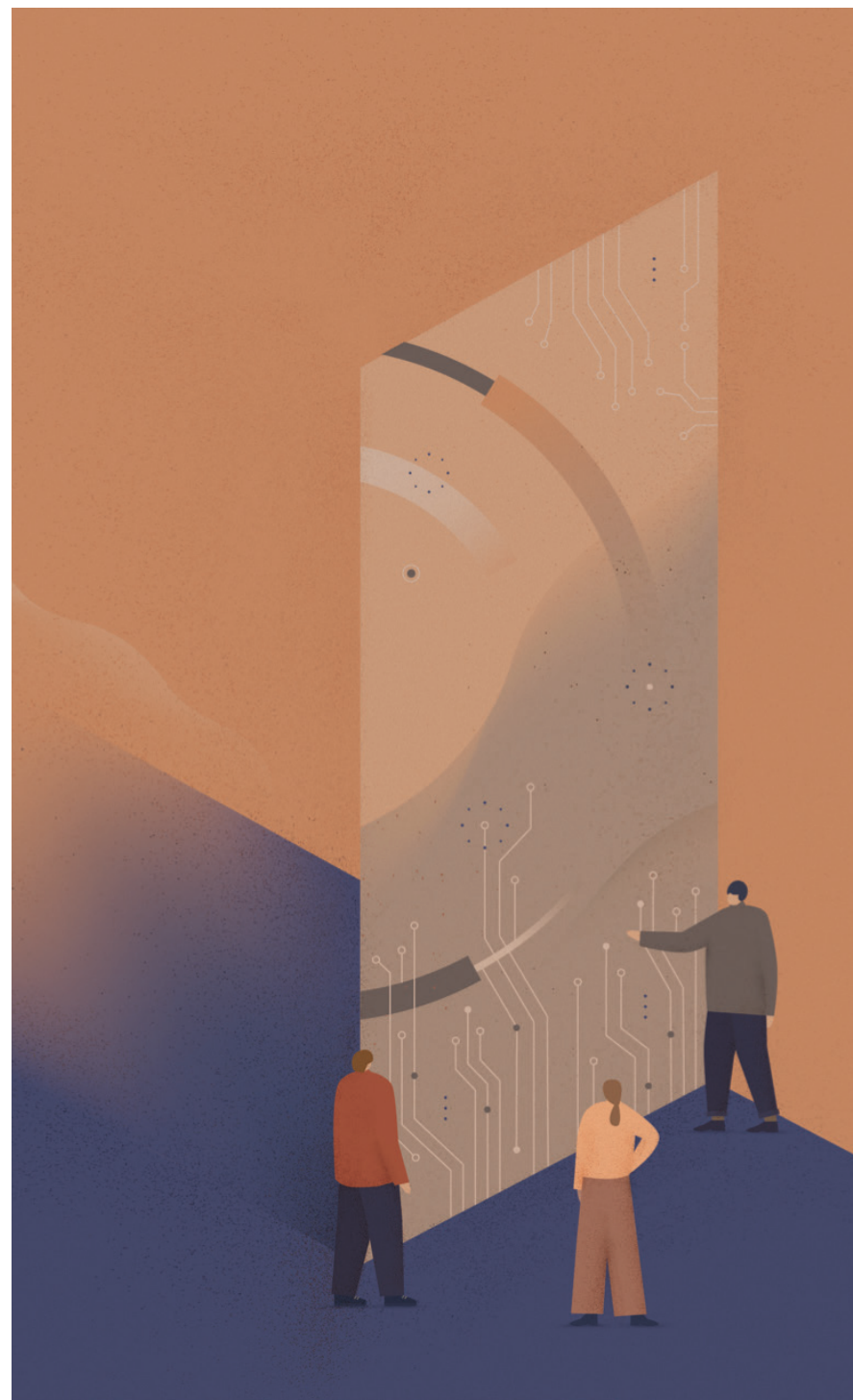


EQUILIBRIUM

EQUILIBRIUM

Equilibrium. A state where all competing forces balance out, become equally strong and thus more stable.

It is a state we strive towards in all areas of our lives, so that we are able to make progress, both personally and professionally.



We live in the age of smart devices, social media, artificial intelligence and automation, all of which make our lives, work and communication easier, but also pose various challenges. Given the myriad of incoming stimuli and possibilities offered by the environment, maintaining equilibrium in personal and professional life is becoming increasingly difficult, and consequently more important than ever.

At Rotinox, 2019 marks 40 years in business, and we consider that maintaining an equilibrium during all these years has been a key element in the company's success. On the one hand, this means keeping tradition alive, on the other, introducing innovative approaches to how we do business. Respecting and supporting the local environment, and at the same time operating on a global level. Mastering the skills of one's craft and introducing principles of operation brought about by Industry 4.0. Realising one's vision, maintaining passion for work and encouraging positive interpersonal relationships.

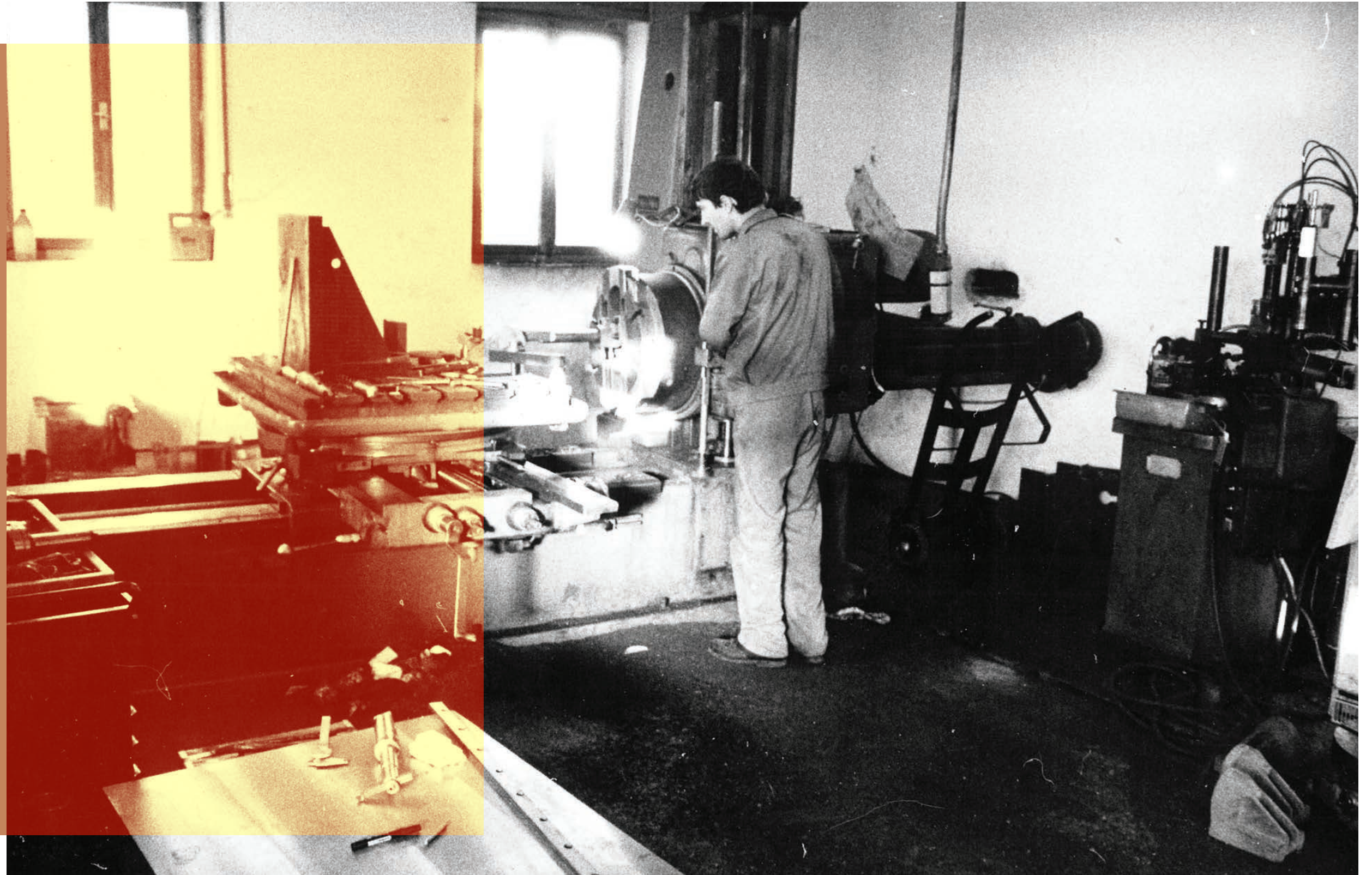
The Japanese, who live longer than most, say that the secret to a long and happy life is finding one's own *ikigai* - mission - and maintaining equilibrium.

