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Breakthroughs in Medical Robotics: From Surgical Tech to Care Robots

Inside Brabant's Complete Value Chain for Medical Robotics

Introduction

Medical robotics is vital for delivering future health services, providing the capability to treat and care for patients more quickly to higher standards while also making provision more accessible with far lower risk. Robotics technologies are already assisting surgeons performing complex procedures and also providing care support for the elderly.

With health services in all countries still feeling the strain from the global pandemic, innovations in robotics technologies are essential to supporting medical professionals and enhancing care options.

And in future, there is a strong possibility that medical robotics operating in clinical settings around the world will have been developed in the highly innovative Dutch province of Noord-Brabant.

For decades, technologies that require pinpoint accuracy and high complexity have been built in the province. In Brabant, the medical sector is closely aligned with the tech industries, notably in the work of Philips Healthcare and also evident in the series of innovations in X-ray machines, starting as far back as 1927 with the world's first portable X-ray machine.

Medical robotics is set to continue this high-tech legacy within the province. Brabant is home to virtually all levels of the robotics markets thanks to its advanced high-tech ecosystem and specialist technical universities. Within these universities, there is a considerable amount of knowledge on the development of small runs of complex image-guided machines and, for example, haptic feedback for users. The presence of these specialist technical universities also means there is always new talent coming through, with students full of fresh ideas and different perspectives.

Brabant excels in robotics, where artificial intelligence (AI) and advanced engineering meet to produce breakthrough technologies. Adding to this are the connections with hospitals, medical facilities and two dominant health insurers within Brabant that collaborate on such projects. Ideas from medical professionals often feed into one of the world-class university departments and spark a new project that may eventually become a start-up company and launch the product commercially. In addition, students have access to vital data archives to aid the development of their concepts.

"The user should be already involved in the very beginning, and that's something that we do as a regional development agency," says Stephan Hulsbergen, venture developer of medical technology at BOM, the Brabant Development Agency. "At the first idea of a project, we involve doctors and medical personnel in the development of the ideas."

"The Quadruple Helix of industry, academia, government, and citizens are all aligned in Brabant to support and drive innovations," adds Mike Houtkamp, project manager foreign investments at BOM. "You can throw any complex problem within our region, and we will solve it. We not only have the suppliers, but we also have the end market," he says.

This white paper will look at the medical robotics value chain in Brabant, profile some of the most promising start-ups, explore how to overcome challenges with getting products to market for smaller companies, and highlight the considerable benefits that investors and innovators have to gain from doing business in the province.

Key figures for MedTech in Brabant

73.1%
Of all MedTech manufacturing jobs in the Netherlands are in Brabant

90%
Of all MedTech-related patent applications in the Netherlands are from Brabant

87%
Of all healthcare robotics-related patent applications in the Netherlands come from Brabant

10,000+
People in Brabant work for Tier 1 and Tier 2 high-tech suppliers to the LS&H manufacturing chain

32,000+
People in Brabant are working in STZ hospitals and specialised clinics

The innovative environment and value chain in Brabant

The Brabant region is one of the leading tech hubs in the world. Eindhoven ranks seventh when it comes to the most promising global science hubs and is making rapid advances in the field of medical robotics. The ecosystem is bolstered by the population of Brabant being highly educated, and the Brainport region is a significant driver of technological innovations.

Brabant is home to numerous robotics suppliers and programmers, meaning that specialist components are easy to obtain and do not always have to be shipped from the other side of the world. In many instances, these advanced components can be manufactured within the province.

Collaboration is a cornerstone of Brabant and been fundamental throughout its industrial history. Companies are actively encouraged to work together, pooling resources and expertise to accelerate technological innovations and resolve any challenges. This shares both the risks and the ultimate benefits.

And with such high levels of complexity required in medical robotics, collaborations between experts are essential. Businesses can communicate freely with specialists to develop a solution, rather than having to perform this remotely with a company that may be in another country and restricted by time differences between global regions.

“Companies can work very efficiently here because we are used to working together,” says Hulsbergen. “It feels like everyone in the Brainport ecosystem, thanks to TU/e [Eindhoven University of Technology] and companies such as Philips and ASML, speaks the same language and works in technology. That’s unique.”

