circular economy, at no point are they self-evident. Transitioning to sustainable business models requires major changes from organizations. For example, a new kind of business thinking and a redesign of planning processes and supply chains are needed.

Flexibility solutions are one significant challenge, and one of the most critical elements is creating transparency.[9] Achieving this requires the integration of customers and resource suppliers into enterprise resource planning systems and sales and delivery processes. In addition, companies must have strong and long-term circular economy visions, as well as clear and concrete plans for achieving these visions. The necessary commitment must be obtained from a wide range of external stakeholders.

Another challenge is the lack of a unified ecosystem. In Finland, work on fixing this situation has begun in earnest, but a lot of work remains to be done. In addition, numerous other challenges must be solved, such as the availability of materials and the maturity levels of technology, changing production lines, and developing product return processes and recycling.

Circular economy accelerates the development of new technologies and solutions

A circular economy promotes sustainable growth by creating a closed cycle system within which waste is minimized and resources are saved. In this way, the circular economy promotes the development of innovative solutions that promote a more sustainable future.

The goals regarding the circular economy are very demanding. Although some actors are already well along the way in this transition, everyone still has the opportunity to choose which stage of the circular economy they want to participate in and which special strategy they want to implement most strongly. The will generally exists, and digitization plays a key role here, but new types of business models and win-win models of value creation are also needed.

In the face of massive change, responsibility guides us to try and do our best. Essentially, the purpose of the circular economy is to create a world in which economic wellbeing is combined with environmental and social sustainability – and one in which current and future generations can thrive.

Examples of circular economy technologies and business models

Performance as a Service

A good example of Performance as a Service is provided by Rolls Royce, which is committed to producing efficiency and profit for its customers with its own technologies based on the Power By Hour model. The company takes care of maintenance and repairs so that the agreed result is achieved as promised.

Similar programs include proven ways to reduce inventory costs in the airline industry. Airlines pay for services based on aircraft utilization. The main advantage for operators is that they do not have to own a warehouse. This reduces recurring overhead costs while improving the quality of the service or operation.
https://www.mrobusinesstoday.com/power-by-the-hour/

Remanufacturing

Many mobile machinery manufacturers have started again to manufacture new components from used components and resell them. For example, Caterpillar promises to remanufacture its products at the end of their service life and restore them to their original condition. This helps reduce the cost of ownership and operation, as the customer gets new quality at a fraction of the cost of a new component.
https://www.caterpillar.com/en/company/sustainability/remanufacturing.htlm

Recycling and repurposing

Spinnova Plc

Spinnova Plc has developed a technology capable of producing textile fibers from wood, leather and other natural materials. Due to the way the pulp is processed, Spinnova can use almost any cellulose-containing biomass, grind it into microfibrils and spin it into textile fiber. Although wood is their spearhead raw material, they have also studied leather waste and agricultural waste, such as wheat straw and cotton waste.
www.spinnova.com/technology

Infinited Fiber Company

Infinited Fiber Company's patented technology utilizes raw materials from textiles that would otherwise end up in landfills or incineration and transforms them into brand-new, high-quality fibers for the textile industry.
https://infinitedfiber.com/about-us/

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(B.Sc.)

Mika works as a Business Development Manager in the Machinery and Equipment business unit. He has more than 10 years of experience in various roles in design, development and management. Mika promotes sustainable growth and the development of products and services and helps companies create circular economy-based business and strategies. His development philosophy is guided by the growth mindset and customer experience, and he utilizes service design and agile methods in his work..