Equilibrium means a balanced view of the past, present and future. It is a story about us and a story about you. After all, we are all faced with similar challenges. Life is not static, and changes are a part of our nature. As the Japanese say, knowing how to establish equilibrium is key.

table of contents

<i>The past</i>	Every Man is a Piece of the Continent	8
<i>The present</i>	The Secret to a Long Life Lies in a Passionate Approach to Work	14
	Simulation and Virtual Process Analysis	16
	Innovative Solutions for the Biggest Challenges in the Process Industry	20
<i>The future</i>	Interview With Marko Grobelnik: One Day, Artificial Intelligence will be able to Predict the Future	26
	Entering the Fourth Decade and the Fourth Industrial Revolution	30
	How to Implement 4.0 in the Process Industry?	32
	What will the World be Like in 2050?	36

The past



Every Man is a Piece of the Continent

The past

“No man is an island entire of itself; every man is a piece of the continent, a part of the main,” wrote John Donne.

A company’s success is also always the result of the combined work of people with a common vision, values and desire to create.

Rotinox, celebrating 40 years in business in 2019, currently brings together thirty-two people who contribute their work, efforts and knowledge to contribute to the common story of the company.

The Pavšič family, which remains the foundation of the company, established the business over four decades ago with the aim of creating new solutions to make people’s lives and work easier.

Founder – A Man With A Vision

Rotinox’s history does not date back to 1979, but to the 1950s, when Miran

Pavšič, the founder of the company, was born. He was very creative, resourceful and skilled with his hands. All this led him from being a metalworker to becoming a personal driver of the director of the Soške elektrarne power plant. When driving, he was privy to numerous interesting conversations about the business world, which planted the seed for his desire to found a company of his own to realise his ideas. In 1979, he made his dreams come true and opened a small tool workshop with his wife Magda. Despite the harsh competition, Miran was able to lead the company into the future with his optimism, strong drive and belief in success. Due to his entrepreneurial spirit, he was able to see opportunities where no one else did, while his drive for innovation helped him to take on the most complex challenges.

Whichever project he embarked upon, Miran left a strong impression. He contributed to the development of the region and its economy. He encouraged cooperation between small business owners and helped develop new solutions and standards of operation in the process industry. He was a great man with an insatiable desire to create.

retrospective

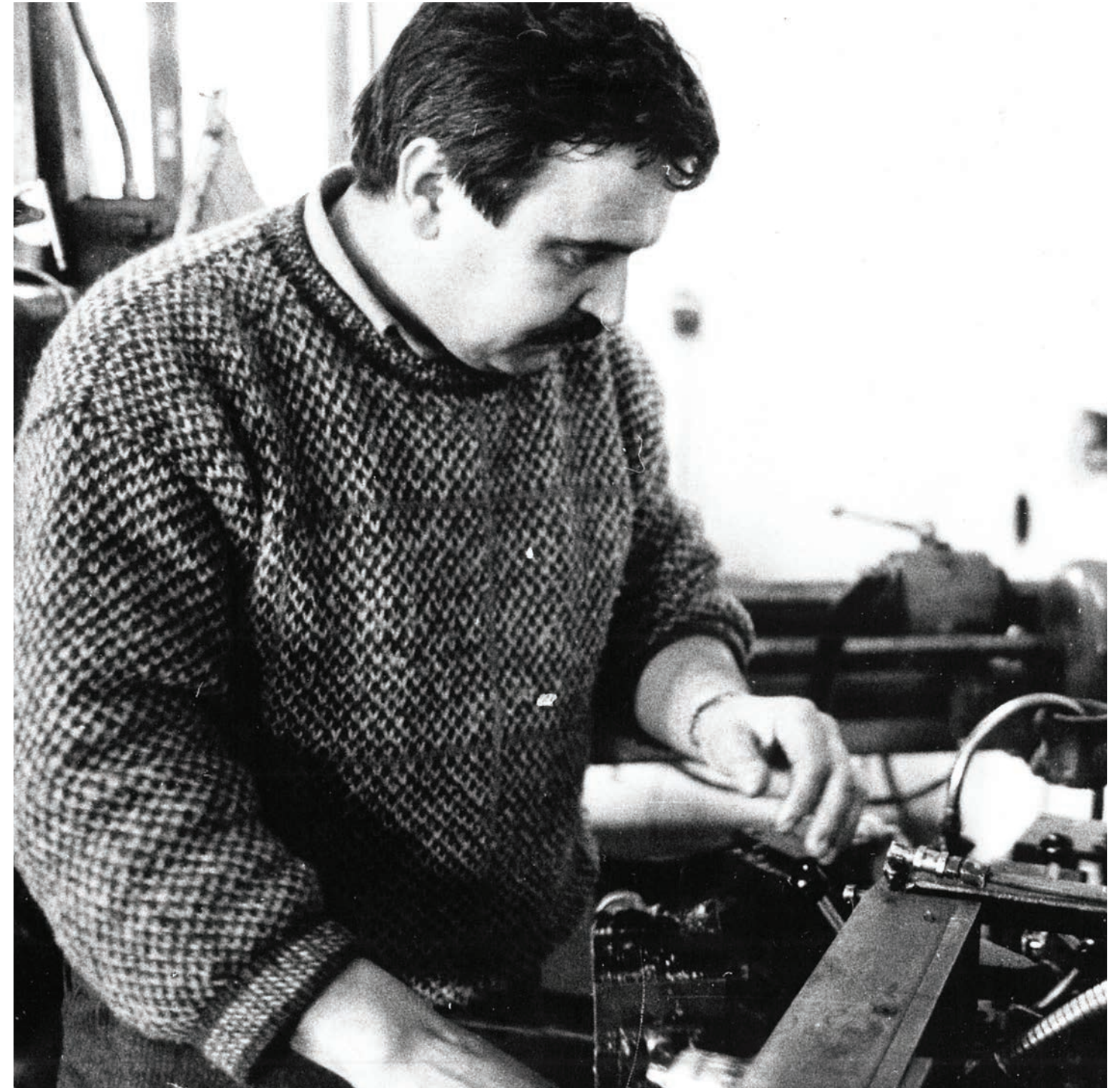


Photo: Rotinox Archive

It was in Nova Gorica where the company developed its first more complex product – a rotation table. This lent the company the name “Roto”, and “inox” was added in the 1990s, when the firm started to manufacture first more complex products made of stainless steel. Miran’s creativity and drive to innovate were boundless, so the company started to develop increasingly complex solutions for the food industry and later for the pharmaceutical industry, which opened up numerous new opportunities and possibilities to expand.