As the Brabant ecosystem develops and matures, companies and institutes can all learn from each other and ultimately achieve a greater technological impact.

Medical Robotics Value Chain in Brabant

Start & Scale-ups

PRECEYES
microsure robot assisted microsurgery
SARA ROBOTICS
Eindhoven Medical Robotics
ICC International Cardio Corporation
XYALL
med eye

Development & Manufacturing

SIOUX TECHNOLOGIES
MTA creating mechatronics
DEMCON
VDL ETG
neways
ONE OF A KIND TECHNOLOGIES
NTS
AME PUSHING TECHNICAL BOUNDARIES
TOPIC
IGS GeboJagema
PRODRIVE TECHNOLOGIES

Regulatory & Market Access Support

STAR DUB Experts in Regulatory Affairs
ZWIERS Regulatory Consultancy A ProductLifeGroup Company
MD squared
Sejigraaf Consultancy B.v.

Clinical & Facilities

elz
máxima medisch centrum
catharina een santeon ziekenhuis
Albert Schweitzer ziekenhuis
Jeroen Bosch Ziekenhuis
Amphia
PHILIPS Innovation Services
Holst Centre Powered by imec & TNO
HIGH TECH CAMPUS EINDHOVEN
TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY
Brainport Industries Campus

Logistics Healthcare Providers

RHENUS LOGISTICS
HealthLink Europe & International A BASE LOGISTICS COMPANY
movianto healthcare dedicated logistics

Leading innovators in medical robotics

Robots can free up the workload of human medical professionals by taking over some of the more menial tasks. Innovative companies in Brabant have developed robots capable of helping to administer medication, for example MedEye and ReMediZ.

Care robots are also predicted to be an increasingly common sight in healthcare facilities within the next few years. “These technologies unburden healthcare workers and allow them to focus on more complex tasks instead of continuously performing time-consuming, repetitive tasks in their daily work,” comments Houtkamp.

Brabant-based companies such as SARA Robotics are making significant progress in this field. The company is incorporating advanced AI in its care robot to help patients in the early stages of dementia, which will be explored in more detail later on in these pages. “Everybody sees that under pressure, we need technology to solve some of the problems,” says Hulsbergen.

Yet it is in surgical robotics that Brabant excels and where we see the greatest opportunities, with several potentially revolutionary technologies having been developed in the region. “We have the potential to become a leader in that sector,” he says.

Furthermore, image-guided technologies are a particular area of specialism in Brabant. And a key driver for innovation in image-guided technology in Brabant is the Medical Image Analysis group (IMAG/e), based at Eindhoven University of Technology’s Department of Biomedical Engineering. The group provides image analysis support for clinicians and collaborates with medical robotics developers for image-guided applications.

Imaging is vital across numerous areas within medical treatment, increasing the accuracy of everything from screening and diagnosis to monitoring disease

progression and patient recovery. As images become ever more detailed and complex, automated image analysis enhances the possibilities for physicians in delivering medical treatment. And that is exactly what IMAG/e offers in medical imaging analysis, incorporating AI, machine learning, and quantification capabilities.

