

IMAGING

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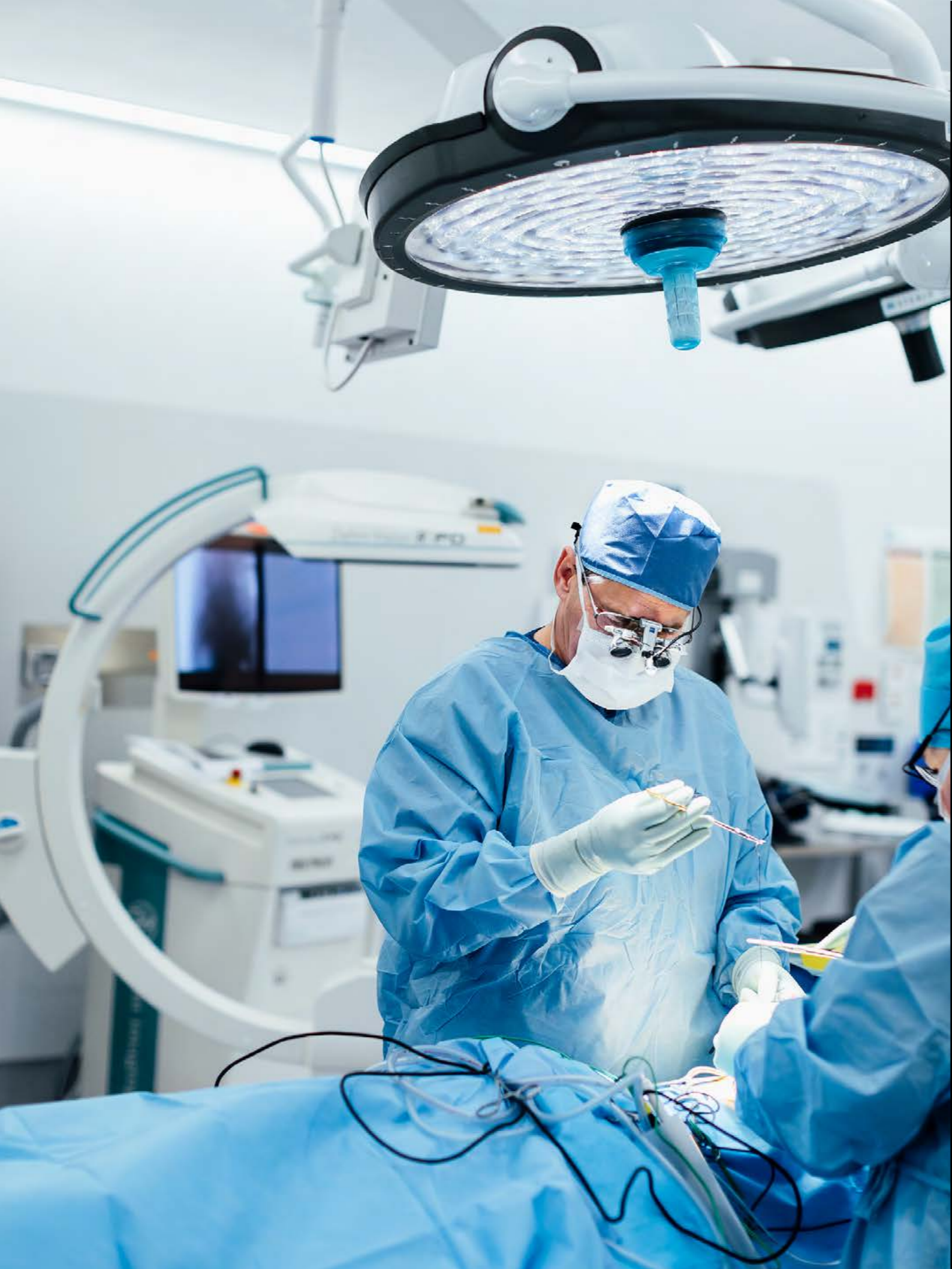
An annual publication presented by

 ziehm imaging

Markets

Different healthcare markets have different needs and requirements. With our experts, we want to offer the best service from our nine subsidiaries to our customers all over the world. We sell our C-arms worldwide and equipment of ours is in use on every continent. Customers appreciate Ziehm Imaging for its innovative products and diverse portfolio that covers their individual needs. In this issue, we look at how surgeons in Miami and Sydney use our high-end systems with an outstanding image quality that allows procedures to be performed at the highest level of quality and with great precision. Find out why OR staff and surgeons in Oslo value the compact design of our mobile C-arms and how important the broad spectrum of system applications is for the Dhulikhel Hospital in Nepal. Look toward the future with us, toward new clinical fields and applications that we want to break into with our C-arms.

Martin Törnvik, Vice President Global Sales and Marketing



When Timothy Steel, both a neurosurgeon and a spine surgeon, began his career 20 years ago, spine operations were risky procedures followed by intensive care. To expose the vertebral body, large amounts of muscle and tissue were removed. Today, Dr. Steel carries out such operations at St. Vincent's Hospital in Sydney with a minimally invasive technique. Modern medical technology helps him reach his highest goal: maximum precision in every procedure.

With precision to perfection

Photos
Michael Kai

On site
[St. Vincent's Hospital Sydney](#)

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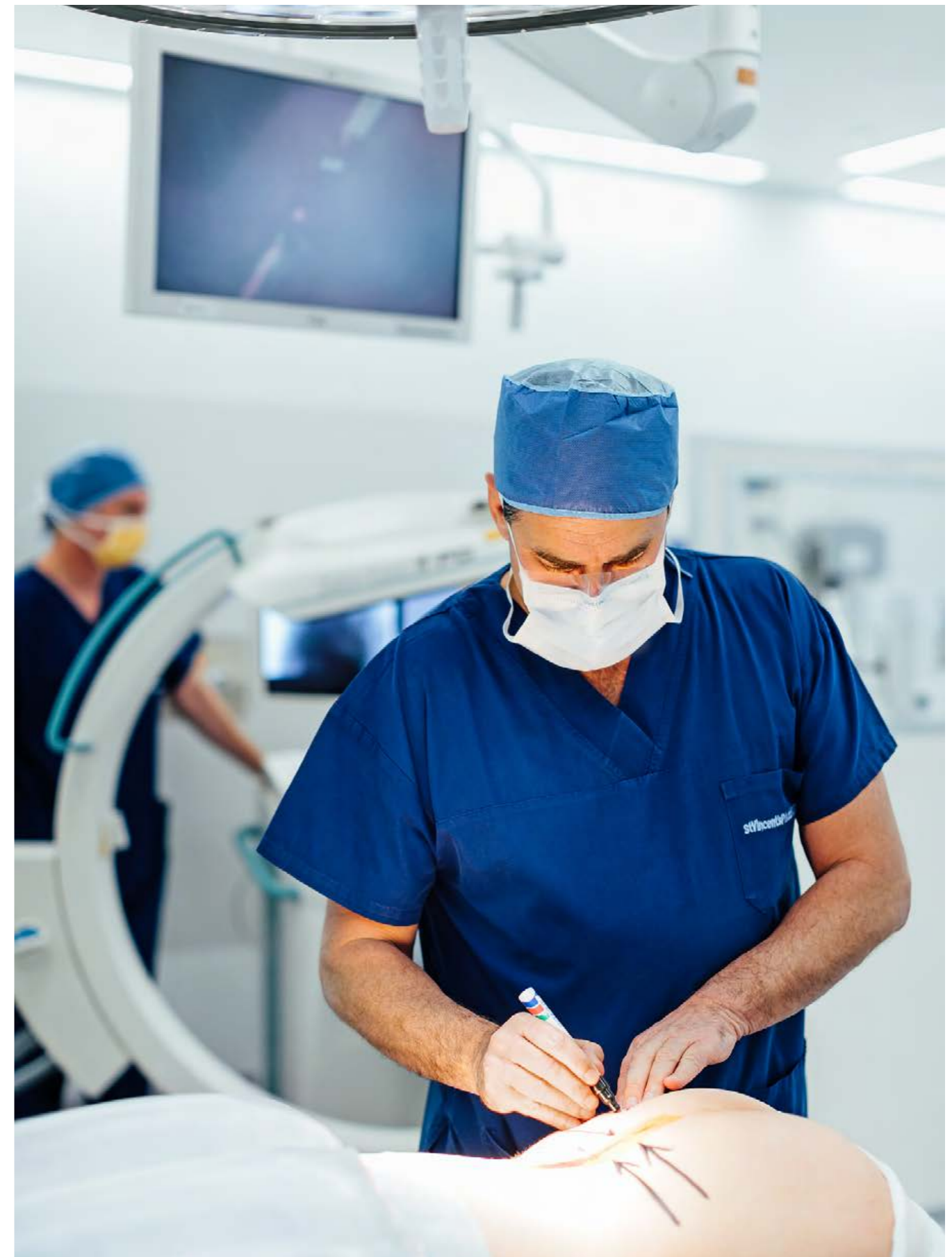
Having performed more than 10,000 operations, Timothy Steel is an internationally recognized expert in the area of spine surgery.

At St. Vincent's Hospital in Sydney, decompressions, or extensions of the spinal canal, are performed to relieve pressure. In spondylodesis, or spinal fusion, two or more vertebral bodies are connected to create stability.

In terms of area, Australia is nearly as large as the United States of America. The two healthcare systems are also very similar. In contrast to other countries, surgeons in the USA and Australia are classified based on their surgical success. For Australian physicians, excellence is rewarded and errors are punished. Those who are negligent in the OR and overlook details lose their patients or do not have many in the first place. This system rewards passionate and ambitious surgeons. Neuro and spine surgeon Timothy Steel of St. Vincent's Hospital is one of them. After he completed his studies in Australia, he worked in various university hospitals in the USA and Great Britain and became familiar with different healthcare systems. Now he has been working at St. Vincent's Hospital for more than 20 years. The hospital, founded in 1857, is one of the oldest in Sydney. Located in

the red light district near the harbor, it was primarily a hospital for the city's poor. To ensure care for the less privileged, a private hospital was built next to the public one. Together, both institutions now serve the eastern part of Sydney and its suburbs. The types of patients and national reputation of the hospital have changed dramatically since then. Wealthy residents of Sydney's coastal region around Bondi Beach are treated here; people from other areas of the country come here for the renowned physicians. For Timothy Steel, patients even fly in from overseas.