The Woman Who Kept Equilibrium

The saying goes that behind every successful man there is a strong woman. That woman was Magda Pavšič. Like her husband, she was used to working hard and was also very resourceful, finding a solution to every problem. She was in charge of finances and human resources, making sure that the business ran smoothly, while Miran was the face of the company. She always believed in him and his dreams, which quickly became her own. Even though she was juggling numerous responsibilities in the company, raising two chil-

dren and running a household, Magda never complained:

“I have no regrets. Given the chance, I wouldn’t change a thing. Of course I occasionally wondered what was the point of everything, but I’m happy and proud that we’ve managed to create something our children have been able to continue so successfully.”

The Motivation Driving The Second Generation

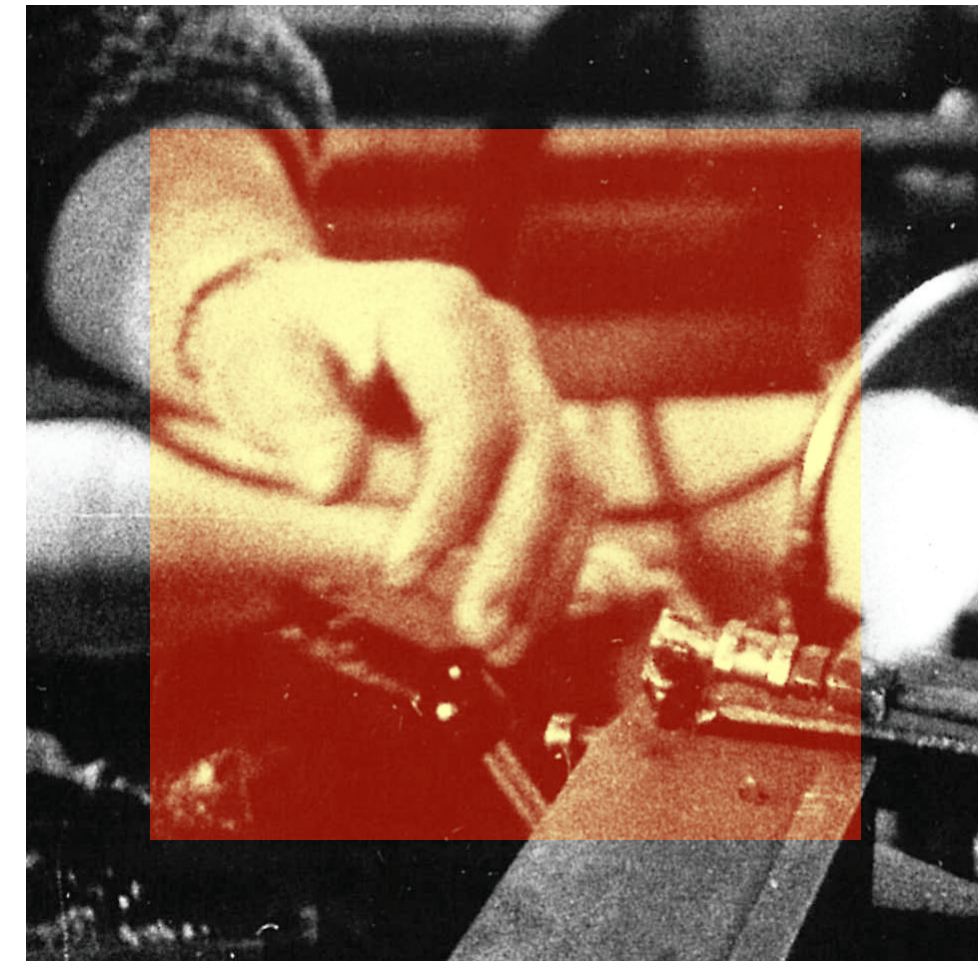
The second generation of the Pavšič family, a daughter and a son, grew up alongside the company since the beginning. Rotoinox was not only a place where their mother and father worked, but a way of life. In addition to the values of honesty and hard work, they also inherited numerous talents. The daughter inherited the sense for design, determination and meticulousness, while the son inherited the passion for innovation and charisma that his father was so well-known for.

Even though the decision was not easy, they gradually took over the running of the company that had been a part of

their lives since childhood. This process coincided with the economic crisis, and the new management took a daring decision that had a decisive impact on the further development of the company – it decided to expand the business abroad. Rotoinox first started to work for smaller and then for increasingly larger pharmaceutical companies in Europe. The projects became increasingly bigger and more complex, while the employees gained experience and expertise. The company began to be seen as a competitor of the most renowned engineering and manufacturing companies in the world.

Rotoinox is a story of courage, innovativeness and exceptional drive. It is a story of the Pavšič family and remarkable individuals striving day in and day out to find new solutions for an easier move into a better tomorrow.

In the words of Magda Pavšič: *“The company is not made of a single element, but of a myriad of small ones coming together to form a whole.”*



