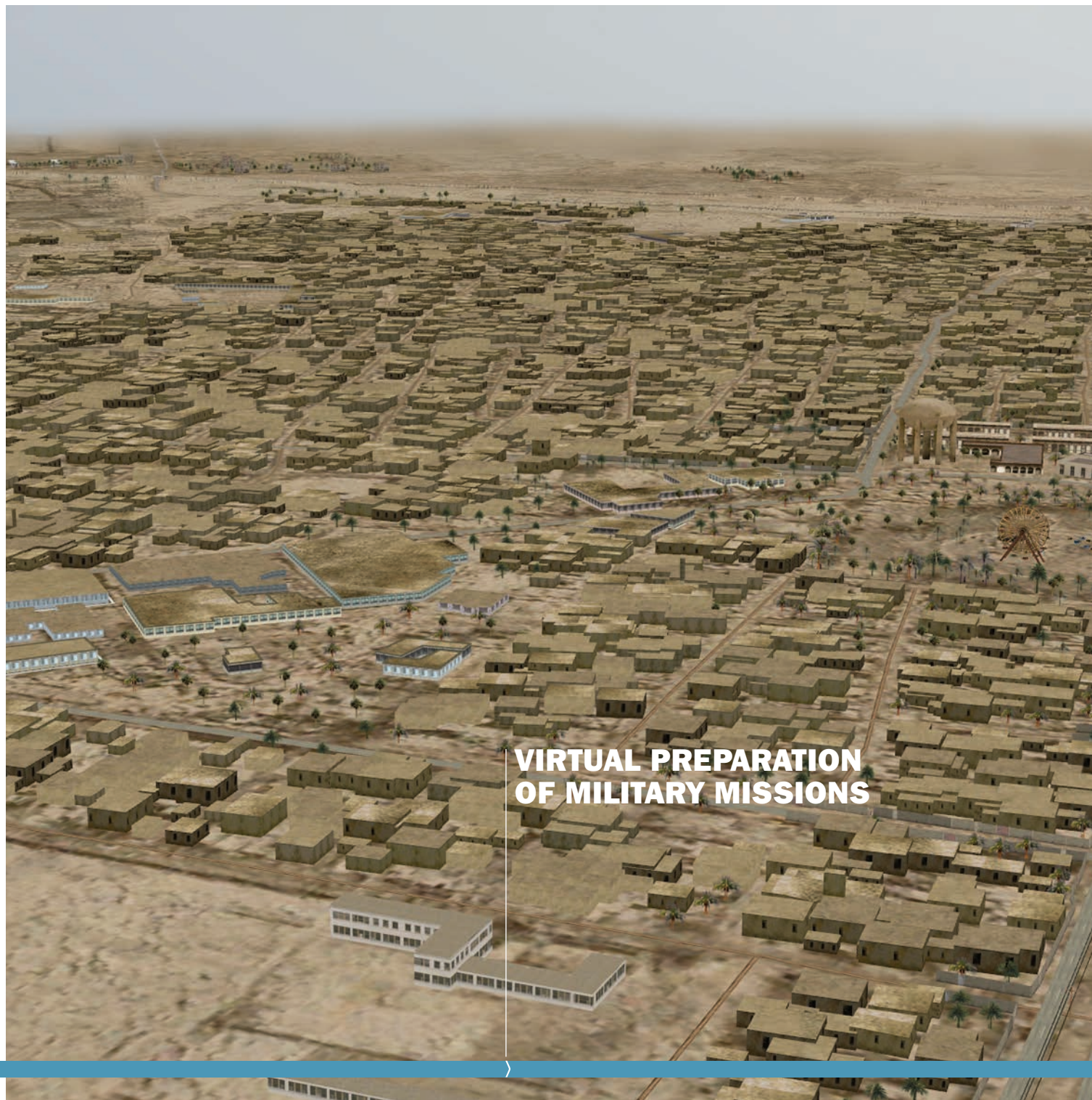




LISTENING TO CRACKS IN STEEL BRIDGES

Inspecting the many hundreds of steel bridges in the Netherlands takes a lot of manpower, time and money, and often causes traffic problems. TNO reckons there is a smarter way to do this. Why not equip the bridge with sensors that register whether, and where, there are problems? So TNO's experts built a model of a bridge in the lab and equipped it with acoustic emission sensors at critical points to 'listen' to whether, and where, the steel exhibits cracks as a result of changes to the load on the bridge. This brings together knowledge of steel construction, sensor technology, calculation modelling and dataprocessing. Following successful lab trials, TNO is now working with the Dutch Public Works department to equip the Van Brienenoord bridge in Rotterdam with tens of sensors that produce a huge stream of data that can be read remotely in a datasystem developed by TNO. The data measurements serve as the basis for predicting whether, and when, inspection, maintenance or renovation is needed. This unique system is expected to generate huge savings.