Steel has carried out more than 10,000 operations in the last 20 years, nearly all of them are spine cases. He is an expert in his area and well-known internationally. His excellent reputation is due primarily to his love for precision. He calls himself a slow surgeon for whom accuracy is more





Assisting physician Ellen Marie Frydenberg is familiar with Timothy Steel's thorough and accurate approach. The operation is regularly and precisely controlled.

A 3D scan is used to check progress while the patient is still on the table. This reassurance makes operations more precise and safer.

important than efficiency. Even on long workdays, when Steel completes five operations in a row, he remains unflustered. Instead, he is thorough and precisely checks the progression as well as the results of the procedure. "For me, it is more important to work slowly, but accurately, instead of having to explain to the patient after the procedure that he will have to undergo another operation because my work was not careful enough," says Steel.

This surgeon wants to operate perfectly in every procedure and intraoperative imaging helps him do so. He uses the Ziehm Vision RFD 3D because its image quality impressed him right from the start. He often operates the C-arm together with his navigation system, which provides a visualization of surgical instruments on the current patient data in real time. The quality of the X-ray images of the C-arm

is always the critical factor for this surgeon. The sharper the images and the clearer the bone edges and structures, the more precisely Steel can evaluate his progress. For him, the images of the 3D C-arm come close to those of a CT, but a critical advantage of the mobile C-arm is the possibility for intraoperative use. The innovative C-arm impressed him, along with the ability to carry out a 3D scan while the patient is still lying on the table. "The C-arm makes it possible for me to do procedures that are faster, safer, and more minimally invasive. You can't ask for more than that," says Steel.

The C-arm is used for all spine operations that Steel carries out today. He uses it at the beginning for exact planning, during the operation to check his progress, and at the end of the procedure to examine the results. Whenever Steel is not one-hundred percent sure, he takes another X-ray image



The navigation interface of the Ziehm Vision RFD 3D allows the visualization of surgical instruments, based on the current patient data in real time.

Thanks to the most advanced medical technology, Timothy Steel can perform operations just as his expectations of perfection dictate: gently, precisely, safely.

or uses intraoperative navigation. For Steel, the combination of mobile 3D imaging and image-guided navigation represents a milestone in medical imaging, which makes it possible for him to meet his high expectations with regard to precision. That wasn't always the case. Steel still remembers the first spine case from over 20 years ago that he attended as a young doctor in training. "It was a spinal laminectomy in which the surgeon had to expose the spine as they did at that time. He removed a great deal of muscle and tissue in order to see the vertebral body. This image stays with me. For me, until that point, spine surgery had been something wonderful; the truth was a shock to me, completely different than I had expected," Steel explains. "Today we do minimally invasive procedures with a small incision with which I can still always see right where I am, thanks to intraoperative

imaging." This method of surgery is significantly less invasive; many patients can be released from the hospital either on the same day or the day after the procedure.

Even though intraoperative 3D C-arms have been on the market for a few years already, it was the Ziehm Vision RFD 3D that first convinced Timothy Steel. The surgeon found the image quality of earlier systems by various manufacturers insufficient. For him, the main problem was the visualization of the anatomy of older patients, who are most frequently affected by spinal disorders. "The bone structure becomes poorer with age and, as a result, it is no longer as sharply defined on the X-ray images," says Steel. At that time, he says, the preoperative CT did provide significantly better images, but due to the patient's movement during the operation, the images were never one-hundred percent sure



Today at St. Vincent's Hospital, spine operations often last just 60 to 90 minutes. Patients can go home again on the same day.

identical with reality. In the meantime, things are different: "The fact that I can take a high quality X-ray image of the patient on the OR table and see the precise anatomy right there in front of me is unbelievable. The intraoperative reassurance makes my procedures for patients of all ages more exact and safer."

Above all, for Steel, precision means safety: "Spine interventions are risky procedures by definition, primarily when you operate on the spinal cord. During every surgery, I could irreparably destroy nerve tissue; there is no second chance." The highly complex procedures can be classified into two types: decompression, or the extension of the spinal canal to relieve pressure, and fusion or spondylodesis, the connection of two vertebral bodies for stability. "Basically, I have been doing primarily these two procedures on the spine for

more than 20 years. The procedures themselves have not changed up to the present day. We either remove vertebral body parts to eliminate pressure from the nerve or we connect vertebral bodies to stabilize the spine. But the surgical wound is considerably smaller today and we hardly need to remove any tissue. In this way, a risky procedure with subsequent intensive care and a protracted healing process has become a 60 to 90 minute operation after which the patient can go home on the same day," says Steel. Looking back on his beginnings as a physician, he would never have dreamed that this standard would exist: "For us neuro and spine surgeons, these are good times. The standard for medical imaging is so high that it can hardly be any better. Each generation of the Ziehm Imaging C-arm is faster, better, and has a higher image resolution, so it is fun to work with the systems."



Future shades

Our clinical images are based on 65,536 shades of gray. Adding color allows details to be seen that were not previously recognizable. Structures can be differentiated more easily, which could help in future diagnostics. The artificial images of complex and unique cases, to which we add a level of information by using color, seem like a kind of homage to the future.



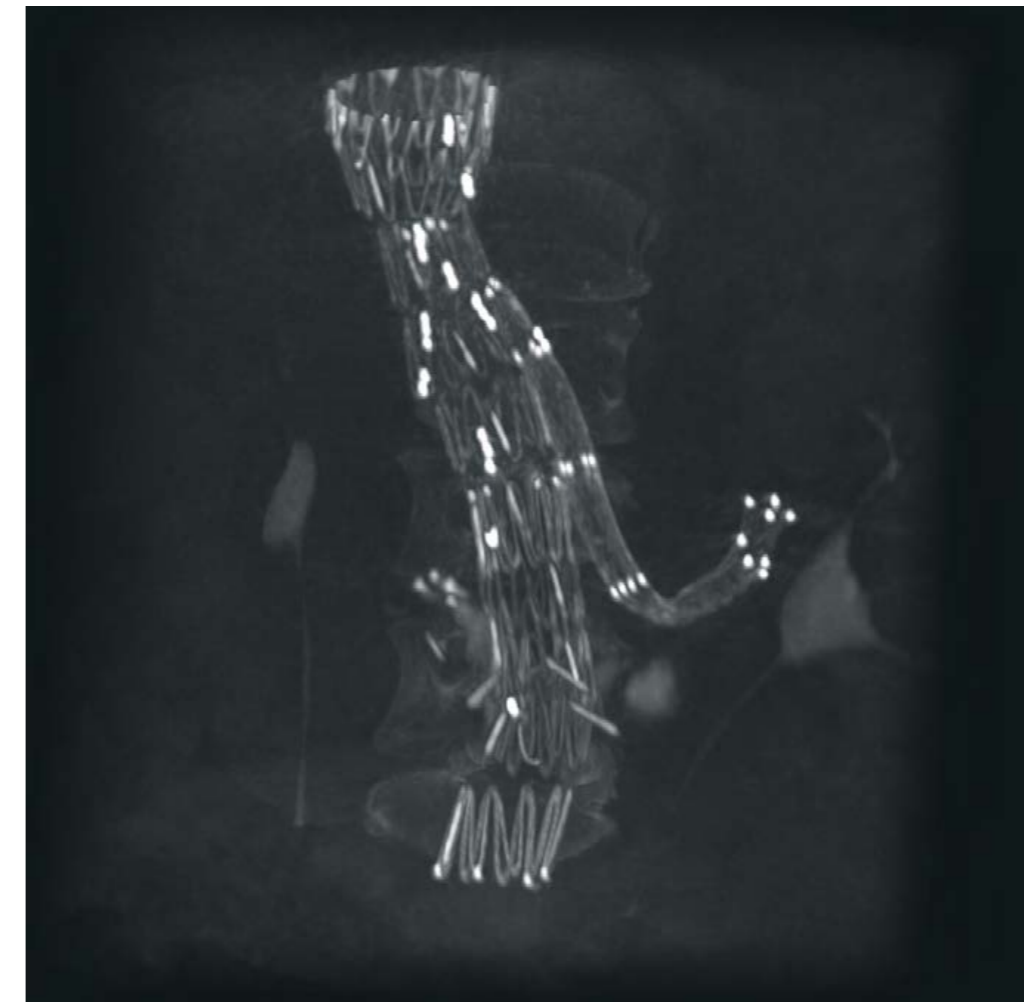
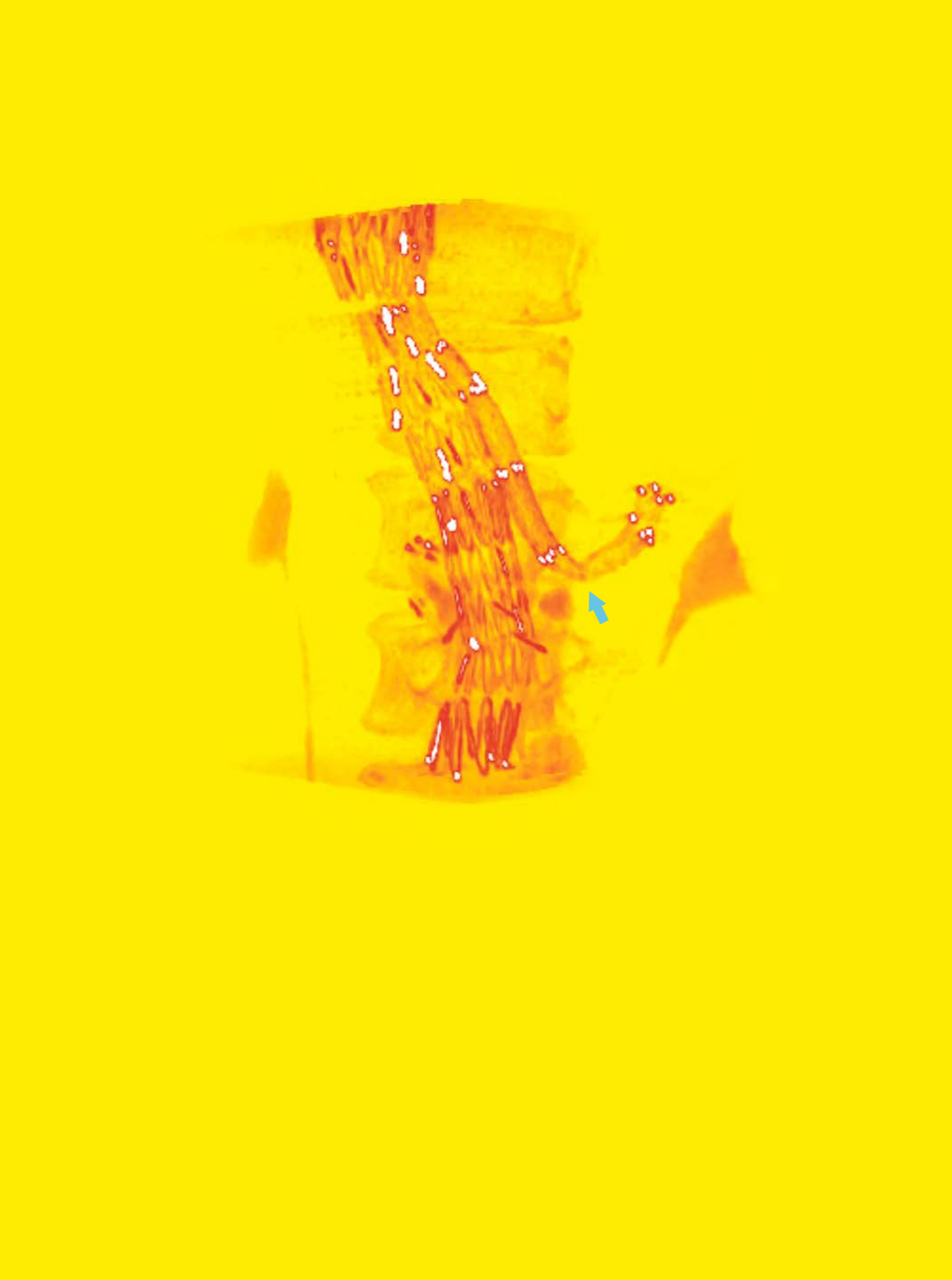
Maxillofacial