The present





photo: Ryoji Iwata

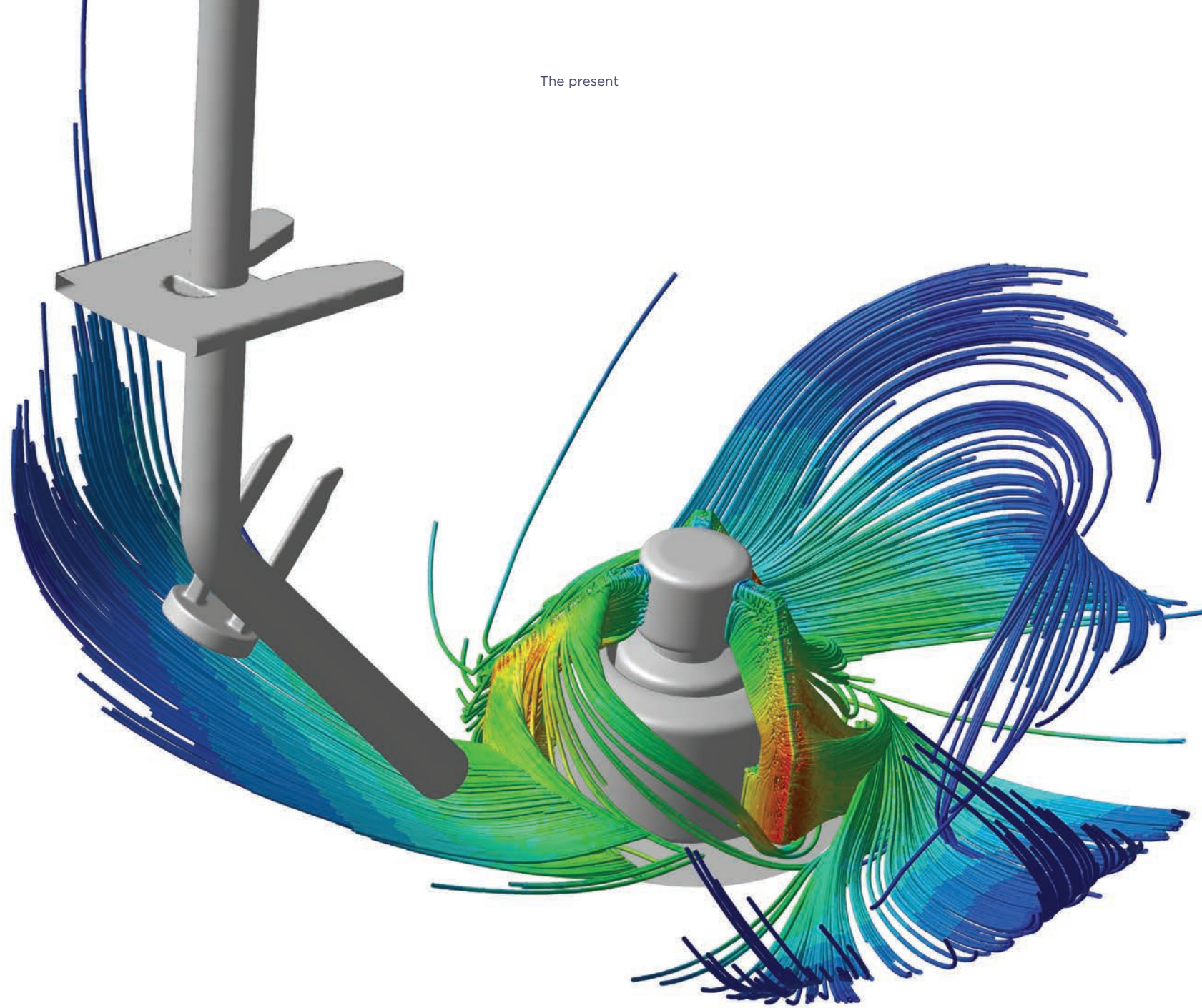
The Secret to a Long Life Lies in a Passionate Approach to Work

The Japanese are known for their longevity. This is particularly true for inhabitants of the island of Okinawa, sometimes called the land of the immortals, as it has the largest share of the population over 100 years of age. The secret to living so long lies in one's way of life, and in recognising purpose in what we do.

Ikigai could be translated as finding what inspires us, and what we are good at. *Ikigai* is equilibrium. The Japanese believe that by discovering your gift and making it your advantage you open up space to develop your passion, and thus also make others happier. They define their function or mission as a priority in life.

At Rotinox, the mission lies in designing and manufacturing high-quality process systems, constant improvements and thus evolution. The work is not seen as just carrying out a profession or following a routine, but as a life's mission making a positive difference in the world.

The underlying philosophy of ikigai: if you dare to do what inspires you, every day can be the best day of your life.



Simulation and Virtual Process Analysis

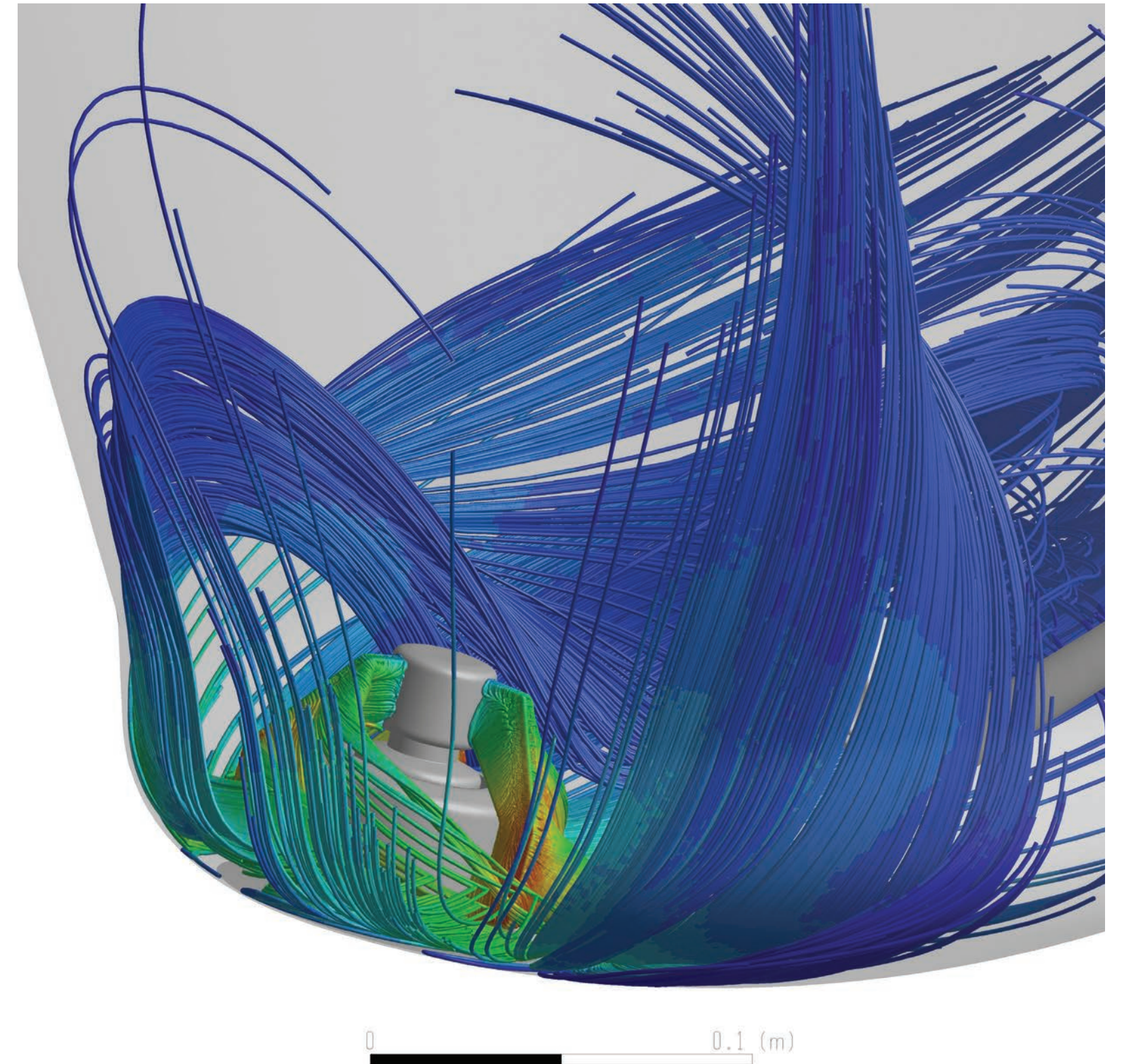
article

Increasingly complex requirements for product development require sophisticated simulation methods and processes. Therefore, it is not always easy to keep an overview of all the available options. A combination of theoretical and experimental approaches together with modern simulation tools have the potential to sustainably change the development of pharmaceutical products, to increase the level of process understanding and finally to dramatically decrease development time and costs.