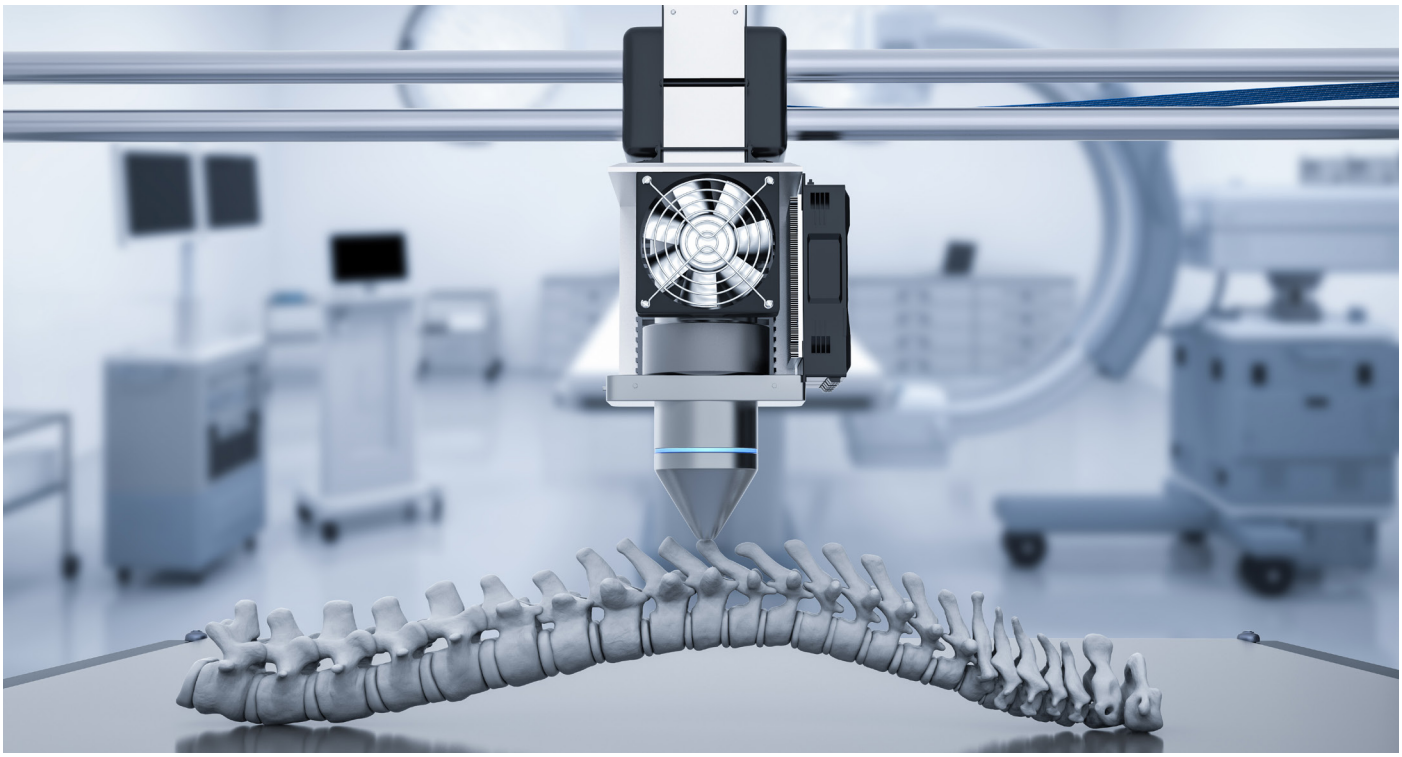
Teams at IMAG/e undertake numerous projects to detect diseases or early signs of conditions using biomarkers or characteristics gathered from extensive clinical datasets, collaborating closely with hospitals and industry across areas such as cardiology, oncology, and neurology. Other areas covered are MRI acquisition, RF safety, and image-guided treatments such as radiotherapy, as well as computational pathology for detecting, studying, and monitoring diseases such as breast cancer.

In addition, TU/e runs bachelor’s and master’s degrees in medical imaging and analysis to help develop the next generation of talent in medical imaging.

“We can take an image to a precise spot where you can deliver a treatment,” adds Hulsbergen.

We will now take a look closer at some of the robotics innovations in the medical and care fields developed in Brabant that are already making a positive difference in clinical environments.

Surgical robots



Profile: Microsure

Eindhoven-based company Microsure develops robotics for super microsurgical procedures that may be beyond the capabilities of even the most experienced surgeon, given how small the parameters are.