The coloration of the image of this complex facial reconstruction clearly shows the distinction between bones and metal implants.



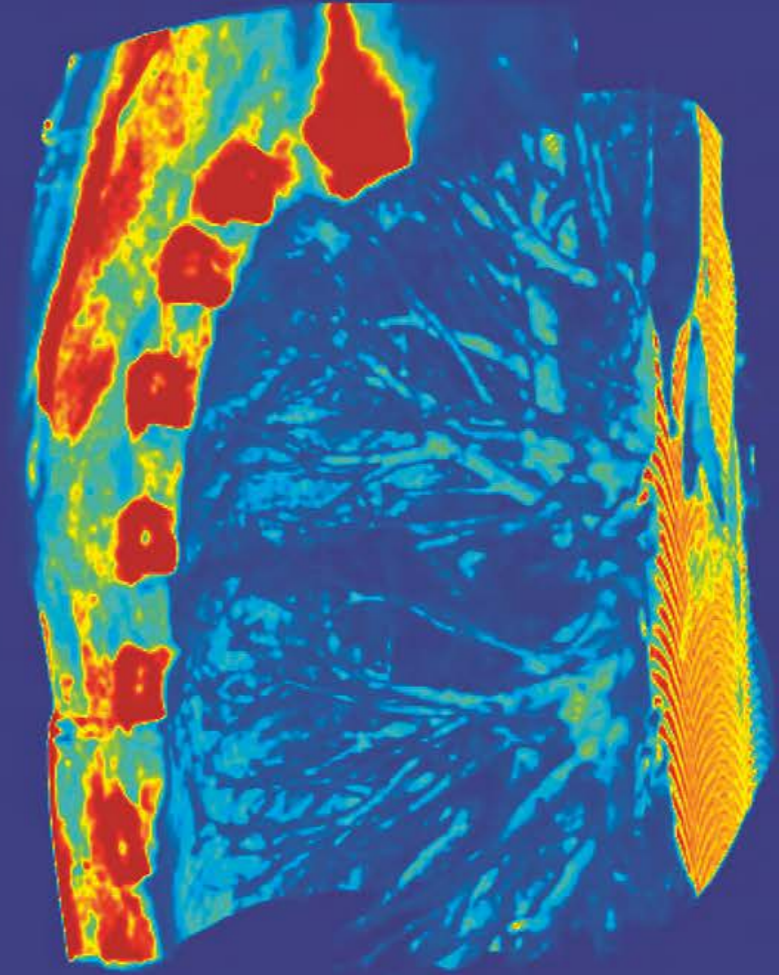
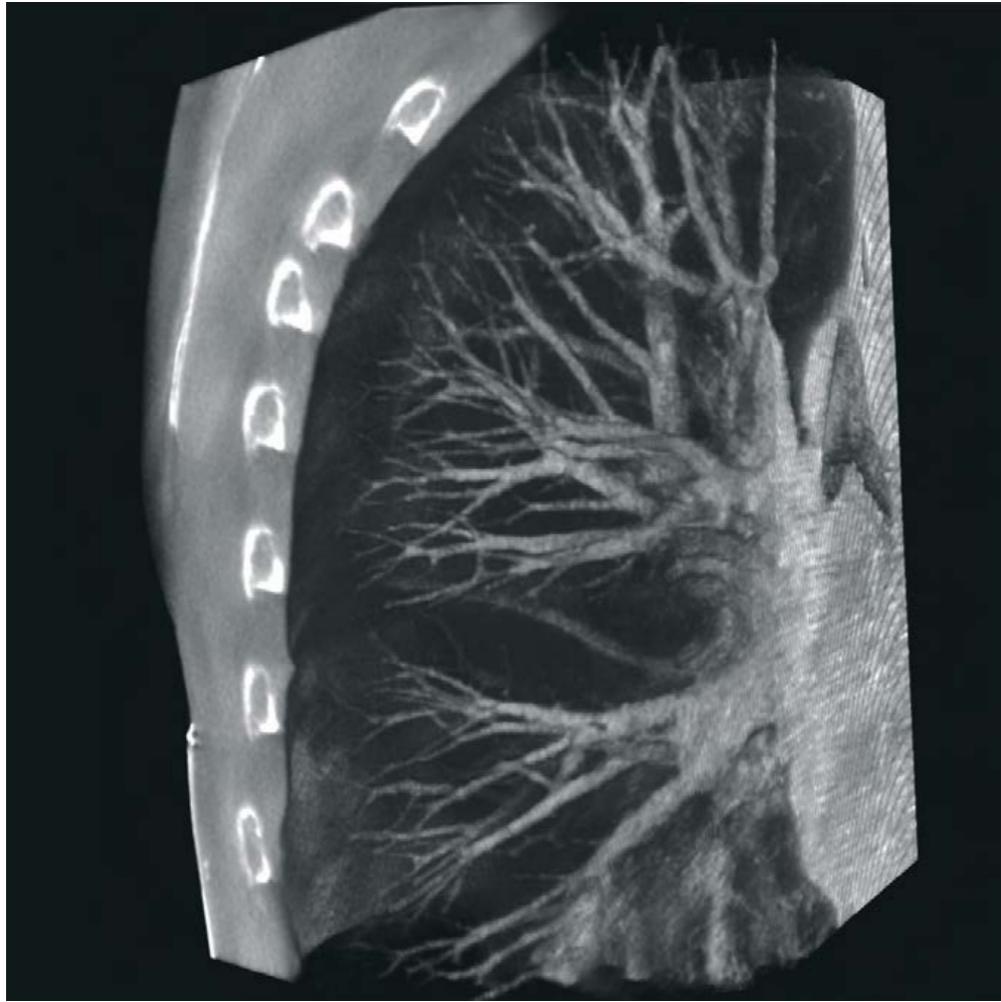
Lumbar Spine

Many screws are used in the derotation spondylodesis technique for stabilizing a spine that is distorted due to scoliosis. Coloration makes it easier to recognize the vertebral bodies.



Abdominal aortic aneurysm

This 3D visualization of a kink in the prosthesis of the superior mesenterica artery was previously not able to be seen in 2D imaging. Only with the advent of intraoperative 3D imaging could it be clearly shown, even more clearly in color.



Lung

Visualization of the bronchus with its lateral branches into the pulmonary lobes during a kyphoplasty. Adding color to the image makes it easier to differentiate bone and soft tissue structures.



Many employees of Rikshospitalet in Oslo come to work by bike, a successful result of urban policy that invests a great deal in cycling routes. Norway is also setting standards in health policy. There are 18 doctors and nurses per 1,000 residents — that's the most in Europe. Well-educated nurses form the backbone of the system in the Department of Orthopedic Surgery. Every day they organize the schedule of events, operate medical technology, and take care of patients.

Before the first cut

Photos
Juli Sing

On site
> [Rikshospitalet University Hospital, Oslo](#)
> [Clinical case movie](#)



Long before the doctor enters the OR, the nursing staff is taking care of the preparations for the procedure.

In 2017, the United Nations published the Human Development Index, which assesses the life expectancy, the level of education, and the income of the residents in various countries. The higher these three factors, the higher the index value. Norway, one of the smaller countries in Europe, is in the top spot. Norway has been and remains a textbook example for healthcare when it comes to its 5.34 million residents. And this despite the country's challenging geography: The thinly settled northern section of the country needs the same quality of medical care as the populous region around Oslo, the capital city. In addition, the weather conditions sometimes cause difficulties as does the poorly developed infrastructure outside of the metropolitan areas.

Norway deals with these challenges with a well-developed network of general practitioners, who are the first point of contact for patients with any type of symptoms. In contrast, hospitals represent central hubs where patients can go for treatment both in acute situations and for scheduled, routine operations. Norway's most important treatment center is the Oslo University Hospital (OUH), the largest hospital in Scandinavia. The OUH is an emergency clinic for all of eastern and southern Norway, covering a large majority of Norway's population.

The Orthopedic Clinic has nine operating rooms at Rikshospitalet where more than 150 types of surgical procedures are performed using various methods. The department focuses on pediatrics, hand surgery, and spinal surgery. Nearly 30 OR nurses and assistants take care of the patients here and attend to the schedule of events and medical technology. Heidi Garberg is the department's head OR nurse. She has been a nurse for over 25 years and, following stints in the army, in sterile services, and as an internal auditor, she has returned to the operating room. "In the end, a hospital ward is a large logistics enterprise," says Heidi. The precise planning of the preparations for an operation is critical. For example, every day, together with the doctors, she determines which mobile X-ray machine will be needed when and where. Each physician has certain preferences and favorite systems, she notes. "The hand surgeons, for instance, prefer a compact system such as the Ziehm Solo FD," says Heidi. Whenever possible, she attempts to satisfy the surgeons' individual preferences.