Modern simulation tools such as Computational Fluid Dynamics (CFD) and Discrete Elements Methods (DEM) are today widely used for the process analysis of different manufacturing steps in the pharmaceutical industry. These tools can be used to investigate the mixing behaviours of different fluids and/or solids and their interactions, as well as complex mass and heat transfer phenomena. Complex multi-physics phenomena occur in almost all processes in the pharmaceutical industry, due to the use of different mixing devices, bioreactors, coating and granulation systems, spray drying, powder feeding and mixing, tableting, tablet coating, etc. The advantage of simulation technology in contrast to experimental work is that it allows a detailed look inside the process and can reveal process characteristics that cannot be easily measured. Furthermore, the analysis can be performed without any existing prototype or device, so that a process can be evaluated before a piece of equipment has been manufactured. This can further significantly reduce R&D costs by evaluating device efficiency in the early project stage.

Further benefits of the simulation technology are the process analysis itself and the development of efficient scale-up/-down strategies, as well as the currently very popular process transfer from batch to continuous manufacturing. Huge numbers of simulation variants are generally executed to obtain relevant process data at different scales. Using such data, an appropriate scale-up/-down and/or batch-to-continuous strategy can be developed, and then experimentally validated considering only a few experimental runs. A very large number of experimental runs using expensive materials can thus be avoided, so reducing costs.

SES-Tec supports Rotoinox in the field of multi-physics simulations and process/device analysis using novel simulation technologies.



Innovative Solutions for the Biggest Challenges in the Process Industry

The present

company presentation



Over the last four decades Rotoinox has designed, manufactured and commissioned innovative solutions for the largest pharmaceutical companies worldwide, and has set standards in the industry on every level. What makes the company outstanding are its high quality and pioneering solutions, a genuine passion for the work and a commitment to a reliable partnership that puts people and relationships first.

Dedicated To Providing The Highest Quality Products And Services

With its deep understanding of specific processes, engineering and manufacturing know-how and a long track record of expertise in the field, Rotoinox offers a large scale of services and products.

Over the years the company has developed a reliable and effective process engineering system that provides high quality solutions with a long-life span. Rotoinox has been ISO 9001 certified since 2005, demonstrating its commitment to consistently providing high quality products and innovative services that meet the needs and expectations of its clients.

All facilities, equipment and critical materials are cGMP and ASME BPE-compliant. Other key quality certificates include a Quality Welding Management System certified according to EN 3834-2, and manufacturing pressure equipment certified according to the Pressure Equipment Directive 2014/68/EU and AD 2000.

Leading experts in the field

The commitment to produce and design high quality and innovative solutions can only be achieved with the support of experts. That's why Rotoinox employs only the best-qualified and most competent individuals in the field.

Over the years the company has designed, manufactured and commissioned many highly ambitious European projects, setting industry standards at every level, and will continue to do so in the coming decades, with its staff equipped with even more of the knowledge, skills and passion that have guided Rotoinox from the very first day.

Range of services

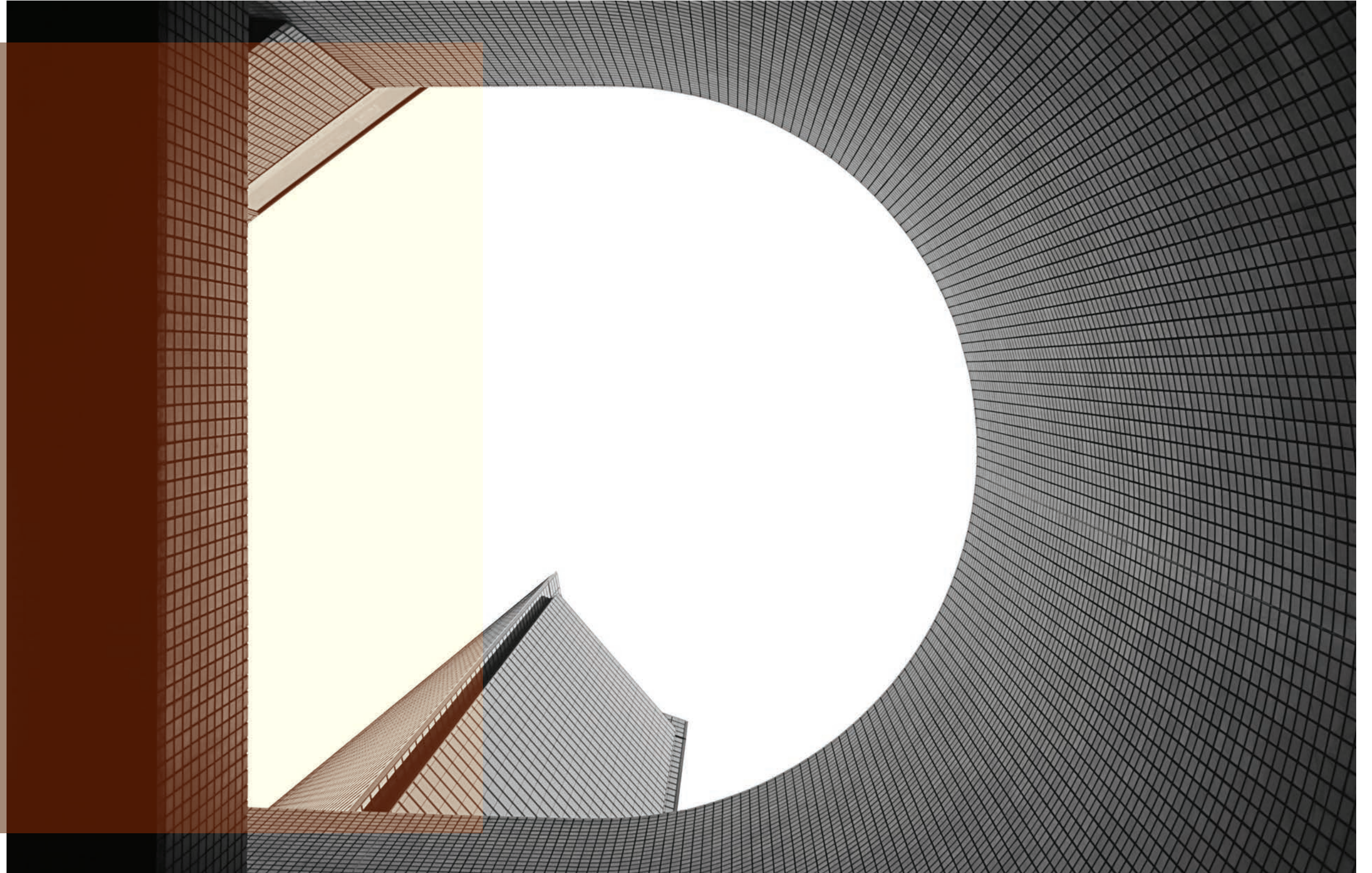
- Consulting
- Conceptual Design
- Basic Engineering
- Detail Engineering
- Customised Process Systems
- Realisation and Construction
- Quality Control
- IQ and OQ Qualifications

Core products

- Pharmaceutical Process Vessels
- Bioreactors / Fermentors
- Filter Units
- IBC Containers
- Material Handling Systems (solids)
- Process Systems / CIP-SIP Units



The future



One Day, Artificial Intelligence will be able to Predict the Future

The future



Interview

Marko Grobelnik is an expert in artificial intelligence at the Inštitut Jožef Stefan research institute. His primary research interests are big data analysis and machine learning. The Slovenian digital expert talked to us about why the fear that we will be replaced by computers in our lifetime is completely unfounded, how work will evolve in the future, and when smart machines will become even smarter.

The 1980s saw the start of the exponential development in the field of artificial intelligence, and one gets the impression that this technology has developed extremely quickly in the last decade. What was the cause of these developments?