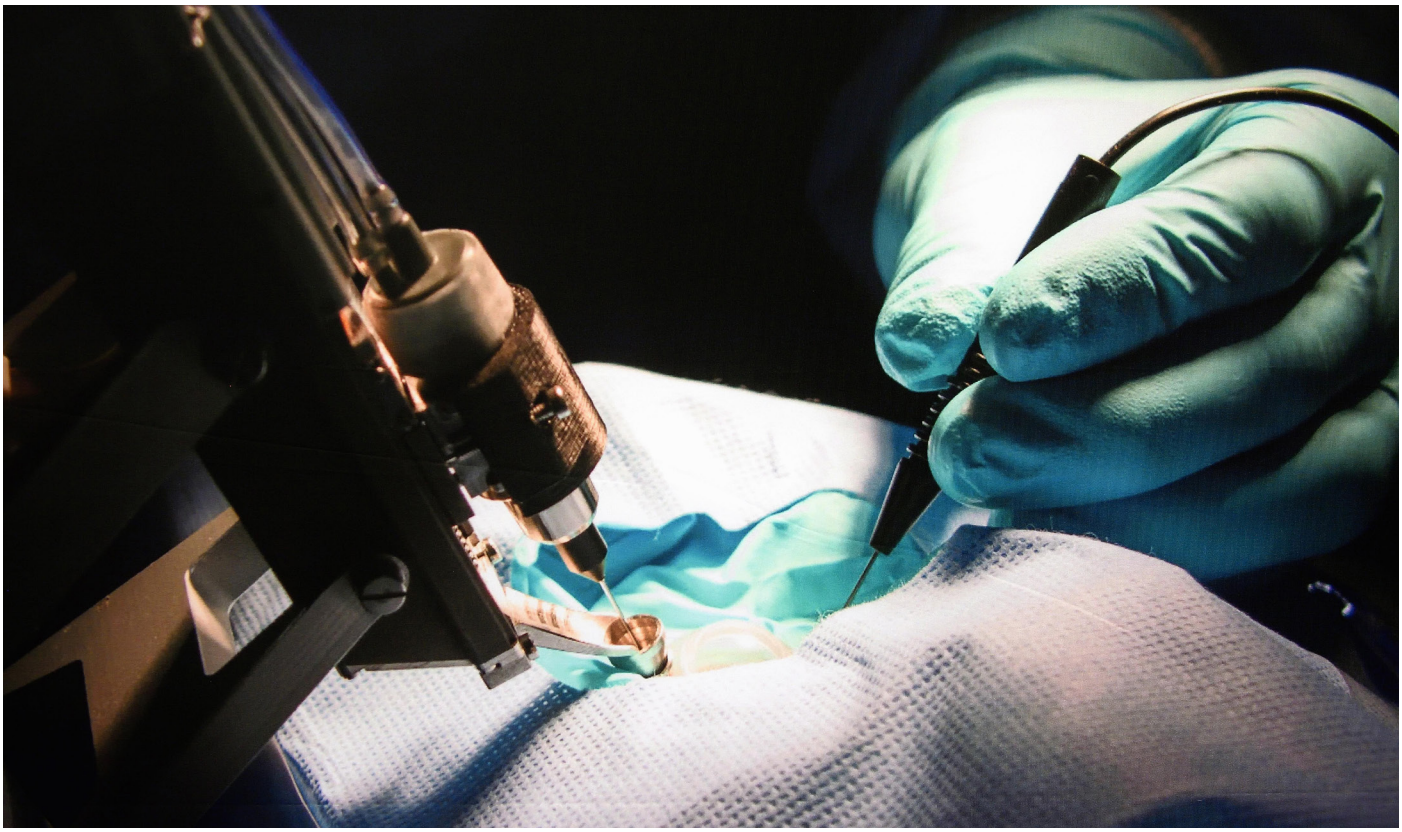
The microsurgeon must stitch together or repair ultra-fine tissues down to the scale of blood vessels, which can have diameters smaller than half a millimetre. The chances of conducting such procedures manually are very low. Even if a surgeon can see where they're operating with the help of magnification, the human hand is not steady enough to operate in such confines. Robotics can dramatically enhance the abilities of surgeons to operate on the smallest of scales.

Microsure was set up to address this very issue. As with many innovative companies in robotics, the company began in a lab at TU/e after the university's Professor Maarten Steinbuch was approached by several plastic surgeons from Maastricht University Medical Centre requesting robotics capable of performing delicate procedures down to a microscale.