If you walk down the corridors that connect the individual operating rooms, it quickly becomes clear how important mobile X-ray systems are to intraoperative procedures because C-arms are parked

The mobile C-arms wait outside the operating rooms, ready for their next use. Thanks to regular training sessions, employees know even the newest technology inside out.



on both the left and the right, waiting for their next use or a professional cleaning. There are five systems with various equipment available for orthopedic surgery alone. A crucial criterion is the compactness of the devices, which have to be easily maneuverable but, at the same time, not take up too much space.

Heidi's colleague Trude Rosvold, an OR nurse who has management responsibilities, gives the nursing team the schedule each morning. She coordinates the staff and equipment in the various operating rooms and even, if necessary, moves the X-ray systems herself to wherever they are currently needed. "We have numerous instruments and systems that not only cost a great deal of money, but also have to be prepared according to detailed specifications. After all, an operation starts long before the surgeon makes the first incision. For us, it starts hours earlier, when we begin the preparations," Trude explains. For this reason, there's a lot going on already in orthopedic surgery at seven in the morning. The corridors are

full of nurses and assistants, who are preparing all of the operating rooms for the procedures. "The OR nurses are on their feet for hours every day doing hard, physical labor. That's why it's so important to us that the C-arms can be so easily integrated into our daily schedule. And we mean light in the most literal sense: We love our C-arms because they are flexible and easily maneuverable," says Trude.

When the preparations are finished, the OR staff run the mobile C-arms during operations. The physicians have to be able to rely one-hundred percent on the nursing staff's knowledge of the system, so they not only have to learn about and practice using the highly technical equipment, they also have to be able to prove their skills. Jorunn Hommelstad is responsible for the initial and advanced training of the OR nurses. In her office are endless rows of binders that hold certificates and documentation. In order to be allowed to work with the C-arm in the operating room, the nurse or assistant must complete in-person



The OR nurses love their C-arms because they are compact and maneuverable. Trude Rosvold, the managing OR nurse, brings the mobile C-arm Ziehm Vision FD into the operating room.

During an operation, the nursing staff operates the C-arm. For the nurses, one thing is critical: they must be able to operate the C-arm without a great deal of physical effort.



The integrated laser helps position the region of interest (ROI) accurately and dose-free.



as well as online training to learn how to handle the equipment properly. In a test, Jorunn assesses both the results of the training and system manual knowledge. Those who cannot answer the questions must take the training again. “We have also developed a short summary of the best tips and tricks. Because all of the Ziehm Imaging C-arms have the same user interface, the OR staff only has to be trained on one system. If you understand one, you understand them all. Of course, that makes our work much easier,” says Jorunn.

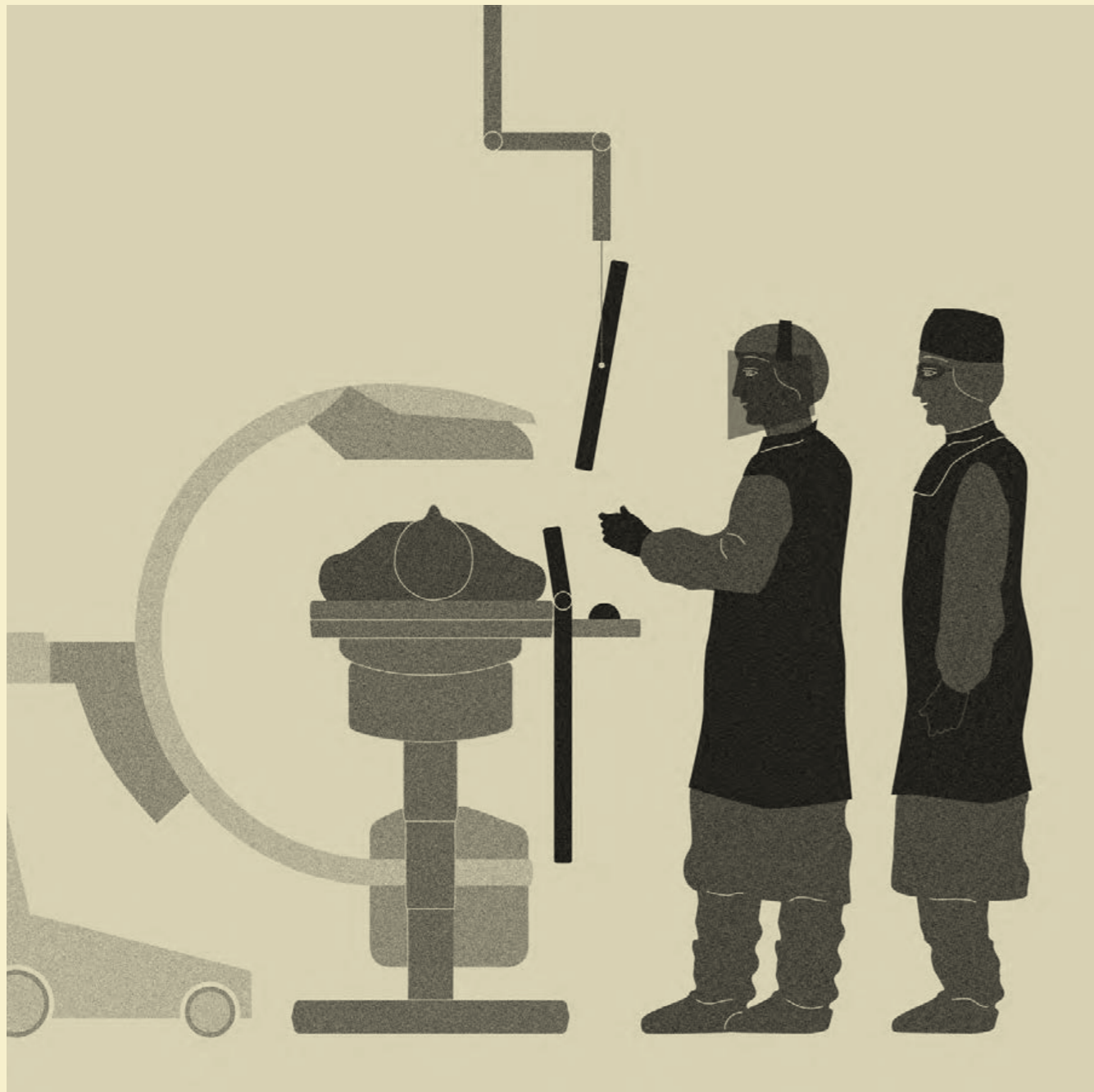
In addition to preparing the operation rooms and dealing with the devices, the OR nurses and assistants are primarily contact partners for patients and relatives. In comparison with the rest of Europe, this allows a very high ratio of OR nurses to patients in Norway. For this reason, the OR staff has more time to take care of the needs of individual patients. Especially in the ward for orthopedic surgery, where operations are performed on even the youngest

patients, it is important to take time with the children and their relatives. The Norwegian healthcare system supports an intensive relationship between nursing staff and people. Because of the national healthcare system, the pressure regarding performance and cost is lower; there is hardly any competition among hospitals for patients. This allows the nursing staff to invest more time in each person’s situation. And that’s important to Trude as well, who has experienced many departments and hospitals in her long career. But one thing has always stayed the same: “Being an OR nurse is a fantastic, but very demanding job. Our nursing staff has had the best training; they must not only be precise, structured and reliable in their work, but also physically fit. In the end, we can never forget that it’s all about the people. People who are in extraordinary situations and who are afraid. And this is exactly the tension that makes our everyday work so exciting. It’s always different and there’s always something going on.”

Three steps to the perfect vascular image



Imaging blood vessels, aneurysms and stents is a daily procedure at many hospitals worldwide, in both standard and highly complex hybrid operating rooms. At Ziehm Imaging, Product Managers Jörg Leonhardt, Wolfgang Keller, and Florian Schnabel work hard every day to create the ideal conditions for demanding vascular operations with a mobile C-arm. They share their knowledge about image quality and reducing radiation dose as well as optimized surgical procedures with physicians and hospital staff worldwide.



Setting up the best surgical environment

- **Proper radiation exposure protection**

In addition to a ceiling-mounted exposure protection panel made of lead acrylic, the ideal protection for personnel requires radiation protection attached below the table. The OR staff should wear not only the classic exposure protection vests and gowns, but also protective glasses or visors in addition to special gloves and hoods.

- **The proper operating table**

A floating, X-ray translucent, carbon table element is ideal. With just one hand, the patient can be brought into the best position with respect to the C-arm in all four

directions. The table top can also be imaged without creating any artifacts.

- **Optimized system usability**

There are two control modules that enable the physician to steer all functions of the C-arm. One is a touchscreen that operates the whole system. The other is a joystick that controls the motorization. Both control modules can be mounted in the sterile field — either on the table or on a special trolley. The wireless footswitch can be placed within easy reach of the operator, enabling intuitive and customizable use.

Important information for vascular procedures

- **Positioning the system properly**

The C-arm should be positioned opposite the surgeon to ensure optimum freedom of movement. To reduce scatter radiation and maximize the field of view (FOV), the patient should be positioned as close to the detector as possible.

- **Accurate system positioning**

The laser can be used to set the region of interest (ROI) without exposure, so the C-arm can be positioned ideally and quickly, without additional dose. The table top floats, so the system doesn't have to be moved. With the assistance of collimators along the course of the blood vessel, the smallest possible radiation field is displayed.

- **Using the Anatomical Marking Tool (AMT)**

The AMT makes it easy to save markings and notes onto the live images: e.g. left/right side marking, drawings of blood vessels, anatomical landmarks or implant positions. This also makes the use of a contrast agent unnecessary.

- **Intuitive workflow with SmartVascular**

SmartVascular enables independent switching among fluoroscopy, digital subtraction angiography (DSA), and roadmapping. The physicians can operate the system with the wireless footswitch with its customizable configuration. Further functions can also be accessed via touchscreen directly from the sterile field with one click.

The best tips for complex vascular procedures

- **Using contrast agent**

To make vessels visible during X-ray monitoring, a contrast agent is injected. To improve effectiveness and patient comfort, the contrast agent can be diluted. To obtain the best image quality, even in complicated procedures, the C-arm automatically triggers the injector for the contrast agent.