Well, the changes actually came about in a considerably more linear and slower manner than perhaps understood by the general public. Still, this perception of a sudden advance was born out of the leap that occurred in 2010 and 2011, when several developments in the field coincided. Smart devices and computers became extremely powerful, which enabled the storage of enormous quantities of data. Consequently, the algorithms on which artificial intelligence is based, and that are in fact over thirty years old, started to produce interest-

ing results and became accessible to basically anyone using smartphones and other devices. This leap came about relatively quickly, and in part this was because these algorithms are not as complex as they seem at first.

Nevertheless, Event Registry, the solution that you developed at the Inštitut Jožef Stefan, is not that simple. Can you tell us what Event Registry is, and who uses it?

The basic idea behind the Event Registry system is that it collects articles in different languages from all around the world in real time and prepares an overview of events based on the collected information. We identify approximately 500,000 articles per day. Seen through this system, the mass of stories crystallises into a clear overview of what is happening around the world. As far as I know, this remains the only system of its kind in the world, and there's a great demand for it. Media outlets use it to understand global developments, while financial institutions use it to predict market trends. Bloomberg uses it for brand monitoring and understanding trends in different parts of the world. We are also discussing cooperation with the OECD, who would like to use the system to monitor the development of artificial intelligence around the world.

Could such a system someday be used to predict the future?

Yes, this is something we are working on. At the moment, the system is used to observe the past and the present. Our database contains five to ten million events, which means several million stories or event sequences. Put together, this provides an outline of developments in society. Based on these outlines, the system will learn to discern how society functions and will be able to predict the future. We have developed the system to such a degree that we know this is possible, but we do not yet have the final solution.

Is it true that the artificial intelligence lacks the ability to understand the world in depth?

Absolutely. The current artificial intelligence systems operate on the basis of searching for and recognising patterns in data. Even if a computer says that an image is one of a dog, a tree or a ship, these algorithms do not recognise what is portrayed, they only know that the shapes correspond to something that has been defined as a tree. People's knowledge of the tree surpasses the mere fact that it is a tree. We know that it grows and what fruit it bears. Algorithms know nothing apart from the fact that the image is an image of

a tree. They lack context as to how all these object that can be identified on the basis of an image, a text or a sound are interconnected and what they affect, what additional information they carry. This is similar to going to a foreign country where a completely different language is spoken and after a while recognising that certain sounds are repeated, without understanding what these sounds actually mean.

Do you see this as the greatest challenge in the field of artificial intelligence?

Considerable funds are now being invested in the next wave of artificial intelligence that will be much smarter than today's technology. Current artificial intelligence is referred to as shallow¹, as it is good at solving certain problems, perhaps even better than humans are, but does not have in-depth understanding, as I already explained. To provide a comparison: when a child begins to learn, it learns to recognise patterns, the faces of its parents and relatives – afterwards, it quickly starts to connect both information and the surrounding world, and in a couple of years it is able

to understand a simple fairy tale. No algorithm today can understand Little Red Riding Hood, while this is not a problem for a child that's a few years old. But changes are bound to occur in this field as well. We expect that such solutions will gradually start coming on the market in five to ten years, making computers much more helpful.

What other solutions are being developed at the artificial intelligence laboratory?

We are currently working on twenty very different projects. For instance, we are helping Spanish historians combine old documents from the time of Marco Polo to form a cohesive narrative, and we're working with Microsoft to develop a programme to monitor scientific developments. We are also developing solutions for smart factories. Smart factories and Industry 4.0 are closely connected to artificial intelligence. At a factory, the various processes are carried out at different levels, which is why something constantly goes wrong. Things rarely turn out as planned, which is why we are striving to design solutions to correctly predict

these errors and anomalies. Our approach is innovative, in the sense that it enables the simultaneous analysis of all factory operating levels.

How is artificial intelligence applied in the field of medicine and the pharmaceutical industry?

Lately, the focus has been on various new methods for the development of innovative medicinal products. As in other cases, artificial intelligence can only be used as an aid; we are not talking about a brain that could think instead of humans. Such aids make it possible to design the medical product better and check the effects more quickly, as well as numerous other things. With medicine, the situation is similar. Better technology means better and more precise insights into the functioning of the human body and the like. What is the common thread then? Where the data is available, artificial intelligence can help by providing additional insights into the established systems in manufacturing, logistics, linguistics and the pharmaceutical industry.

Could a system such as Event Registry, which predicts events, use patient data and predict their health in the future?

With appropriate data, yes. However, the key question here is if the right data is available. Currently, the only analytics available are genetic tests used for easier diagnoses, however, even these can be very complex and are not yet properly researched. We do not yet have data on many phenomena, including the functioning of the brain. No solution to measure the functioning of the brain in a satisfactory manner or track thoughts exists at the moment. We see which part of the brain is activated, but this only gives a very general idea. The algorithm would be able to predict a person's health in the future only if it were able to obtain the information necessary for generating these predictions.

Some people fear that artificial intelligence and smart devices will be able to completely replace humans. Is this fear justified?

Currently, this does not seem to be the case. In some parts of certain processes, robots can indeed make a huge difference, but they can only replace repetitive manual tasks. We need to be aware that life in the factory is much more than that. Even a hundred and fifty years ago, at the time of the industrial revolution, when machines started to replace manual labour, there was a similar public debate; however, this process was exactly what enabled progress. It needs to be emphasised that we are only moving forward along this same line. Some jobs will likely disappear or there will be fewer of them; however, there will be more creative and socially intense jobs requiring lots of interaction and soft skills. There are very interesting developments ahead in the field of artificial intelligence, for instance autonomous cars. Personally, I'm looking forward to these developments, as life will be easier. Technology is changing our lives for the better, and artificial intelligence is only a part of this.

¹ *Shallow or narrow artificial intelligence* is a type of artificial intelligence that outperforms humans in a limited and narrowly defined task.

Entering the Fourth Decade and the Fourth Industrial Revolution

The future



article

In its 40 years of existence Rotinox had seen many changes. The company had to reinvent itself many times to respond to the changing social and economic environment. After being in the field of stainless-steel equipment production for two decades, the company decided to make its way in the process industry, a change that required a complete redefinition of processes and standards, leaving behind the old methods and developing new ones.

Entering its fourth decade of existence the company decided to leave its comfort zone once again and celebrate this important milestone by starting to implement the methods of smart manufacturing and embracing the potential of Industry 4.0.

The company started to implement new software solutions to optimize its management and is currently looking for new systems and applications that will enable the firm to rapidly gain value from data by turning them into actionable information.

Rotinox is keenly aware that a trained and skilled workforce is vital for successful 4.0 convergence.

The company thus started to employ more highly specialised personnel and experienced mechanical engineers. It started to build its R&D department that will be appointed to optimise the manufacturing processes and set the ground for smart manufacturing.

In the next decade the company plans to digitalise all its processes, including using advanced data systems, additional IoT/IoTT technology² and artificial intelligence. This will help the firm to optimise all operational processes, reduce quality and safety issues, accelerate change in resource management and most of all enable the delivery of top quality and innovative solutions at any given time. The road to smart manufacturing will start in a newly built facility that will enter operation in 2021.

² IIoT - Industrial Internet of things. This mainly refers to an industrial framework whereby a large number of devices or machines are connected and synchronised through the use of software tools and third platform technologies in a machine-to-machine and Internet of Things context, and later an Industry 4.0 or Industrial Internet context. IoT - Internet of things.