Working alongside PhD student Raimondo Cau, Steinbuch helped to develop the MUSA-1 prototype, which is a microsurgical robot that assists surgeons in operating within these fine margins. Surgeons control the robotic arms with two joysticks, and it is possible to scale movements down by as much as 20 times with any vibrations from the doctors' hands nullified. The robotic arms can be fitted with instruments as required by the surgery such as needle forceps, scissors, or tweezers. A digital microscope hangs over the patient and the surgeon has full visibility of the area via a large screen, with special viewing apparatus offering a closer inspection if required.

On the back of successful trials, Microsure was established as a company in 2016 to launch the technology on a much larger scale. The company is now working with medical professionals and doctors to develop the MUSA-3 model, with MTA Group helping to build the business case and progress to series production.

Surgical robots



Profile: Preceyes

Eye surgery is highly complex and even the most experienced surgeons can struggle to have steady enough hands for all procedures, with no margin for error. The slightest tremble of a surgeon's hand can cause permanent damage to a patient's eye and may lead to loss of sight. To address this, Preceyes has developed advanced surgical robotics that enables eye surgeons to conduct intricate retinal procedures by using a robotic arm controlled by a joystick. Using Preceyes technology, a surgeon can insert a needle through a tiny hole into the wall of the eye without damaging surrounding tissue from unintended movement. Preceyes robotics have been used to perform successful eye surgery all over the world.

Ophthalmic surgeon Professor Marc de Smet came up with the idea in 2007 when observing the difficulties with retinal surgery and realised that the answers lay in assistance from robotics. De Smet partnered with Professor Maarten Steinbuch at TU/e, who drafted in colleagues and medical professionals to research the potential of using robotics to support eye surgery. The projects were a success and Preceyes was established in 2015, with the first surgical procedures carried out in 2016. Gerrit Naus was responsible for establishing Preceyes as an independent commercial company and has seen the life-changing difference this technology can make to patients.

"We can directly influence the quality of people's lives with our system. Retinal disorders are currently the main cause of poor vision and blindness in the Western world and the number of patients is growing exponentially due to the strong link with old age and diabetes," stated Naus. "However, operations on the retina are extraordinarily difficult procedures. The assistance provided by our robot means that more surgeons can successfully perform these interventions. The extra capabilities mean that they can even develop new forms of treatment, which could never have been performed with the human hand."

Surgical robots

Profile: Eindhoven Medical Robotics

Eindhoven Medical Robotics (EMRobotics) is an established developer of high-precision surgical robots, which began at TU/e before spinning out and becoming a business in its own right in 2018. The company has been attracting interest from around the world in the advanced surgical solutions it has been developing.

EMRobotics collaborates closely with highly respected surgeons to develop practical engineering solutions that support them in performing complex operations in areas such as bone surgery, microsurgery and retinal eye surgery.

The multidisciplinary team is composed of engineers in electronics, mechanics, and software, with systems architects to overcome many of the challenges facing surgeons in complicated procedures.

A range of projects is underway that cover early research, rapid prototyping that progresses to preclinical uses at hospitals, and clinical trials involving humans.

Robots can work faster and for longer periods, resulting in shorter surgery times for patients. This could ultimately reduce the costs of operations and increase the number of patients that can be treated.

One example is RoBoSculpt by EMRobotics, which performs autonomous skull-drilling procedures with high levels of precision. While many surgical robots provide assistance to human surgeons who still control them, RoBoSculpt has been designed to work independently according to pre-programming. The idea is that surgeons will still direct operations but only intervene when required. Surgeons do not need to be in direct control of the operational instruments at all times, unlike in traditional surgery. The robot can work on scales as small as 0.25 millimetres and drill into the skull to remove tumours or insert implants. The plan is for EMRobotics to bring RoBoSculpt to the commercial market.

By 2028, the ambition at EMRobotics is to become a world leader in surgical robotics. And if advanced products such as RoBoSculpt enter the market and fulfil their potential, it is realistic to see this ambition being realised.

Profile: SARA Robotics

Robotics is going to play an increasing role in helping to care for elderly populations in the not-too-distant future, with capacity in care homes and hospitals unlikely to be capable of meeting demands.