- **Selecting the right contrast agent**

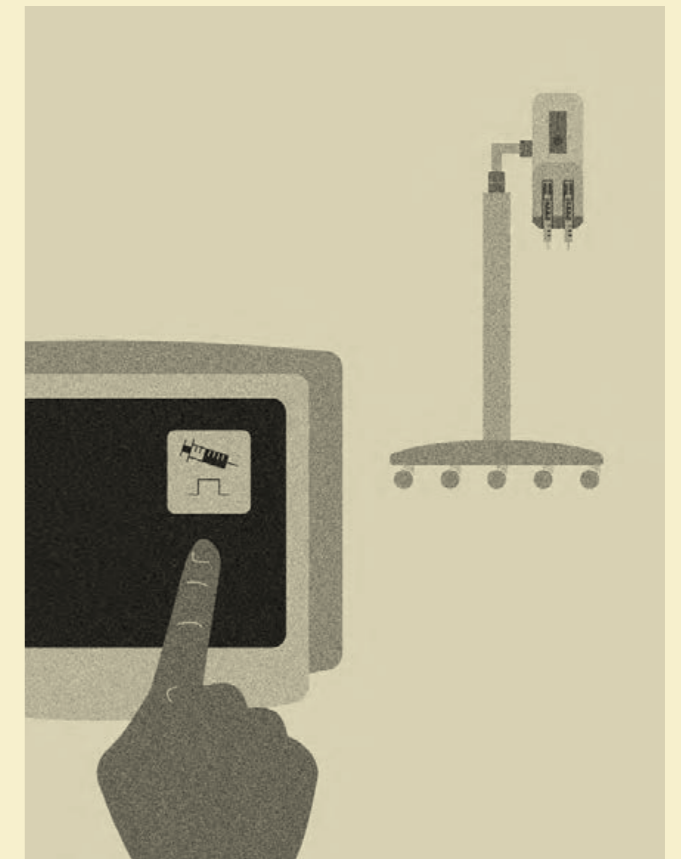
For patients for whom a conventional contrast agent cannot be used due to contraindications, CO₂ represents an advanced, safe, and cost-efficient alternative. CO₂ can also be used in a diluted state to keep the stress on the body as low as possible.

- **Advantages of CO₂ as a contrast agent**

With the special CO₂ package, the imaging adapts perfectly to changed conditions. However, all of the workflows and tools remain unchanged for the user, so it appears that an immediate inversion of the subtraction image has occurred. The surgeon sees a familiar image — the CO₂ in the blood vessels is shown in black; the contrast and image quality remain unchanged.

- **Single frame roadmapping**

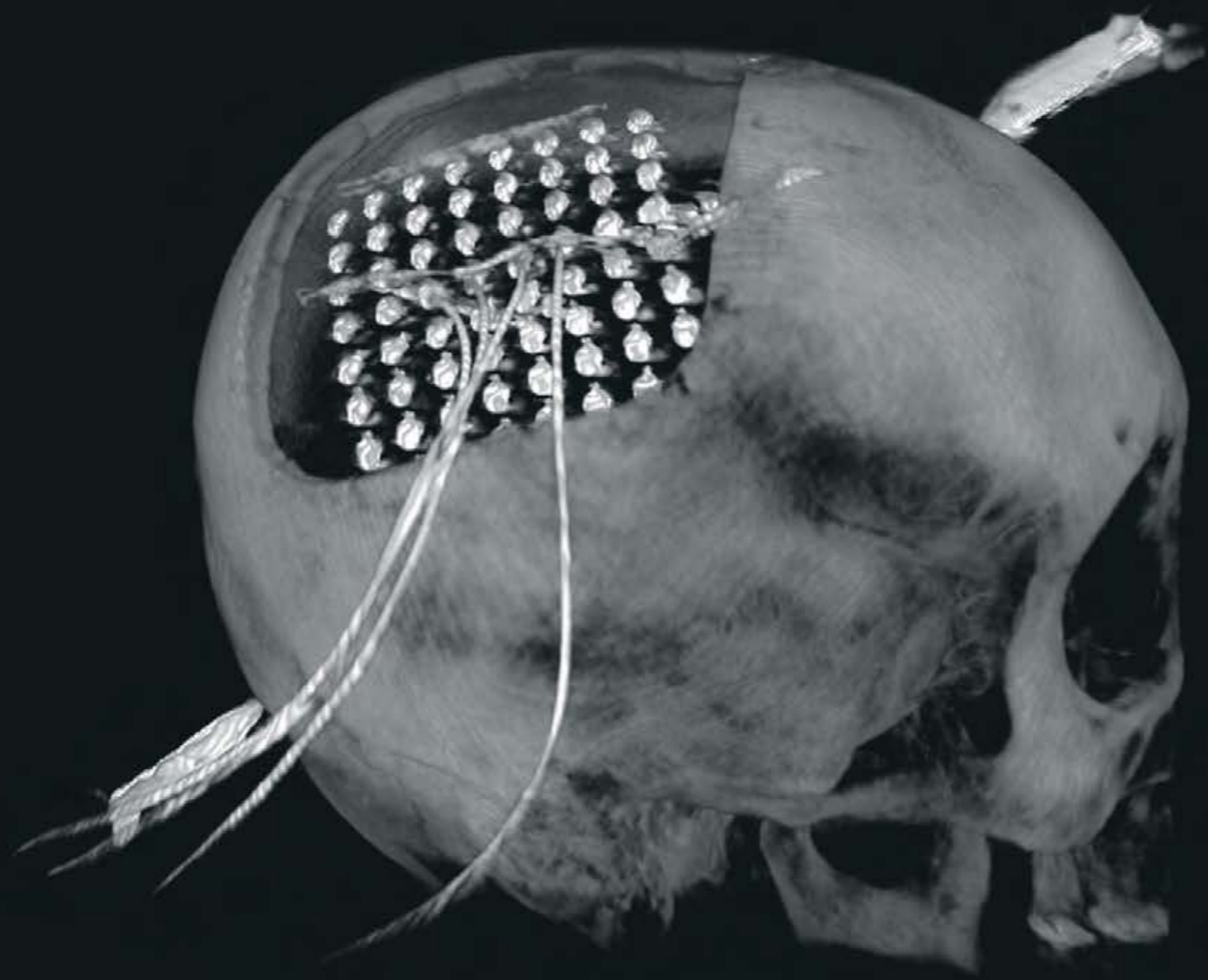
If an image is less than optimum due to patient movement during the DSA, single frame roadmapping can be applied. In this case, the entire DSA sequence is no longer used for roadmapping, but instead, only the best image. This effectively eliminates the movement artifacts in the sequences, so the DSA with the injection of contrast agent doesn't need to be repeated.



- **Breathing stop for better image quality**

To keep patient movement to a minimum during the DSA and get the best possible image quality without movement artifacts for the subtraction, breathing can be interrupted. If this is known in advance, the patient can be hyperoxygenated beforehand.

Image of the year



Nearly 50 million people worldwide suffer from epilepsy. For about a third of those affected, the only possible therapy is a neurosurgical procedure.¹ In order to carry out a almost injury-free operation, stereotaxy is used. This means that several imaging techniques such as MRI, CT, robotic-guided navigation, and intraoperative X-ray all work together. During the surgery, a grid of subdural electrodes is implanted that works similarly to a seismograph that measures earthquakes. The affected regions of the brain can be exactly plotted for subsequent therapy. Due to its CT-like image quality, the C-arm Ziehm Vision RFD 3D serves as an intraoperative control alternative, contributing to an optimum surgical outcome.



Beams from a lighthouse

For years, Professor Heiner Winker has been dedicated to supporting the Dhulikhel Hospital (DH), located 35 kilometers south of Kathmandu. He is interested not only in supplying materials and technology, but also in sustainable knowledge transfer. He uses his camera to document his impressions. On the following pages are selections from his collection that provide insight into the events in 2015 in Nepal and the significance of the clinic.

Photos
Prof. Dr. Heiner Winker

On site
[Dhulikhel Hospital Kathmandu](#)

Nepal is one of the 20 poorest countries in the world. How would you describe the medical infrastructure in this country?

Because there is no social security system, there is no healthcare system either. In the largest urban area, the Kathmandu Valley, and in the larger cities beyond, there are substantially sized clinics that provide treatment at no cost for those in need. Everyone else pays a small daily fee of about five euros for basic treatment. Further examinations and therapies as well as stents, implants, and vascular prostheses must be paid for based on the services. The level of quality of the hospitals varies widely; private clinics in Kathmandu meet the standards of Western countries, but only tourists, those who work for foreign countries or embassies, and rich Nepalese residents can afford their services. There are no local resident doctors; everyone goes to the outpatient clinics of the hospitals or to the so-called 'outreach' clinics in the mountains.

How does the spectrum of illnesses differ in comparison with a country like Germany?

COPD, or chronic obstructive pulmonary disease, is quite widespread because in many rural areas, wood-fired heating is still common. Tubercular infections and severe gastrointestinal diseases also occur quite frequently in children and older people as a result of poor hygiene. On the other hand, cardiovascular diseases, arthritis of the larger joints, and cancer are less frequent. Much more common are severe injuries due to traffic accidents, and in the home environment.

Especially in the rural regions of Nepal, many residential areas are difficult to reach. How are remote areas provided with healthcare?

The hospital 'outreach' clinics, the remote facilities mentioned earlier, provide decentralized care. For example, Dhulikhel Hospital has 30 such 'outreach' clinics which are very well equipped in terms of structure, personnel, and technology. Office hours are held in these clinics every day and young doctors from DH are required to work there for a certain period. About once a month, staff from DH travel to the remote facilities to perform minor operations. These could involve hernias, small tumors, dental operations, and similar procedures. Severe cases are referred to DH, which can, however, mean up to three days of travel.

What is the role played in Nepal by Dhulikhel Hospital, a facility of the Kathmandu University?

Dhulikhel Hospital acts as a sort of a lighthouse, its significance radiating out across the whole country. Exactly because it is not a private clinic, it is especially accessible to the poor. Moreover, it

is known for its high level of expertise, and with its status as a university clinic, it provides leadership in both science and academia.

You have already completed ten deployments in Dhulikhel Hospital. How did your special connection to Nepal and this hospital get started?