How to Implement 4.0 in the Process Industry?



While the manufacturing industry has been successfully implementing the principles of Industry 4.0 for a while, the process industry is only slowly adopting this new approach. The process industry has done its part with regard to process automation and digitalisation over the past two decades, and so at the beginning could not see the full potential of Industry 4.0. The game changed, however, when the industry realised that this new paradigm is bringing a completely new approach to the use of data and could help turn the collected process data into actionable information - like predicting maintenance or energy management. This was the turning point when the process industry started to embrace the new industrial revolution.

According to the magazine *Manufacturing Global*, Industry 4.0 will bring the process industry four main advantages: linking information with operations; increasing productivity; linking employees with valuable data, thus leading to better decisions; and connecting facilities to the supply chain.¹

The heart of Industry 4.0 is data, which is also the core of the process industry. In the chemical and pharmaceutical industry there is no room for error, and every decision is based on verified and reliable data. **The latest technological revolution uses data to bridge the gap between information and operations.** With the help of advanced software and AI, information is measured and categorised to automate processes, predict control and maintenance, reduce quality and safety issues and most of all minimise errors.

Thanks to advanced digital technologies, employees in smart industries can access information about equipment virtually, can learn to operate new equipment or new skills through virtual reality, and benefit from many other new developments. But as with every disruptive technology the concept of Industry 4.0 also raises some fears and doubts. Many times we hear the

misconception that automation will replace humans. **The use of software will of course reduce the need for physical labour during operations, but people remain the key factor in making decisions on how to act on the collected data.** What is more, the algorithms the software uses to schedule maintenance and plan operations are based on human workers' experience with the equipment. Without human insight and experience, these developments would not be possible.

Industry 4.0 facilities have equipment sensors that are connected to the supply chain. As pointed by *Manufacturing Global*, smart facilities send signals to the inventory computer when raw materials, components or other supplies need replacing, and the computer then checks the availability of these and orders more if out of stock. With the help of advanced monitoring and GPS systems, it is also possible to track the locations of products and, most importantly, critical factors such as humidity and temperature – which are very important for many process industry products, such as chemicals and drugsⁱⁱ.

Another key element that Industry 4.0 brings to the process industry is energy and resource efficiency. As pointed

out by SPIRE, the European contractual partnership that operates under the Horizon programme, smart industries enable the electrification of industrial processes and the move toward renewable electricity (via electrochemical, plasma or microwave technologies), opening up an important pathway toward carbon neutrality. Moreover, advanced technologies and systems help maximise efficiency in the use of primary resources, the full re-use, recycling or recovery of waste as alternative resources, supporting the substitution of chemical solvents by water, zero water discharge, etc.ⁱⁱⁱ All of this will lead to an advanced digital European Process Industry that will drive growth, address climate change and enable a fully circular society.

The Biggest Challenges and Next Steps for the Process Industry

Stefan Zippel, Industry 4.0 architect and expert in smart industries, points out that when it comes to implementing 4.0 the process industry has one big advantage – many facilities are already collecting most of their process data through various control systems. The biggest challenge however might not be technology, but the knowledge and skills needed to properly use it. According to Zippel the most time-consuming

and difficult challenge will be to train or hire data scientists, data miners and developers as well as redefine company operations and find new solutions for cyber security.ⁱⁱⁱ

Based on Zippel's vast experience with smart manufacturing and Industry 4.0, he suggests two possible frameworks for the process industry:

- 1. The use of the international standard ISA 95³ Level 0-2 and additional IoT/IIoT technology to close existing information gaps.** To transform data into information the process industry could use the MES system⁴, which many companies already have in place and that allows horizontal and vertical integration.
- 2. Incorporate a “Digital Core” into the ISA 95 Layer 3.** The Digital Core would work as a central data collecting and information distribution system deploying Big Data principles. It would consist of several data engines integrated within a managed framework and usually have an advanced analytic toolset. The Digital Core would enable businesses to

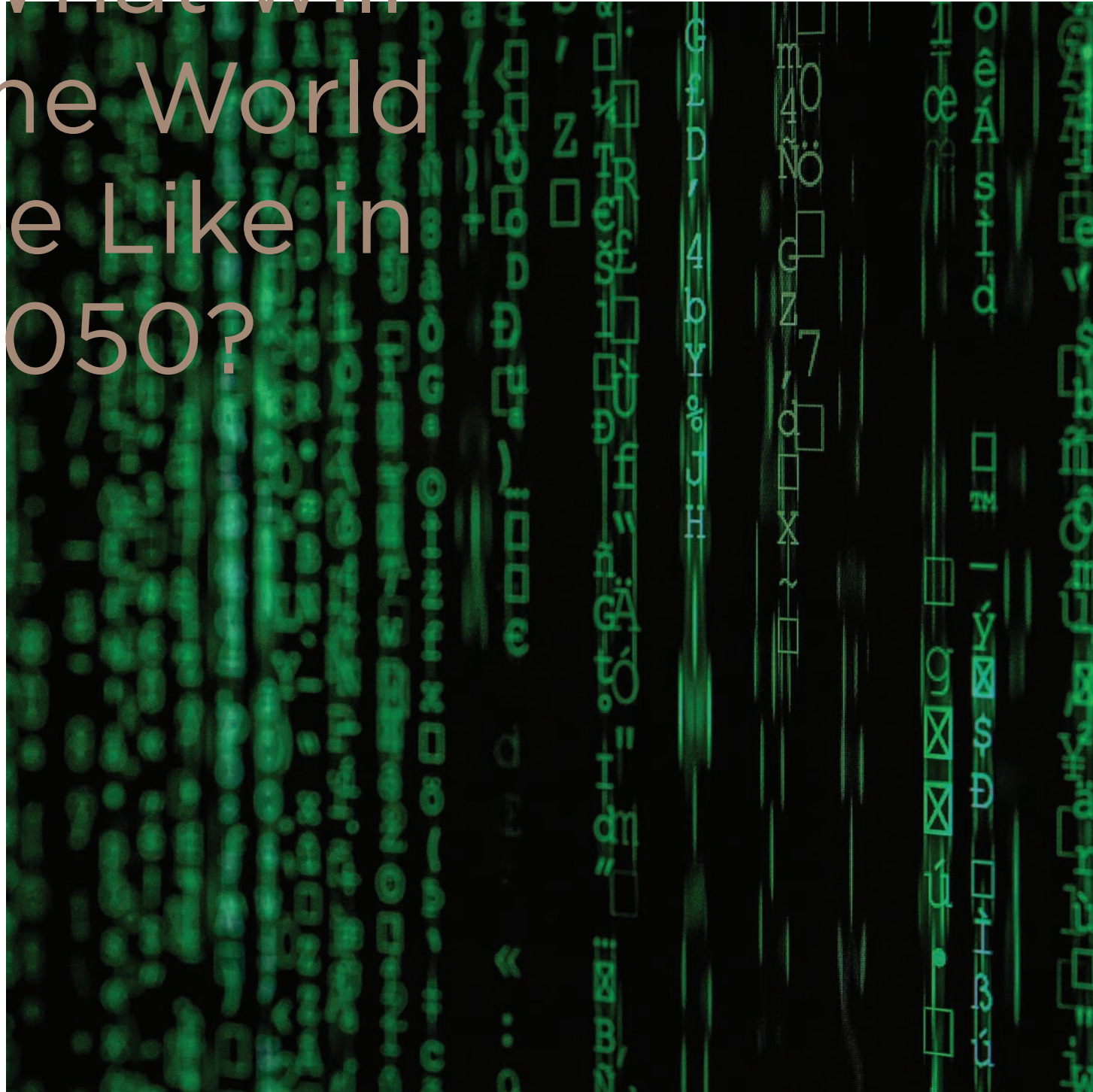
transform the static hierarchy of the current ISA 95 to a more cloud- or service-based model, where all the data sources are connected. The information will be accessed through mobile devices and desktop applications –providing greater accessibility while maintaining data security by limiting access to the platform.