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References

1 Ellen MacArthur *https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview accessed 31.3.2023*
2 Circularity GAP 2023 *https://www.circularity-gap.world/2023*
3 Circular Economy Playbook for Finnish SMEs – Sitra, Teknologiateollisuus & Accenturestrategy Circular Economy Playbook | Teknologiateollisuus
4 Goldman Sachs *https://www.goldmansachs.com/insights/pages/gs-research/gs-sustain-circular-economy/report.pdf*
5 Schwarz et al 2017; European Commission 2014 *https://ec.europa.eu/commission/presscorner/detail/fi/ip_22_2013*
6 Nancy M. P. Bocken, Ingrid de Pauw, Conny Bakker & Bram van der Grinten (2016) Product design and business model strategies for a circular economy, Journal of Industrial and Production Engineering, 33:5, 308-320, DOI: 10.1080/21681015.2016.1172124. Product design and business model strategies for a circular economy *https://www.researchgate.net/publication/309699661_Product_design_and_business_model_strategies_for_a_circular_economy*
7 Kirchherr, J., Reike, D. & Hekkert, M. 2017. Conceptualizing the circular economy: An analysis of 114 definitions. Resources, conservation and recycling, 127, pp. 221-232. doi:10.1016/j.resconrec.2017.09.005 *https://www.sciencedirect.com/science/article/pii/S0921344917302835#fig0005 9R*
8 Adaped from Waste to Weath, 2015, The Circular Economy Handbook, 2020 & Sustainable growth with circular economy business models, SITRA
9 Bain & Company *https://www.bain.com/insights/operations-priority-number-one-global-machinery-and-equipment-report-2022/*

Teemu Turunen says scaling up is not just for startups:

"Established operators need the same kind of thinking"

Business Development Director Turunen has been working at Elomatic for a total of six years over two different periods. Recently, he has been involved in developing a model to help scaling in an industrial environment.

What attracted you to Elomatic?

The chance to work on diverse cross-sectoral projects was appealing. I also saw an opportunity to do meaningful work towards the future.

What kind of projects have you been working on lately?

I have worked broadly on sustainable solutions, primarily related to clean energy and the hydrogen economy, as well as the bio- and circular economy. Among other things, I have been developing a scale up model that allows us to help our customers refine their industrial innovation ideas into commercial plants.

What made you begin developing a new scale up model?

Scaling anything or any function from one size class to another is always a challenging task. It can be easy to develop a good process, but it takes a lot of funding and the right choices to turn it into a business. In addition, you need to collaborate with many different parties.

It is therefore important to understand the steps in which scaling should be done and what special features are involved in each step. For example, different technology suppliers are needed in different phases. If the objective is a large, replicable solution, you must have a clear goal and proceed with it determinedly.

Do you see a demand for this kind of model today?

As we all know, everything has to be rethought in a new way at the moment. Clean energy production, the circular economy and the bioeconomy are taking on an increasingly significant role. The response to this challenge has already been impressive, and many bio- and circular economy projects and innovations have emerged. So there is clearly a need for the model we have developed.

It is also worth noting that our model is not only suitable for startups but provides a good framework for established operators as well. For example, switching raw materials may require a change to the process, in which case

new equipment is needed and you will have to think about how they fit into the current layout. The dimensions and, for example, the reserve capacity required by the process may also require rethinking, and safety and licensing issues often play a more important role than previously.

What kind of team was needed to develop the new model?

We have been carrying out similar projects for a long time, and we possess a wide range of expertise within Elomatic. We involved several of these experts in the development work, as they were able to view the project from slightly different angles and contribute their strong content expertise to the work. It was up to me to combine all this expertise into a logical package and clarify the customer perspective.

How should a good idea be further refined?

According to our model, first comes the idea stage, where we think about how to move forward with the idea. There are no known technical or commercial limits, and obtaining financing can be challenging. There is still a long way to go before the idea becomes viable.

In the laboratory and modeling stage, we begin to acquire an understanding of the phenomenon. For example, testing in a test environment or process engineering simulations can be performed. For the first time, something concrete can be accomplished, and we often discover that it is difficult to find suitably sized test equipment or machine parts.

In the pilot stage, a small-scale plant or a combination of process parts is built for the first time, and we begin to understand what kind of technological implementation could be possible. This stage requires flexibility, as a lot of manual work still has to be done. The need for financing starts to increase sharply: we are easily talking about 7-figure investments.

What follows the pilot stage?

The output of the demo stage is an industrial-scale plant already, but it is not yet intended to generate significant turnover. Whereas in the pilot stage we were looking for equipment manufacturers, we are now looking for different technology suppliers. We have to find out what ready-made pieces they have, and we also need to tackle the business aspect even more strongly.