Healthcare services are already struggling with workforce shortages globally and the strain is only expected to increase due to the ageing population. According to UN figures, one in four people in Europe and Northern America will be aged 65 or over by 2050. While globally, the number of people aged 80 or above is projected to triple, from 143 million in 2019 to 426 million by 2050.

To meet this growing need, robotics experts in Brabant are developing solutions. SARA Robotics is a start-up that has created a care robot that is currently working in care homes and providing support for healthcare staff. SARA is a robust robot that moves around on wheels, standing 90cm tall and 42cm wide, with a depth of 33cm and weight of 19kg. SARA is capable of moving autonomously, which is currently a very rare feat for robots within healthcare institutions. The robot was created in collaboration between experts in robotics and AI, and specialists in long-term care.

SARA has been developed to be intuitive and user-friendly so that anyone can engage with the robot without requiring instructions or training. Patients interact with a screen on SARA's face. Modules and programs have been designed to provide cognitive stimulation and engagement for patients with limited mobility or those in the early stages of dementia. Research suggests that brain-training exercises can boost mental fitness and even delay the progression of dementia, which SARA Robotics has been researching with TU/e.

SARA uses facial recognition to identify patients and will start a program created specifically for that individual. This may be an interactive game that the patient enjoys or play some of their favourite music.

The care robot can also help patients who may wake up in the middle of the night and start wandering around thinking it is time to get dressed and have breakfast. SARA can assist here to decrease the workload of healthcare staff.

"In some institutions, you have 200 clients and seven employees, so staff don't always have time," explains Maartje Claassen, director of SARA Robotics. "When SARA can do an intervention, sometimes you don't have to attend any more as a care professional, or sometimes at least you can buy some extra time before you have to be there. In 50% of the cases, people are going back to bed themselves."

Claassen predicts that within the next five years, SARA will work with Internet of Things technologies to detect when an intervention is required for a patient and act accordingly. Voice commands are also in development for SARA.

In addition, patients are more likely to remain in their homes for longer and will require at-home assistance. Having a care-assistance robot is predicted to become a common feature in the years ahead.

"The potential for robots is enormous, but we still have a lot of work to do," adds Claassen.

Care robots

Development in Brabant's high-tech ecosystem

Collaboration within Brabant's ecosystem has been integral to the development of SARA. The company has been able to access experts from different sectors to develop the technology. Furthermore, SARA Robotics has been able to share resources and insights with other companies within the ecosystem. An illustration of this is that SARA shares an office with Mentech, another start-up, which has developed highly innovative smart socks that use AI and sensors to monitor stress levels among patients.

"We have a lot of other companies in our region where we work together. That's also resulted in us now being in the same office as one of the other AI suppliers within healthcare," says Claassen. "We work closely because we are both working with the same audience."

Another important organisation for the robotics ecosystem in Brabant is Breda Robotics, which was founded in 2018 and describes itself as a smart industry field lab that is a cross between a business and a school. To increase the use of automation technology, the organisation connects students and teachers with innovators and businesses by enabling a hybrid learning environment to share knowledge and skills. A key goal of the organisation

is getting younger people interested in careers in robotics and automation, with a series of projects run with schools and universities regionally and nationally, as well as international collaborations.

Longer term, Claassen would like to see Brabant grow as a recognised hub for robotics and believes all the ingredients are there for this to become a reality.

"I hope that we are going to create a big robotics hub here in Brabant where we can all learn and help each other," she says. "We have everything in Brabant to create our own supply chain for robotics."

"We have everything in Brabant to create our own supply chain for robotics"

From prototype to series production

There are multiple technical and financial challenges for start-ups and small businesses in getting new products to market, yet medical robotics has significantly more obstacles to overcome than most industries. It may be possible to develop an impressive concept into a working prototype, but it is another challenge entirely to take the next steps in bringing the product to series production and entering the market.

Numerous promising concepts have never made it to market due to the regulatory and economic obstacles that have blocked their progress. Medical robotics products must undergo rigorous clinical trials before they can receive regulatory approval. Materials that come into contact with patients need to be easy to sterilise, and there are also issues with insurance that need to be resolved.