My love for this country, which is special in every regard, and for the extraordinary people there, started way back in 1975 when my wife and I traveled there on our honeymoon. The connection to DH happened both on a private level and through the German Rotary Volunteer Doctors, a registered association active in Nepal, which sent a request to me near the end of my clinical work.

What do you remember most about your first visit to Dhulikhel Hospital?

In 2014, my wife and I were at Dhulikhel for the first time, and after a few days, we thought the level of service in this clinic was so high that they didn't need our support. After about ten days of observing clinical and outpatient procedures, however, we gained greater insight into the deeper structures where there were ample opportunities to help.

Is there an event during your previous deployments that you especially like to look back on?

The earthquake of 2015 was a very dramatic, but not at all an enjoyable event. However, I still like to think about some particularly positive courses of treatment, some of which took years to complete, but which ended well, such as an incident with a male victim of the earthquake. This farmer, fifty years old, had such a severely injured leg that amputation was considered. A massive supuration of the bone made the conditions even more difficult, but still, after three years and several procedures, I was able not only to save the leg and overcome the infection, but also restore the patient's ability to walk. That satisfied me immensely.

What motivates you in your work?

The give and take: We bring a great deal of both experience and 'hardware' to Dhulikhel and, in return, we receive the unbelievable openness and friendliness of the patients and employees, which make me start looking forward to my next visit every time I leave.

Prof. Dr. Ram founded the hospital in 1996. How has it changed since then?

Dr. Ram has a very charismatic personality and completed a top-notch surgical education program in Austria. Even after twenty years he is still promoting advancements and innovations. For this reason, nowhere on the campus is DH the same as it was in 1996. Literally every day there is progress in medical knowledge or in the structural or



Professor Winker was in Nepal when the earthquake occurred in 2015. The image on the left is from a video recorded near the 'outreach' clinic of the Dhulikhel Hospital located directly on the Tibetan border.



Often, the severely injured patients were brought to Dhulikhel Hospital on simple, bamboo stretchers by their family members or other assistants.



Following the catastrophe, up to 933 patients had to be treated daily at Dhulikhel Hospital, which had 250 beds.



This man had such a severely injured leg that amputation was considered. After three years of treatment, Professor Winker managed to heal the patient, returning to him the ability to walk.



After a correction of her hip misalignment, this young woman enjoyed the full range of motion again.



Professor Winker surrounded by his team at Dhulikhel Hospital. In Nepal, there is one doctor per 16,830 people. In Germany, this ratio is one doctor per 333 people.



Positive courses of treatment that sometimes take years make the patients happy and are also an acknowledgement of Professor Winker's work.



Professor Winker's project depends on donations. The children of Kathmandu are grateful for the support.

technical equipment. The ten beds at that time have become just about 300 today.

Which fields and departments are currently provided? Originally, there were surgery, internal medicine, dentistry, and obstetrics. Now, however, nearly all of the specialized departments available in large, Western hospitals are here, too, such as pathology, psychiatry, pediatrics, gynecology, and obstetrics, as well as trauma surgery, orthopedics, urology, and physiotherapy, and an eye clinic, an ear, nose and throat clinic, and a dentistry clinic, and much more. All of the clinical and preclinical theoretical disciplines are offered here on this campus in the context of student education. At the Kathmandu University of Medical Sciences, studies include not only medicine and dental medicine, but also physiotherapy, nursing care, and soon, a program in public health services will be available as well.

Dhulikhel Hospital is an independent, non-profit institution. How are you still able, then, to set high medical standards?

This status as an 'independent' institution must be emphasized because this status makes it possible to develop and advance things even without government involvement, and the readiness to support such a sustainable institution and work, particularly in Dhulikhel, is truly great worldwide. Anyone can have a look here on site and see that the entire amount of the support they provide is applied directly.

What future developments at Dhulikhel Hospital are you looking forward to?

As a trauma and orthopedic surgeon, of course the issues in these areas concern me most: These extend from the preclinical care of accident victims, i.e. rescue service, to the emergency department and on to a trauma center that is supposed to be built in 2020 and is already in the detailed planning stages — and everything con-

nected with the education and advance training of personnel in all areas.

The hospital will soon receive a C-arm from Ziehm Imaging. For which operations will it be used?

The X-ray image intensifier is incredibly important for expert, professional treatment. Naturally, this includes all trauma and orthopedic procedures, but indicated treatments in the areas of vascular, general and abdominal surgery as well as urology also call for the C-arm.

Had you ever used a C-arm from Ziehm Imaging? If so, what do you appreciate about this system?

I have used and trusted C-arms by the Ziehm company since the 1980s as reliable workhorses that have been helping me since then with my work, night and day. However, the equipment is good not only due to its solid technical properties, which are seldom prone to faults. Also part of the package is the extremely reliable and personal service as well as the readiness of the manufacturer to take customer needs into account in further developments. This and more has impressed me over all these years with regard to the products and the company.

How does Ziehm Imaging support you in implementing the project?

The Ziehm company sent very robust equipment for use in a developing country, equipment that was just a few years old, back to headquarters in Nuremberg and had it completely refurbished. This means that equipment that is practically new can be used every day in the OR at Dhulikhel Hospital. In terms of logistics, the Association of German Rotary Volunteer Doctors, DH, and Ziehm Imaging work very closely together. This guarantees professional transport to Nepal as well as installation and equipment training on-site, in addition to proper maintenance of the equipment by a service partner. Especially that last item is not a matter of course in Nepal.

Structures

REGGIO EMILIA

pop.
171,977

km²
232

pop./km²
742

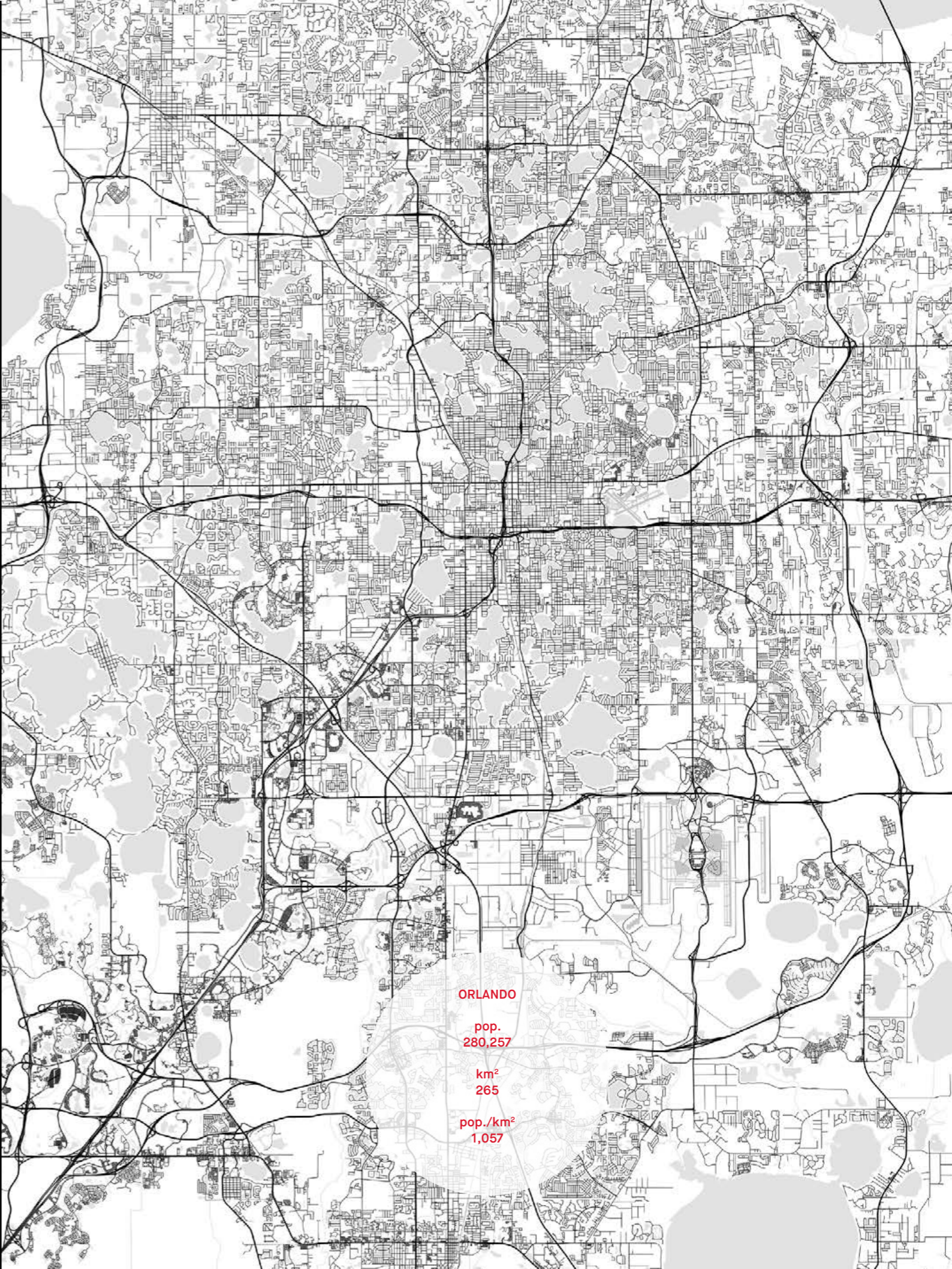
From our headquarters and nine international locations, Ziehm Imaging serves markets worldwide. Large metropolises and the urban areas that surround them are hubs for people, goods, capital, and information. Just as the markets on different continents differ significantly, so do the outlines of their cities.



SINGAPORE
pop.
5,638,700

km²
722

pop./km²
7,804



ORLANDO
pop.
280,257

km²
265

pop./km²
1,057

SINGAPORE

The geography of the smallest country in South-east Asia is distinctive. In addition to the main island, this sovereign island city-state encompasses sixty smaller islets. The former British colony made the leap from an emerging country to an industrialized country in just a single generation. Stability in the political and socio-economic environment as well as in trade has enabled Singapore to develop into a global hub for finance, education, technology and healthcare. Although it is saturated to a great extent, the medical technology market continues to grow; demand for innovative, high-end systems is increasing. Primarily, new equipment is needed for government-operated clinics. Above all, products from Germany enjoy a great reputation in Singapore: more than 20% of imported X-ray devices come from there. The high standards for quality and control in Singapore are clearly demonstrated by the service life of medical devices. On average, diagnostic imaging equipment is replaced after just ten years.