VIRTUAL PREPARATION OF MILITARY MISSIONS

Military missions, like those in Afghanistan and Mali, pose many challenges to Defence forces, so good preparation is absolutely vital. The terrain is often inhospitable and little if any reliable information is known about it. TNO helps Defence to accurately chart mission areas. Up-to-date photos taken by satellites, drones or aircraft are made and other sensor data are converted into a virtual 3D world using sophisticated technology. And so a virtual mission area is created that soldiers can experience on their laptop, tablet or in a training simulator complete with all the roads, buildings and overgrowth. In their education and training they can drive their armoured vehicle through a village, walk through the streets and even check out the houses as if they are on the spot. With the slogan 'we simulate tomorrow's mission today with yesterday's data', the armed forces can prepare optimally for the tasks that face them. Together with Defence TNO is working on automating and improving the production chain that makes this possible and therefore enable the armed forces to prepare missions faster, cheaper and more effectively, which boosts the safety of the soldiers.



TESTING NEW MEDICINES SAFELY

Sick children are often treated using medicines not specifically tested or registered for that purpose. And the child dose tends to be simply adjusted according to the difference in body weight with adults. But adults and children differ in many more ways than body weight, of course. Many of these key differences are known but that does not mean that we can predict the child dose. In short, testing medicines in children is indispensable to treating them safely and with optimum effect. TNO has a research facility that is unique in Europe where experts are working on a method to ascertain the right dose that should be administered to children by using extremely low and therefore very safe doses in studies in children. This microdose ensures that for most medicines the child dose can be objectively substantiated.



CYBERSECURITY: COOPERATION AND OPEN INNOVATION

No company or organisation, no matter how big, can stand up to cybercrime completely on its own. So it is crucial for government, industry and research, the so-called golden triangle, to join forces. This is why TNO, as an independent expert, is orchestrating cooperation with and between companies. A striking example of this is The Hague Security Delta (HSD) that formally began in the summer of 2013 as a Brainport for security, an initiative that derived in part from the ambition of the municipality of The Hague, international city of peace and justice, to become the cybersecurity capital of Europe. TNO, one of the founders of HSD, brings in knowledge, organises cooperation between parties in open innovation and has also accommodated its Cyber Security Lab here. Various SMEs have already successfully introduced commercial products based on the technology developed by TNO.



SHALE GAS: EMOTIONS AND FACTS

Emotions often run high in the debate about shale gas. Is it safe to drill for this natural gas that is sealed in layers of clay that lie kilometres deep and are difficult to penetrate? The method used for this is called fracking whereby chemicals and large quantities of water are used. Noise pollution, water contamination, earthquakes and truck after truck constantly driving past are the inevitable consequences according to the opponents of drilling. TNO has carefully listed all the evidence for and against in a shale gas arguments map. Citizens, interest groups, companies, civil servants and politicians can debate the topic properly using these insights and come to considered opinions.

The arguments map is gaining popularity in Europe: following presentations in English, French, German and Polish, it was presented to the European Parliament at the beginning of 2013. TNO is working on new technologies to make the production of shale gas safer and prevent or substantially reduce the negative effects on the surrounding environment.

TNO is regarded in Europe as a forerunner in shale gas knowledge and is now leading a sizeable research consortium, comprising tens of knowledge institutes from some fifteen countries.



TOWARDS A SUSTAINABLE WORLD

One of the biggest challenges of the 21st century is the transition from fossil to sustainable sources of energy like sun, wind and biomass within a few decades. If this gigantic operation is to succeed, substantial scientific research has to be done. During the transition it is essential to closely monitor the effects of current and future energy use, both fossil and renewable, on the environment. A major source of information for this comes via the many orbiting satellites whose onboard instruments, often designed by TNO, measure climate and air pollution. In this respect TNO is coordinating the EnerGEO research project of the European Commission to calculate future scenarios through to 2050 and to develop tools to link energy models to those for environmental effects. This will enable government or industry per country or region to establish the most suitable locations for building wind farms, solar panels or biomass power plants so that the biggest energy yield is gained with the least harm to the environment. Thanks to EnerGEO governments can implement a well-founded energy policy and a greener, more sustainable world comes ever closer.