However, it is possible to address many of these hurdles at an earlier stage in development to avoid delays in time to market in the later stages. And in Brabant, there is a well-trodden path in medical robotics from proof of concept to preclinical device and then taking the next step to a commercial launch.

MTA Group is one organisation that can help start-ups and smaller companies advance their technologies from working prototypes to series production and build their business models. Crucially, MTA can also assist in getting products to an acceptable price level for the market.

“We can pool our ideas of how to develop this business from start-up to scale-up to a viable, sustainable, long-term business,” says Edgar Langen, business manager of MTA Group.

Medical robotics requires expertise from both the technological and clinical sides. This is where Brabant has a substantial advantage due to the knowledge and expertise from multiple sectors that are concentrated across a relatively small area. And with MTA, there is very much an emphasis on co-creation.

“It’s a multidisciplinary approach we have. For us, it’s very complex to have all the domain knowledge,” says Richard van Lieshout, CTO of MTA. “Of course, we grow by doing these kinds of projects. But to really understand the details of what’s happening inside an operating theatre, that’s not our main competence. That’s why we create the right team and co-create the systems.”

A core philosophy at MTA is thinking ahead to series production and related economics earlier on in the development process to avoid obstacles later. MTA's unique V^2 model has been developed from this philosophy to help increase the chances of a successful product with an effective business case.

"One of the things often forgotten is to develop a system that not only can do the task as required but is also developed at the right price level. Not only that, but you can also produce hundreds of them with a comparable quality level," adds Van Lieshout. "When you start a new development, from day one in your architecture phase you need to think: 'How will the system work in the field? How is it used?'"

Having a proof of principle is typically required for MTA to agree to start working with a company. It is also helpful for companies to have a well-thought-through framework of both the practicalities and economics of moving up to series production and the target end user. However, MTA can assist with this. The most important factor is that the technology and application concept is proven.

"Our business model is developed for series production. That's the DNA of our company," adds Langen. "And it only makes sense to prepare production in series if our customers have proven that the product is ready for market introduction."

Mock-ups of working models and projections are regularly produced to ensure a project is heading in the right direction. Furthermore, MTA only works with smaller and medium-sized companies to help them in their product development and scale-up.

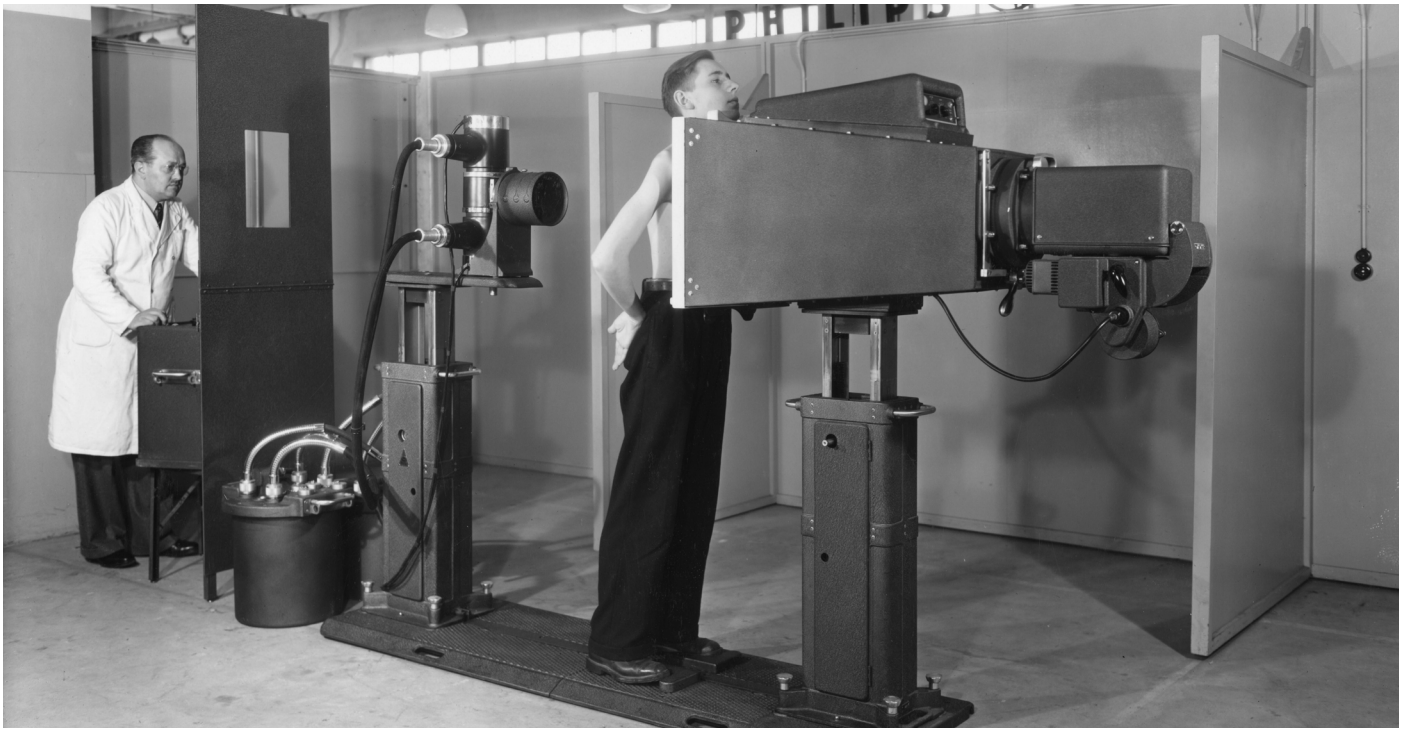
"MTA has consciously decided to focus on medium-sized customers including start-ups and scale-ups. We are organised to give our customers