REGGIO EMILIA Italy

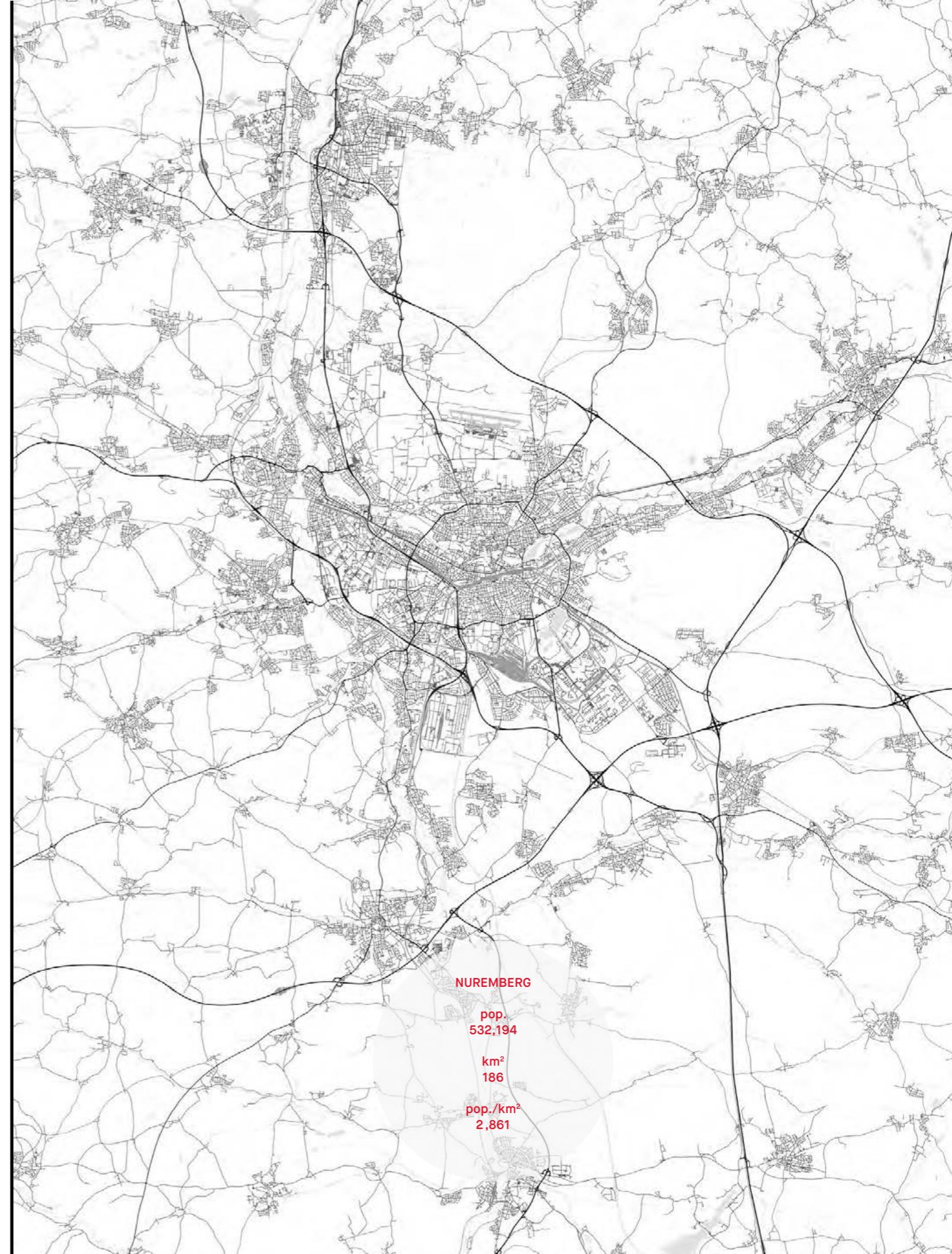
Our Italian subsidiary in Reggio Emilia is located right on the Autostrada del Sole, the Highway of the Sun. One of the main cities in the Emilia-Romagna region, Reggio Emilia is characterized by its historic old town, with its abundant churches and houses. As the population of northern Italy grew and the region industrialized, a modern manufacturing city was established around the old town. It is connected to all of the important national and international hubs. The Italian subsidiary is among Ziehm Imaging's oldest. Since 2016, it has been located in Emilia Romagna, one of the top five regions in Italy in terms of the establishment of medical technology companies. In this modern environment, our Italian colleagues take care of selling and maintaining our C-arms. There is a great need for X-ray systems: Accompanying the increase in the ageing population and the ever greater amount of people who are overweight are a series of challenges to the entire healthcare industry. Above all, purchasers here are interested in high-end systems with powerful generator performance.

ORLANDO USA

The straight lines of the streets and the large amount of water immediately demonstrate two important characteristics of this city in central Florida: a good traffic network with connections to transregional highways and marshlands that offer expansion possibilities. Founded in 1875, Orlando gained its current significance in the second half of the 20th century. An important reason for this development was the construction of Interstate 4, a highway connecting Florida's western and eastern regions. From Orlando, Ziehm Imaging supplies the largest medical technology market in the world: the United States of America. Because the population is growing and the standard of living is increasing, demand for medical treatment is continually evolving. Not only the enormous rates of growth, but also the sheer size of the country makes America the most lucrative market in the world. No wonder that the healthcare industry is booming in Florida: More than 600 national and international medical technology companies are located there, including the largest subsidiary outside of Nuremberg, Ziehm Imaging Inc. In addition to managing business in America, Ziehm Imaging Inc. in Orlando also manages Canada, Latin and South America.

NUREMBERG Germany

The Pegnitz River flows through Nuremberg which, at first glance, still looks like a medieval city today: The Romanesque castle, which dominates the skyline, can be seen from almost everywhere, and the old city wall together with the ring road that follows it encircle the city center. The second largest city in Bavaria forms the center of an urban region that lies at the heart of Europe and features an airport, a complex network of highways, and a harbor, which provide very good logistics. Since the decline of larger, traditional industrial enterprises such as Grundig and AEG, the city has been undergoing a transition to industries related to information and communication, energy technology, power electronics, and research. Because many medical technology companies have been established in this urban area, the region calls itself 'Medical Valley'. Ziehm Imaging has been located in Nuremberg since 1972. The C-arms produced here are shipped all over the globe.





SÃO PAULO

pop.
12,176,866

km²
1,523

pop./km²
7,389



SHANGHAI

pop.
25,582,138

km²
6,341

pop./km²
4,034

SÃO PAULO
Brazil

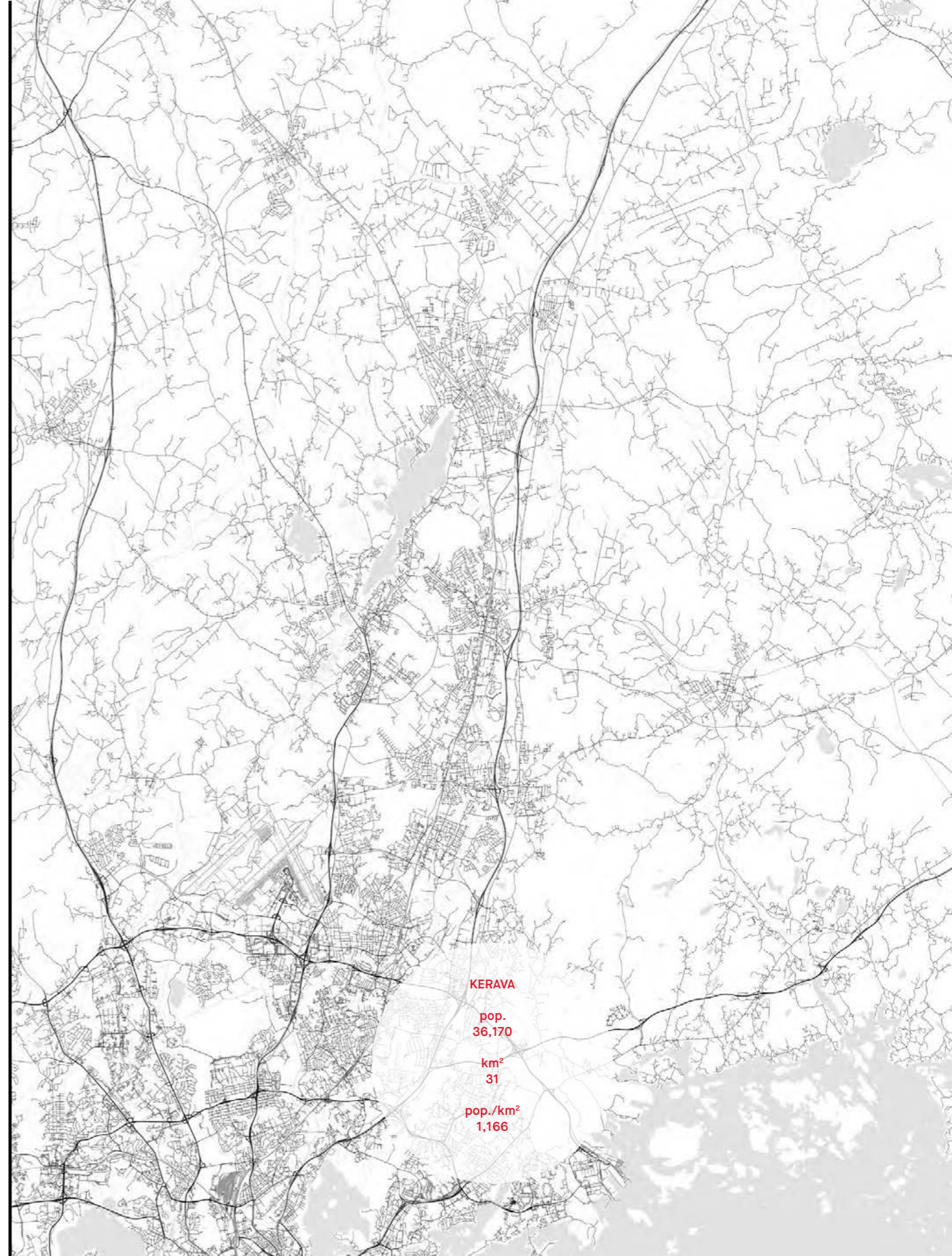
São Paulo is the most high-profile city in Brazil in terms of economic power and population. It is also the main financial and commercial center of South America, and is the most populous city in the Americas with over 11 million inhabitants. Historically, the city established itself as national flagship in the 19th century, and during the industrial boom of the 1930s, became 'the city that can't stop'. It became internationally influential in cultural, economic, and political issues, and is considered the 11th most globalized city on the planet today. It is also home to the largest number of Japanese, Lebanese, and Italians living outside of their countries of origin. The Ziehm Imaging office in São Paulo supports not only Brazil, but also South American countries like Argentina, Uruguay, Colombia, Peru, Bolivia, and Chile, reflecting the emerging market for medical devices. Technology and brand reliability are the demands of this growing market, which are strengths that Ziehm Imaging has to offer.