In the next stage, a commercial facility will be built. The goal is for it to generate a profitable business, so the business aspect starts to dominate at this stage. Essentially, a commercial plant is an actual industrial plant that has to show what is needed when we start replicating it for the world.
The last step is the duplication stage, where money is made. Different business models are available: you don't necessarily have to carry out the expansion yourself, as it is also possible to sell licenses or participate in a co-ownership model.

What do you consider to be the most challenging aspect of scaling?

When talking about scaling operations in an industrial environment, the emphasis is on acquiring sufficient financing and managing timetables and risks. Obtaining financing especially is the key, which is why things have to be done in the right way and at the right stages. The amount of financing needed also increases from stage to stage. In addition, financiers want a return on their investment as quickly as possible, which is reflected in timetable pressures.

Finding technological solutions is not simple either. For example, when we start developing an idea for a production facility, we need many things around it: piping, electrical automation and weather protection in the form of a building.

It has to be remembered all the time that it is a creative process that is constantly evolving, so there must also be room for creativity and flexibility. They act as counterforces to the slavish scaling process, and you have to be able to combine them well.

What kind of advice would you give in terms of risk management when scaling?

The controlled implementation of scaling is the best possible risk management. In this way, technology risks, commercial risks and operational risks are managed at the same time, and both personal and process safety are taken into account. It is also important to take project risks into account, as many startup operators have limited project management skills. This is highlighted in the pilot, demo and commercial stages.

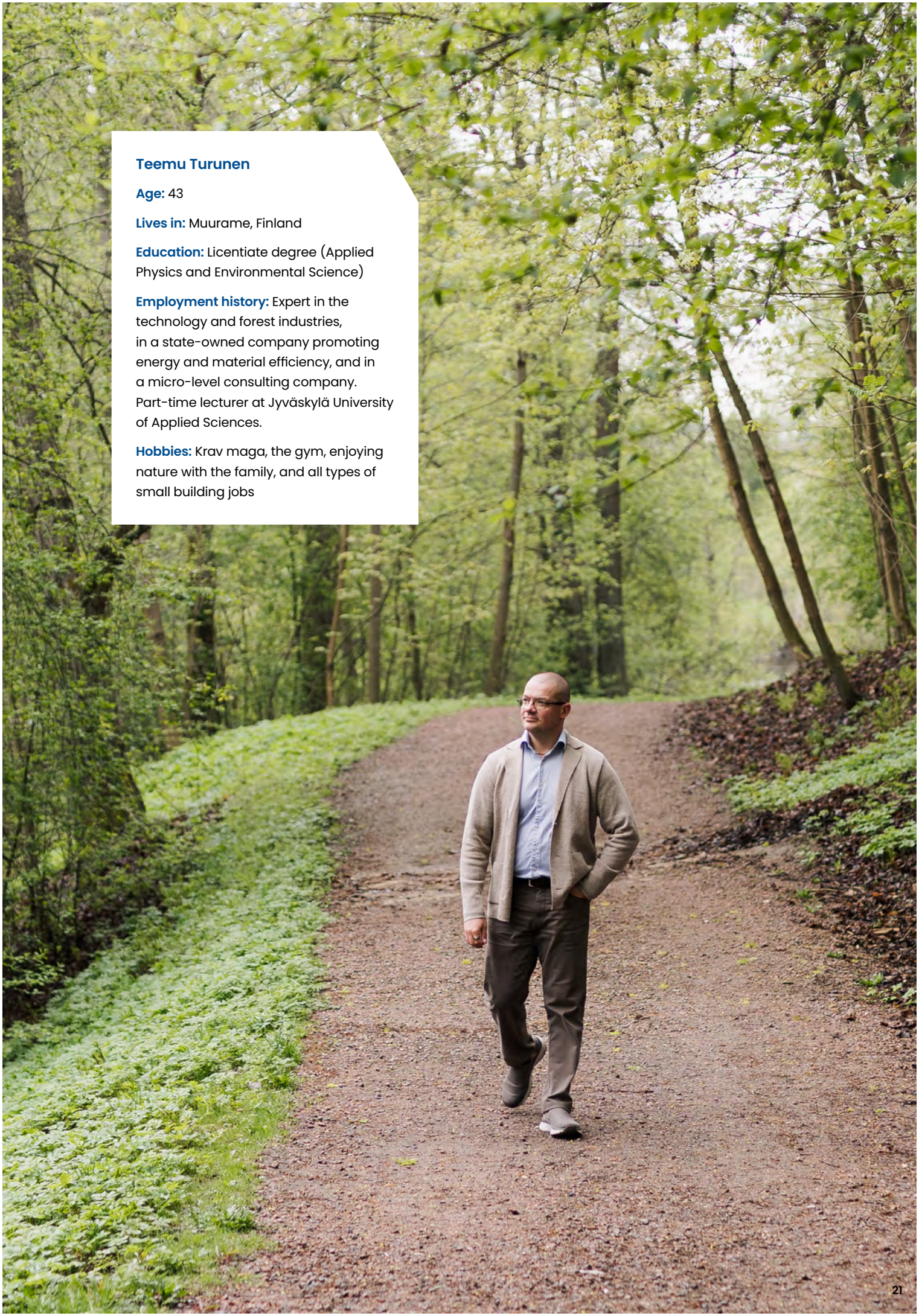
In particular, I would like to highlight business risks, because industrial projects require financing, and at each stage of scaling, you have to convince your financiers by providing them with the right level and scope of evidence. In the first stages, the idea is proven, then the technology, and finally the business.