Driverless trucks on the road in five years time? Yes, if it were up to TNO. The modern technologies developed by TNO make this technically possible. In 2013 TNO demonstrated how safe automatic driving is and, to prove it, the Dutch Minister of Infrastructure and the Environment, Melanie Schultz, successfully drove in the first automated car on the Amsterdam motorway in November. TNO is working on a comparable concept for trucks that will drive without a driver in columns. We begin simply. One truck drives closely behind another as the two trucks use wireless technologies to communicate with each other. That already makes a difference of 10 to 20 per cent on fuel consumption and just as much in CO₂ emissions. Traffic flow is improved and so traffic jams are reduced. Because the second truck needs no driver, transport firms save on personnel costs. The sector is enthusiastic as are the government and truck manufacturers. The technology has already been developed by TNO and the business case looks good. Now it's time to put it to the test. TNO is quickly bringing smart, efficient, safe and green road transport closer.



REVOLUTION IN 3D PRINTING

TNO is developing a new generation of 3D printers, christened Print Valley, which will be the factory of the future. They will soon be manufacturing personalised products like dentures, hearing aids, artificial hips, clothing or jewellery locally, quickly and on a large scale. The range of materials that can be used is endless. In the Netherlands TNO has been the forerunner since the 1990s in 3D printing, or additive manufacturing. We work closely with innovative small and medium-sized companies, who are then able to tap into new markets. Our aim is to co-develop this highly promising new technology with industry into a mature production technology for high-tech, high-precision and high-complexity applications. TNO has managed to add more and more materials for use in 3D printers, resulting in the manufacture of complex composite products. Like printed food. Our revolutionary 3D food printer will soon be making quick, customised, on-the-spot meals at home, in a restaurant or in the kitchens of nursing homes. Substance, ingredients, composition, shape, colour: every variation is possible. So a hospital will be able to make hundreds of different meals, each with the exact ingredients that every individual patient needs.

A person wearing a blue cleanroom suit and a white face mask is working in a laboratory. The background shows blue equipment and another person in a similar suit.

FROM INVENTION TO GLOBAL PRODUCT

At TNO experts in all kinds of field constantly conceive and design innovations that enable companies to make new products or services. But sometimes a few of those inventions are kept to one side because either the company or the market is not quite ready for them yet. So once a year we present some twenty ideas at the special 'Technology seeks entrepreneur' day in the hope that some of the hundreds of SMEs there can make something out of these ideas. A nice example is the Technology of Sense company that was impressed by our optical system to measure the quantity, location and cause of contaminating minuscule dust particles in real time. The current methods are slow and laborious. For cleanrooms in industry, clinical labs and operating theatres in hospitals it is vital to be able to immediately and precisely dust particles. Together with TNO the company developed the idea at rapid speed into an actual product that is now conquering the world. In the words of director Jan Gerbrands: 'TNO is the best thing to happen to us in years.'



A SMART, FLEXIBLE ENERGY SYSTEM

If energy-intensive SMEs were to flexibly adjust their consumption to the supply of renewable energy, they could generate significant savings. Savings are already possible by modifying the business process. It is a win-win situation: the company saves energy and costs while the amount of renewable energy increases. TNO is working with a number of energy companies and SMEs in the Flexiquest project to investigate how we have to change our energy system to make that flexibility both feasible and profitable. That will turn the current system on its head: it won't be demand that determines supply but the supply of cheaper renewable energy that generates demand. TNO has developed an open technology standard for electricity grids where the partners in Flexiquest will be engaging in large-scale pilots. The idea is that companies will soon align their demand for renewable electricity to the supply of solar and wind energy on a large scale. This energy will be supplied not only by the major energy companies but also by local suppliers like collectives that resupply the grid.



OUR MILKY WAY MAPPED IN 3D

Can you measure the thickness of a hair at a distance of a thousand kilometres? Until recently no, but TNO has made such an inconceivable feat possible through the instruments it conceived and developed for the ESA satellite GAIA. This unprecedented level of precision is essential to GAIA's five-year mission to measure more than a billion stars in our galaxy. GAIA will gather more than a million gigabytes worth of data that will give scientists all over the world insight into the creation of our galaxy and the role of dark matter in the universe. To this end the optical telescopes, which are super stable thanks to TNO's ingenious instruments, will be making very high-resolution 3D images, resulting ultimately in an enormous map of the stars. We will then know exactly where the stars are, at what distance they lie and in what direction and at what speed they are moving, what their chemical composition is and much more. GAIA is expected to come up with a whole host of important discoveries. Astronomers are licking their lips at the prospect.