Industry 4.0 has the potential to radically transform the way in which the process industry operates. However, there is no “one-size-fits-all” solution, and all of these changes will have to happen gradually and in line with the capabilities of the company. Finding the right equilibrium among old and new ways and transforming them into a whole new concept will be key to success in this context.

³ **ISA-95** – An international standard for enterprise and control systems integration developed for manufacturers. The objective of the standard is to provide abstract models and standard terminologies for the exchange of information between the enterprise business systems and manufacturing operations systems in an enterprise. ⁴ **MES** – A *manufacturing execution system* (MES) is a software control system for managing work processes in industrial situations. Businesses can use this software as part of an enterprise resource planning solution for tracking manufacturing data in real time.

What will the World be Like in 2050?

The future



Social trends are difficult to predict. According to some forecasts, by 2050 the population will increase, while according to others it will decline. The tendencies for both options are equally strong, so it is difficult to predict the situation in the future and claim with certainty which ones will prevail. In contrast, technological development is much easier to predict, as is also the opinion of the futurologist Ian Pearson.^{IV} In a couple of decades, the breakthrough in key enabling technologies, advanced manufacturing and processing technologies will give rise to numerous changes. By 2050, we can thus expect changes that will alter our way of thinking, and also our way of life.

The Development of Smart Clothing will Give us Superpowers

The concept of clothing intended only to cover the body and to express one's style will be upgraded with the concept of clothing that improves performance. Hyundai has already developed an exoskeleton reminiscent of a "hero suit" with comparable functionality and power. It was developed to make lifting heavy parts in car factories easier, and thus improve productivity. A

revolutionary line of robotic trousers was also adapted to assist paraplegic patients and the elderly with walking. The trousers with which Hyundai thus made a great leap into the future began a trend in clothing that will make it possible to enhance existing human skills or replace missing functionalities.

We will be Able to Live in a Simulated Reality

In the future, life as we've encountered it in *The Matrix* will not be impossible. According to Pearson, around 2045 it may be possible to connect the human brain to a computer to such a degree that a person will believe they live in a virtual world. Progress in the field of nanotechnology will enable us to change the inputs to our brains and convince us that we live in a simulated reality. A similar concept of a neural lace has already been discussed by Elon Musk at the Vox Media Code conference in California. Musk, the CEO of SpaceX, actually took a step forward and began developing a project called Neuralink. Neuralink is still in the earliest stages of development; its goal is to create devices that will be implanted into the human brain and that people would then be able to connect to software and thus keep up with the progress that occurs in the field of ar-

tificial intelligence. Such devices would improve people's memories and enable them to connect directly to computer devices.^V

Hyperloops Will Be Used for Intercity Travel

Cities will be connected with hyperloops or high-speed transport systems. Virgin Hyperloop One is already testing a system that would enable intercity travel via vacuum tubes. Such intercity travel would reduce the transport time to a fifth of its current duration. The hyperloop concept has already been reviewed in terms of technical characteristics and costs by, among others, the NASA Glenn Research Centre in Ohio, where they found that the estimated energy prices, passenger flow and task analysis all support the hyperloop as the fastest and cheapest alternative to other modes of short-distance travel (400-800 kilometres).^{IV} Similar travel modes are also being developed by other companies, meaning that the realisation of hyperloops can be expected considerably sooner than predicted by some experts.

From "One Model for All" towards More Personalised Medicine

In the field of medicine, we will see a major shift towards an emphasis on dis-

ease prevention instead of treatment. Artificial intelligence will play an important role in this, assisting people by providing advice on how to lead healthier lives. Consequently, a new era is also approaching in the field of medicine, where we can soon expect a model of personalised treatment of diseases – a model where medical decisions, interventions and products will be adapted to the individual patient on the basis of a predicted patient reaction or disease risk.^{vi} Currently, the main obstacles to developing such therapies are handling the big data needed and updating the related databases. However, the trends are already changing, and automated tools for acquiring gene data that are currently somewhat unrefined are being developed. In the future, we can thus expect more information on genes and their correlation with diseases.^{vii}

Multimodal Industrial Manufacturing

Digitalisation of the process industry will dramatically accelerate the changes in resource and process management, and

in planning and introducing new stimulating business models. We can reasonably claim that by 2050 the average machines will be fully automated and better performing. It needs to be stressed here that multimodality will increasingly be the norm, perhaps becoming a universal trait, since this trend is already well established. Scott Walker, president of Mitsui Seiki USA, notes that some machines already combine grinding and milling or grinding and strengthening, and adds that the benefits of this are considerable, as it enables better use of the workspace. All these functions need to be upgraded and developed to work correctly and consistently; he believes that in the future, when the related technology and software improve, this is bound to change. The greatest changes in the process industry are thus expected to occur in the direction of digitalisation, which will immensely accelerate the manufacturing modes, as well as connections with artificial intelligence, which will decisively improve the ability to carry out manufacturing processes with the minimal workforce and energy use.

»To keep your balance you have to keep moving.«

A. Einstein

ⁱ NICHOLS, Megan Ray. 2018. How can the process industry implement Industry 4.0? Global Manufacturing (online). Available at: <https://www.manufacturingglobal.com/technology/how-can-process-industry-implement-industry-40-0> (21st september 2018).

ⁱⁱ SPIRE. SPIRE 2050: Vision Towards the Next Generation of European Process Industries (online). 2018. Available at: https://www.spire2030.eu/sites/default/files/users/user85/Vision_Document_V6_Pages_Online_0.pdf

ⁱⁱⁱ ZIPPEL, Stefan. 2017. How to implement Industry 4.0 within the process industry. Medium (online). Available at: <https://medium.com/marcus-evans-webinars/how-to-implement-industry-4-0-within-the-process-industry-by-stefan-zippel-1616381aa74d> (7th august 2017).

^{iv} PEARSON, Ian. 2016. Mobility 2050 - Interview @ VIM Congress 2016. *VIM - Vlaams Instituut voor Mobiliteit* (online). Available at: <https://www.youtube.com/watch?v=5cEZtOiiUw0> (29th august 2016).

^v NEURALNIK. 2019. Available at: www.neuralink.com

^{vi} VOGENBERG, Randy F. and others. 2010. Personalized Medicine: Part 1: Evolution and Development into Theranostics. *P & T : a peer-reviewed journal for formulary management*. vol 35 (10), p. 560-76. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2957753/>

^{vii} JAASPRET KAUR, B. Rahat and other. 2017. Chapter 15 Trends in Precision Medicine. *Progress and Challenges in Precision Medicine*. Elsevier. p.:269-299 Available at: <https://www.sciencedirect.com/science/article/pii/B9780128094112000155>

40 years

rotoinox