It may also become clear at some point that the idea is not viable. Then you have to know how to stop or change direction, for example, in terms of raw materials. When scaling is done in a controlled manner, it is possible to change directions quickly enough.

What has working with startups taught you?

I lift my hat to all startup operators who boldly and passionately set out to change the world. It has become clear that effective collaboration between different parties is very important in order to succeed in scaling.

I also like how startups dare to think big and develop quickly – and also to fail. Many traditional and established operators should learn from this, including us!



Teemu Turunen

Age: 43

Lives in: Muurame, Finland

Education: Licentiate degree (Applied Physics and Environmental Science)

Employment history: Expert in the technology and forest industries, in a state-owned company promoting energy and material efficiency, and in a micro-level consulting company. Part-time lecturer at Jyväskylä University of Applied Sciences.

Hobbies: Krav maga, the gym, enjoying nature with the family, and all types of small building jobs

District heating – an advanced driver of the green transition

Text: Ville Korpinen
Images: iStock

Few people outside the industry would have believed a couple of years ago that district heating is being talked about today as a solution for the future. However, district heating networks play an important role in the green transition, as they enable new, emission-free methods of heat production, such as the utilization of waste heat. Moreover, in the heat recovery of green hydrogen projects, they are irreplaceable.

The term “district heating” has an old ring to it. It is thought of as a municipal service that had to be developed in Finland’s cold conditions to enable the effective distribution of heat even to remote areas. Within the last year, however, the term has resurfaced in connection with the energy crisis and green projects: district heating is suddenly seen as a significant enabler of the green transition.

The district heating network is largely a Nordic solution. District heating has also been used in Central and Eastern Europe but not in such an advanced way as in Finland, where it has a long history. According to Statistics Finland, district heating was the most popular heating solution in Finland in 2020.

District heat production also in transition

In 2020, more than a fifth of Finland's district heating was produced using forest fuels, and the figure was expected to increase.[1] At that time, the energy crisis was not yet in sight, and some of the fuel was procured from Russia. Now Russian imports have ended, and a shortage in the supply of energy wood is looming. This has accelerated, among other things, investments in electric boilers, which are currently mainly made by larger operators in the district heating sector.

Of course, wood chips will continue to be used in heating centers and current power plants, but large district heating companies in particular are struggling with the challenge of how heat production will be implemented in the future. Also in smaller district heating networks, various heat

> **The ongoing sector integration can be seen, for example, in the merger of the electricity and heat sectors. At its most advanced, it means the heat recovery of green hydrogen projects.**

> Since the start of the energy crisis, energy companies have become increasingly interested in waste heat.

recovery solutions are already being implemented, and the introduction of electric boilers is being explored.

Electricity can help make heat production greener, as long as the electricity itself is produced using renewable energy, such as wind power. Today, the use of electric boilers still relies on cheap hours: their use is limited to times when cheap spot market electricity is available.