the time and attention that is required, and smaller companies and start-ups just need a bit more of that," says Langen. "Some of our customers came to us and they felt neglected in Eindhoven because there's so much attention going to bigger companies."

"Our business model is developed for series production. That's the DNA of our company"

Typically, companies approach MTA through the Brainport network. A prime example is Microsure, which MTA has been collaborating with to allow the company to advance its surgeon-assistance robot to series production.

"For Microsure, we're doing the gen three product, so they are way beyond the proof-of-principle stage," adds Langen. "For MTA, having a proven functional model in place is the right moment to start engaging with its medical customers."



Why investment is essential for developing vital medical robotics

BOM recognises the need to build an effective medical robotics ecosystem that offers a comprehensive range of experts and specialists from right across the value chain.

“Our mission is to attract foreign companies that complement the medical robotics value chain and strengthen the ecosystem, ultimately resulting in the creation of a medical robotics hotspot,” explains Houtkamp.

And funding is integral throughout all of this, as there are considerable expenses involved in making a medically certified product. Without sufficient funding, promising concepts in medical robotics will not enter the market. However, patience is required from investors and any quick returns in the short term are unlikely. Yet the opportunity is available to invest in technologies that are going to make a significant difference in healthcare delivery.

“If you invest in building a robot in Brabant, you are not only building on the development side, but also on the application of the robot,” adds Stephan Hulsbergen. “We want to show investors that it’s not just about the money, but that we use the entire value chain on the technical and commercial side to minimise risk at an early investment stage. This way we can enter the market faster than anyone else.’

“It works well here. Because in terms of speed and precision, we are unparalleled in Brainport.”

Importantly, the presence of technical universities and use of their facilities helps to further reduce the amount of risk involved in developing new technologies, making it a safe location for international start-ups to develop their technologies in the early phases and then achieve growth. Meanwhile, the €250m allocated from the Dutch Government and Invest-NL’s Deep Tech Fund means that considerable support will soon also be available.

“It mitigates risks for the investors and actually speeds up progress for those start-ups,” says Hulsbergen. “We can show how strong the MedTech value chain is here and encourage innovators to settle here.”

“With our soft-landing services, such as fact-finding trips and innovation tours, we assist prospective companies and current investors in exploring the region’s opportunities by guiding them through the value chain and introducing them to relevant networks, resulting in robust and innovative collaborations,” adds Houtkamp.

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Contact

To find out more about the services available for investors and businesses through BOM, get in touch using the contact details below:

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