KERAVA
Finland

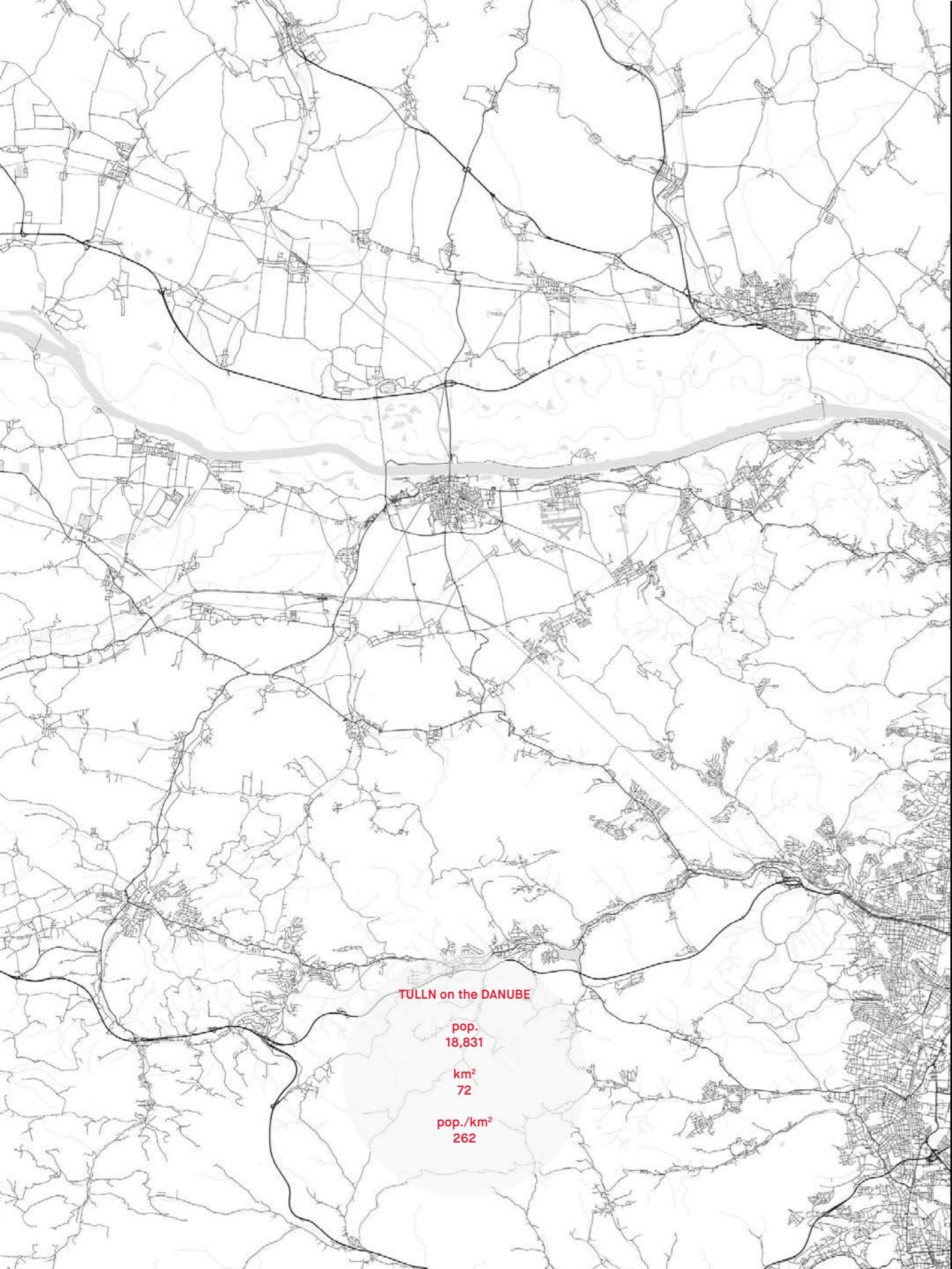
The Ziehm Imaging Finland Kerava office in southern Finland is a subsidiary with a history. It is connected with the capital city of Helsinki via European route E75, and from here, employees serve Great Britain, the Benelux countries, Scandinavia, Eastern Europe, Russia and the CIS countries, the Middle East, and Africa. Two lines shape the city's structure: The Keravanjoki River, flowing north to south, divides Kerava, though many bridges span it. The proximity to the economic hub of Helsinki transformed Kerava into a commuter town; nearly two-thirds of the residents drive to the Finnish capital every day to work. When the railway line was extended in the 19th century, more and more enterprises were established here and the city grew. Moreover, Helsinki-Vantaa Airport is only twelve kilometres away. The short distances to Russia, other Scandinavian countries and Eastern Europe as well as the coastline are among Kerava's advantages. Nowhere else offers access to as many different markets: from here, service is provided to regional dealers from London to Kazakhstan and from Norway to Johannesburg.

SHANGHAI
China

At the mouth of the Yangtze River lies Shanghai, China's largest city. Its distinctive geography is marked by the Huangpu River, which meanders through the city center. Water characterizes this district in the Yangtze delta. Thanks to the many canals, rivers, and lakes, it is one of the most fertile regions in China. Due to good irrigation, Shanghai is the country's largest cotton supplier. Cotton, as well as the proximity to the main trading routes for silk and tea, were the main reasons that the city grew into a significant harbor and industrial center over the centuries. Today, this Chinese metropolis is known for technical innovations. The largest container harbor in the world is located here as well as the only magnetic levitation train used for commuter traffic. The booming economy and the high-tech district of Pudong show how well Shanghai is doing. Many healthcare companies are located here; China's market for medical technology will likely grow more than ten percent again in 2018. The situation is becoming increasingly difficult for foreign companies because, in the context of its industrial modernization program, China wants to reduce its dependence on imports. For this reason, local experts with deep knowledge of the market are even more important. Such experts can be found in our subsidiary in Shanghai, which celebrated its 10th anniversary in 2018.



KERAVA
pop.
36,170
km²
31
pop./km²
1,166



TULLN on the DANUBE

pop.
18,831

km²
72

pop./km²
262



TOKYO

pop.
13,491,000

km²
2,191

pop./km²
6,157



TULLN ON THE DANUBE
Austria

No other river on earth flows through as many countries as the Danube, the greatest river in Europe. In Tulln, one of Austria's oldest cities, it sharply divides north from south. Because the city is full of flower beds, plant breeding operations and plant nurseries, it is also called the 'City of Flowers'. Tulln is just half an hour by car from the capital city of Vienna and is home to one of the newest Ziehm Imaging subsidiaries, which takes care of the emerging Austrian healthcare market. Modern X-ray systems, from the compact unit to the innovative 3D device are in demand here. The Austrian Health Plan (ÖSG) prepared by the Austrian Federal Ministry of Health is significant with regard to country-wide investments in the area of medical technology. The objective of this plan is to achieve the same standards of care across Austria within the diverse supply structure. The goal of the ÖSG is to ensure that healthcare is distributed evenly throughout Austria and that it is provided at the same high level of quality. Many hospitals investing in new medical technology benefit from this plan. The new construction and refurbishment of large hospitals in Vienna provide further potential for investment.

TOKYO
Japan

Our newest subsidiary is located in the Japanese metropolis of Tokyo on the island of Honshū. In recent centuries, this region has experienced many volcanic eruptions, resulting in fertile soil. Today, more than a quarter of Japan's entire population lives in the 23 districts of Tokyo. The city is not only Japan's most important financial hub — it is one of the five largest centers of trade in the world. Along Tokyo Bay, large, modern businesses form an industrial belt between Tokyo and Yokohama, a city of millions to the south. The Olympic Games will bring more economic growth to Tokyo, which will host the Games in 2020. There are few countries in which the people's average age is as high as it is in Japan, which has resulted in many government initiatives for improving quality of life for seniors, so medical technology is in high demand. Japanese physicians are most interested in sophisticated, high-end systems: Many hospitals, often smaller in comparison to others internationally, have the newest diagnostic equipment.

VILLEJUST
France

Not even thirty kilometers separate our French subsidiary in Villejust from the most influential and well-known city in France. Its proximity to Paris and the Parc d'Activité de Courtaboeuf, the largest industrial area in Europe with more than 1,000 companies, makes this small town an attractive economic location. France is known for its high industrial standards and highly qualified workforce and, as the world's sixth largest economy, it has great potential simply due to its sheer size. According to the World Health Organization (WHO), high quality basic healthcare makes the French healthcare system one of the best in the world. A special condition in France is that hospitals are combined into regional groups and purchasing is done through central associations. The annual purchasing volume for medical technology is estimated at about 25 billion euros; medical products from Germany are in especially high demand. The French healthcare market is moving ahead, primarily in the area of digital transformation, in order to advance the 'industrie du futur' through networked solutions. This government initiative also concerns the medical technology industry to make it more innovative and more efficient as well as advance digitalization. For this reason, the industry is full of start-ups and mid-size firms with high-tech products.

VILLEJUST

pop.
2,301

km²
5

pop./km²
429

Cover
Vessels of the extremities
Medical University of Lublin, Poland

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Cf. WHO (World Health Organization), 2018: Factsheet on
the subject Epilepsy. Retrieved December 14, 2019, from
<https://www.who.int/news-room/fact-sheets/detail/epilepsy>

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Ziehm Imaging is specialized in the development and manufacture of mobile C-arms. For more than 45 years, we have produced technologies that enhance imaging and streamline clinical workflows. The mobile X-ray devices' exceptional image quality and flexibility in the operating room serve as an important basis for treatment success.