Hydrogen economy is coming – with the help of district heating networks

The ongoing sector integration can be seen, for example, in the merger of the electricity and heat sectors. At its most advanced, it means the heat recovery of green hydrogen projects: the hydrogen plant operates on wind power, and the waste heat is used to heat cities.

Elomatic's project development company Green North Energy also has similar plans. The waste heat from the Naantali plant under development is to be used in Turku's district heating network. The amounts of energy generated by hydrogen plants are usually huge. Finding a use for all the waste heat in summer, when less heating is needed, can even be a problem for the energy company.

One seventh of Finland's district heating already comes from waste heat[2]

In addition to hydrogen plants, waste heat is generated in industrial processes, data centers and various refrigeration devices. If a factory is able to utilize the heat itself, it is usually the best option. Otherwise, waste heat is collected in the district heating network and transferred to where there is a sufficient demand for heat.

Since the start of the energy crisis, energy companies have become increasingly interested in waste heat. The growing interest can also be seen in our Elomatic consulting group. We are commissioned to explore the possibilities of utilizing different sites for district heating networks and clarifying what type of power they can receive.

Utilizing waste heat always requires detailed assessments. It is not always possible due to technical or commercial limitations, for example.

Waste heat even from waste water

New sources of waste heat are constantly being researched, and one subject of interest is treated wastewater. A good example of this is the recovery of waste heat at the Pått wastewater treatment plant built by Vaasan Sähkö: the heat from the plant is directed to the district heating network, where it is sufficient for the needs of almost 2000 detached houses.[3]

Especially if operations involve a lot of energy consumption and there are large amounts of waste heat in the buildings, it is usually profitable to recover the heat. For example, it might make sense to build a two-way solution in connection with the energy renovation of a large spa if it is located close to a district heating network.

Heat storage also needed

Renewable energy sources are cyclical by nature. When using them, heat storage is needed to enable heat to be produced when it is most profitable and used when it is needed. The district heating network is itself a form of short-term storage. To enable the use of it as storage capacity, measurement technology and digitization are needed.

One possible solution is the combination of an electric boiler and storage. In addition, very large-scale storage facilities are under development. For example, Vantaa Energy is planning the world's largest seasonal heat storage under Ring Road III.

Towards low-temperature networks

New energy production methods, such as waste heat recovery, typically produce slightly cooler water than traditional technologies. In the future, district heating networks will be built largely as low-temperature networks in which the temperature of the circulating water is lower, as the name suggests. To be precise, the rating has been dropped from the previous 115 degrees Celsius to 90 degrees Celsius. These lower temperature levels can be used in networks outside of the coldest periods of frost and the heating season, and on a case-by-case basis throughout the year.

The challenge in this is the long transition period, as the renewal time of current networks is 60 to 80 or even 100 years. Current networks are designed for a larger temperature range, so the narrowing of the temperature range caused by the drop in supply temperature and the resulting increase in flow cause a limitation to the network's transmission capacity.

A drop in the temperature level nevertheless improves the energy efficiency of networks, as heat losses remain lower than in traditional district heating networks. In addition, a low-temperature network enables heat pump energies to be taken into the network, meaning that the temperature level is more favorable for transfer.

Clear advantages for district heating customers

With the help of district heating, entire cities can switch to green heating at once without the need for local companies and residents to acquire new heat production equipment. Digitization will enable even more in the future, such as demand flexibility that will let consumers limit their own heat intake if there is a need to reduce heat consumption.

From our consultants' point of view, things get more complicated as heat production becomes more diverse. Managing energy production will be even more challenging when heat production units and heat storage are added here and there along the grid. However, the network still has to operate on the customer's terms: demand and supply must meet.

Ville Korpinen
B.Sc. (Tech.)

Ville has more than ten years of experience in simulation, consulting and planning tasks related to the distribution and generation of heat in district heating networks. He currently works as Team Leader of the District Heating Team in the Process and Energy sector consulting group. The focus of his work is consulting and developing the heat distribution of district heating networks.

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References

1 Vaasan Sähkö 2021 Kaukolämpö on tulevaisuuden lämmitysratkaisu | Vaasan Sähkö (*vaasansahko.fi*)
2 Finnish Energy, Kaukolämpötilasto 2021 *https://energia.fi/files/7487/Kaukolampotilasto_2021.pdf*, page 4
3 Elomatic 2022 Vaasan Sähkö has commissioned Elomatic to design and project manage a future heat pump plant – Elomatic

New ways to estimate and predict health

Improving the treatment of brain aneurysm with computational methods

A new world of possibilities is opening up to the healthcare sector with the latest advances in artificial intelligence, numerical methods and computing power enabling new ways to estimate and predict our health. The treatment of brain aneurysm is one of the many fields that could greatly benefit from this. The results of the research project carried out by the Southwest Finland wellbeing services county (VARHA) and Elomatic support this assumption.

Text: Kalle-Oskari Suvanto, Valtteri Ala-Ilomäki
Images: Elomatic, iStock

Data is becoming more valuable than ever as the methods to utilize it improve at a fast pace. In line with this development, computational methods are expected to provide better treatment decisions and predictions, resulting in a healthier population and improving the efficiency of the healthcare system. Both aspects become increasingly critical as the population ages.

To address the challenges associated with treating a brain aneurysm, a common cerebrovascular disorder, VARHA and Elomatic partnered in a research project to better understand the disease. VARHA provided their medical expertise, while Elomatic brought their expertise in computational fluid dynamics (CFD) and machine learning to the project. The primary goal was to discover new predictors of intensive care unit (ICU) death for patients suffering from aneurysmal subarachnoid hemorrhage.

Today, brain aneurysms are typically found by accident

Brain aneurysm means a weak spot in a brain artery wall that has developed into a balloon-like bulge. Its prevalence is estimated to be around 3%[1]. Although most aneurysms do not cause symptoms, they are at risk of rupturing. Ruptured brain aneurysm causes subarachnoid hemorrhage, which is a neurological emergency. Its mortality rate is approximately 40%, and survivors are often left with neurological deficits due to the complicated and poorly understood aftereffects of the condition[2,3].

However, the diagnosis and treatment of unruptured aneurysms is not a straightforward task. Brain aneurysms are often found by accident and although a ruptured aneurysm causes a life-threatening condition, many do not rupture during the patient's lifetime[4,5]. Treatment of unruptured brain aneurysms has major risks, and physicians must carefully assess the risk of rupture on a case-by-case basis.

CFD could help assessing the rupture risk

So far, CFD methods have seen little clinical use due to the trouble in acquiring enough patient-specific data cost-effectively and the difficulty of validating the results. Additionally, the true connection between flow dynamics and aneurysm pathophysiology is yet to be revealed, which currently limits the potential for clinical use.

However, progress has been made, as patient-specific geometries are already the industry standard. CFD can be used to predict phenomena such as loads on vessel walls, clotting of blood, vortices and fluctuation of blood flow. Different flow-derived parameters linked with aneurysm formation, growth and rupture can also be utilized to determine the behavior of blood flow.

Challenges of blood flow simulation

Simulating blood flow is a particularly interesting topic due to its complexity. Blood is a non-Newtonian fluid as it becomes runnier when it is stirred. Adding up to the challenge, the boundary conditions associated with the flow are complex. They describe the conditions on the boundaries of the domain such as vessel walls and flow inlets and outlets.

As is the case with all CFD models, correct boundary conditions are of extreme importance in order to produce a realistic solution. The boundary conditions are particularly complicated in this case as the heart creates a pulsating flow, and the vessel walls are distensible. Being able to accurately incorporate these features in the simulation model via boundary conditions is very difficult, because a great deal of complex medical measurements would have to be made to

implement them.

In the end, the simulation model is quite complicated and incorporates some features rarely seen in other engineering CFD models. For example, in Elomatic's pilot simulation, the outlet boundary conditions were implemented using the Windkessel model, meaning that for every flow outlet there is a small virtual electronic circuit. Circuit theory is then utilized to compute the transient boundary condition for each instant of a heartbeat.

The structural solver is also needed

Solving the velocity field over the course of a heartbeat is only one part of the whole solution, which includes the deformation of the vessel walls as well. This must be accomplished by coupling the CFD solver with a structural solver. This way, the CFD solver gives the flow field, and the structural solver computes the resulting deformation, creating a fluid-structure interaction.

Solving the vessel wall deformation accurately is challenging as each person's personal tissue properties would have to be measured or predicted. Things such as age and plaque buildup affect vessel wall properties, adding up to the challenge.

Insights into events in the vascular system

As an outcome of the pilot simulations done at Elomatic, we gained important insight about implementing the mentioned dynamic inlet and outlet boundary conditions and utilizing magnetic resonance imaging in producing patient-specific geometries using real patients. Different flow-derived parameters inside an aneurysm were analyzed in order to study the flow details.

The simulations also gave us insight of what could happen in the vascular system in terms of stresses and vortices when the fluid is considered as non-Newtonian. In future research, the focus is to be directed in the implementation of fluid-structure interaction and more thorough patient-specific boundary conditions to make the model more realistic. Eventually, the model has to be validated to see how well it represents reality.

Mining patient data

Next, our task was to train a machine learning model to predict ICU outcome: death or discharge to hospice. VARHA provided us with a dataset containing thousands of features from brain aneurysm patients, which was used to train the model.

In modern hospitals, a single patient visit generates a significant amount of data. While this data can contain valuable insights, the size and quality of the dataset can make it difficult to mine effectively. Fortunately, artificial intelligence-based solutions offer a powerful means of learning from large volumes of data.

The difficulty of producing a generalizable machine learning model

With thousands of features and only hundreds of patients, the risk of overfitting is high, meaning that the resulting model can become closely tailored to this specific dataset and may not perform well with new data.

Furthermore, a vast majority (98%) of the features were missing, which is a common issue with this type of data. As an example, only half of the patients may have had their hemoglobin levels measured, while the other half may not, and therefore their values are missing. The missingness can itself be meaningful since it can reflect the physicians' decisions. The time-series nature of the data, among other things, adds to the complexity of the dataset, making it crucial to carefully select the appropriate processing methods.

Excellent short-term predictions of ICU outcomes

As the goal of the research was to discover new predictors of ICU death for patients suffering from aneurysmal subarachnoid hemorrhage, we employed a combination of simple and complex feature selection techniques. This reduced the number of features from thousands to a handful. These features were then used to train multiple machine learning models and their results were compared.

The models demonstrated excellent performance in predicting ICU outcomes that occur within a week, although their performance decreased for longer-term outcomes. Overall, the model performance was good, but what was even more interesting was that the remaining features contained three predictors of death that had not been considered in prior machine learning-based research work.

Increasingly reliable early warning signs

Computational methods undoubtedly have their place in tomorrow's healthcare: they can uncover new insights about diseases and enable physicians to peek into the future. In the case of ruptured and unruptured brain aneurysms, these methods can be used to assess the risk of rupture, to predict

> **Overall, the model performance was good, but what was even more interesting was that the remaining features contained three predictors of death that had not been considered in prior machine learning-based research work.**

the likelihood of death in the event of a rupture, and to predict how well the patient recovers.

We have already continued the work with VARHA to repeat the data mining experiment with a larger patient population to validate the results. The newly discovered predictors can be combined with previously known predictors to improve the model's performance. This will give clinicians more reliable early warning signs of poor patient outcome.

These examples are just the tip of the iceberg of all the possible applications. Ultimately, use of computational methods can lead to the development of more effective treatment options at every stage of the patient journey. In addition, the predictions generated by these methods can have an immediate impact on patients' lives.

Kalle-Oskari Suvanto
M.Sc. (Tech.) in Biomedical Engineering

Kalle is passionate about the entire machine learning lifecycle, including identifying business problems, collecting and processing data, and machine learning operations. With a background in computer science and engineering, coupled with experience in software development, he possesses the skills necessary to effectively tackle a wide range of technical challenges.
He actively seeks opportunities for growth and strives to enhance his skills.

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Valtteri Ala-Ilomäki
M.Sc. (Tech.) in Mechanical Engineering

Valtteri joined Elomatic in 2021 and currently holds the position of Senior Design Engineer in the CFD Analysis team. He has worked on a variety of marine CFD projects, as well as hemodynamics simulations. He graduated in 2022 from Aalto University, where his studies focused on fluid dynamics.

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References

1 Vlak M.H., Algra A., Brandenburg R. & Rinkel G.J. (2011) Prevalence of unruptured intracranial aneurysms, with emphasis on sex, age, comorbidity, country, and time period: a systematic review and meta-analysis. The Lancet Neurology 10, pp. 626–636.

2 Geraghty J.R. & Testai F.D. (2017) Delayed cerebral ischemia after subarachnoid hemorrhage: beyond vasospasm and towards a multifactorial pathophysiology. Current atherosclerosis reports 19, pp. 1–12.

3 Van Gijn J., Kerr R.S. & Rinkel G.J. (2007) Subarachnoid haemorrhage. The Lancet 369, pp. 306–318.

4 Seibert B., Tummala R., Chow R., Faridar A., Mousavi S. & Divani A. (2011) Intracranial aneurysms: Review of current treatment options and outcomes. Frontiers in Neurology 2. URL: *https://www.frontiersin.org/article/10.3389/fneur.2011.00045*.

5 Tawk R.G., Hasan T.F., D'Souza C.E., Peel J.B. & Freeman W.D. (2021) Diagnosis and treatment of unruptured intracranial aneurysms and aneurysmal subarachnoid hemorrhage. Mayo Clinic Proceedings 96, pp. 1970–2000. URL: *https://www.sciencedirect.com/science/article/pii/S0025619621000410*.

/// INSIGHT ///

What significant changes do you see in your field in the near future?

Jukka Turunen | **Sales Manager** | Machinery and Equipment

The technology industry is now experiencing enormous pressures of change, and these changes are happening faster all the time. For example, the use of artificial intelligence is increasing rapidly. In the fifth industrial revolution, priority is being given to environmental protection, and this has a strong impact on business.

The machinery and equipment industry is becoming a smart and resource-wise operator. The trend is towards people interacting more and more with machines and devices, and interaction between people also takes place to an increasing extent remotely or in a virtual environment. The automated efficiency of machines is combined with human creativity, which can be seen, for example, in the sustainable use of resources and in safety aspects.

The background to all this is society's increased awareness of environmental issues and higher requirements. Previous paradigms have caused significant damage to the environment, and now it is man's turn to take responsibility for his actions by being a resource-wise actor.

Riikka Peltola | **Sales and Development Manager** | Pharma

The pharmaceutical industry is a vital sector that plays a significant role in healthcare by developing new drugs, vaccines and treatments. In recent years, development has been seen in the areas of biotechnology, precision medicine and gene therapy, for example.

In the near future, pandemics will have a big impact on the pharmaceutical industry. Companies around the world will compete in the development of vaccines and treatments, as well as diagnostics.

Another trend is precision medicine, which takes into account the patient's genetics, environment and lifestyle when planning treatment so that the drugs can be more effective and cause fewer side effects.

The third trend is biological drugs, which are already used in the treatment of common diseases, such as diabetes and rheumatism. Their importance in the future will be considerable – half of the drugs under development are biological preparations.

However, the pharmaceutical industry also faces challenges, such as increasing regulation, expiring patents and rising drug development costs. There is also a lot of discussion about the pricing and availability of medicines. The continuous development of science and technology will certainly continue to support innovation in the field of drug development and healthcare.

Hannes Lehtinen | **Consulting Engineer** | Energy Consulting

The energy industry is changing rapidly, and the challenges and opportunities brought by the energy transition are constantly reflected in our work. The pace of change has increased significantly within a few years, as the EU's ambitious climate goals and Russia's war of aggression in Ukraine have awakened us to our dependence on fossil forms of energy.

We want to get rid of fossil forms of energy, and emissions trading and taxation are already effective guides for achieving this. As a result, new projects related to burning fossil fuels have decreased, while renewable forms of energy, the electrification of industry and the utilization of waste heat have become key. The amount of renewable forms of energy production, such as wind power, is increasing considerably in the Nordic countries, while the electrification of industry is increasing consumption.

Regarding the electricity system, stable basic production will decrease in relation to renewables, and price fluctuations will increase. To tackle price fluctuations, the electricity market needs consumption flexibility, which is provided, for example, by the production of green hydrogen. Another way is the effective optimization of production, which is suitable for both industrial production and electricity-intensive forms of heat production.

We design solutions that increase the wellbeing of people and the environment.

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