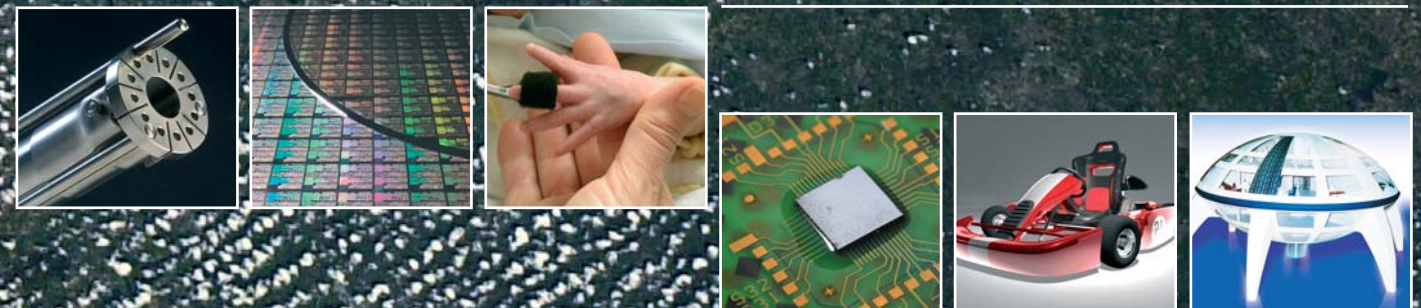


DUTCH TECHNOLOGY TRANSFER PROGRAMME

Knowledge from Space
within Reach



Foreword

Space travel is all about expanding our horizons, and one of its fascinating aspects is the development of new technologies and materials. Space is a hard, demanding environment. Weightlessness, large temperature ranges, harsh radiation, severe vibration and limited access for maintenance demand new ways of thinking and the creation of highly specialised materials, hardware and techniques.

As a society, we have decided to fund the collective cost of these activities, delivering knowledge faster than the normal process of study and development. The Dutch DELTA Mission called for new developments because of the large numbers of experiments that had to be performed. This is enabling us to improve technologies and hardware for other processes, ultimately delivering better products.

The success of the DELTA mission was possible only through the use of existing technology, like the highly reliable Soyuz spacecraft and the technology testbed of the International Space Station, with its solar panels, control systems and life support. The idea that these specialised technologies can also be used for profit and innovation on Earth is, of course, not new, but it had never before taken concrete form in The Netherlands until the Dutch Technology Transfer Programme began a few years ago. Through this initiative from ESA, the Ministry of Economic Affairs and TNO, the Dutch business sector can now profit from the wide range of knowledge built up in the European space sector over the past forty years.

For me, it is gratifying that the great amount of energy, time and money invested in the DELTA Mission is finding its way into applications here on Earth.



André Kuipers
ESA Astronaut

Introduction

Whenever space-related activities gain significant media attention, as in the case of André Kuipers' space flight, the question is raised whether investments in this sector are merited. Given that many space programmes, especially the scientific ones, tend to rely on public funding, this question is justified. However, it is a difficult one to answer. How does one value the benefits of fundamental science or all the benefits of an activity that is highly complex, involves many people and organisations and touches the lives of billions? And finally, how does one value space exploration as a source of inspiration for future generations?

Advocates of space programmes frequently answer this question by referring to the 'spin-off' potential – the use and benefits of space technology and activities for other sectors. They often support these claims with examples of products and services that have become so much a part of our daily lives that we do not even realise they are the result of space activities or space-related research. They include global telecommunications, weather forecasts, the airbag and the microwave oven.

The Dutch Technology Transfer Programme (DTTP) actively promotes the spin-off of space technology in the Netherlands. ESA, the Dutch Ministry of Economic Affairs and TNO set up the programme jointly in 2001. The objective of the DTTP is to bridge the gap between the European space sector and industry players to enable a more effective and efficient process for the transfer of knowledge between these parties. By ensuring that investments in space programmes find their way into innovative products and services in other sectors, the programme fits in very well with the Dutch Government's policy of promoting innovation.

TNO's primary objective is to develop and adapt knowledge for use in the private sector. TNO Space is therefore a logical partner for the DTTP, and we are proud that ESA and the Ministry of Economic Affairs have asked us to take on this programme.

This brochure provides a number of examples that show how technologies that have been developed for the space sector can be applied in other sectors. I hope that it will be a source of inspiration for current and future entrepreneurs, and for those in product and process development, and that it will encourage them to seek opportunities to benefit from some of the most exceptional technologies, products and services that space has to offer.



Friso van Oranje
Director of TNO Space

Contents

ESA – Benefits from space

The achievements of space programmes have become so much a part of the economic, social and scientific scene that there is a tendency to undervalue their significance and the benefits associated with them. Through its Technology Transfer Programme, the European Space Agency (ESA) has recognised the importance of helping other areas of industry to benefit from space research to meet the needs of the population of Europe.

Technology transfer is the process of utilizing technology, expertise, know-how or facilities for a purpose not originally intended by the developing organization. To transfer technologies originally developed for space to terrestrial applications ESA uses the assistance of so-called technology brokers in several of its Member States.

ESA is very pleased to cooperate closely with the Dutch Ministry of Economic Affairs and TNO in the Dutch Technology Transfer Programme. Together we even intend to take technology transfer in the Netherlands a step further: the support of new business development through the European Space Incubator at ESTEC in Noordwijk. As a technology broker, TNO's space business centre, TNO Space, will be the spider in the web.

Dutch Ministry of Economic Affairs – Sustainable growth and innovation

The Dutch Ministry of Economic Affairs is strongly devoted to ensuring sustainable economic growth in the Netherlands. The Ministry is not only focused on today's market, but also on the market of tomorrow. This is the reason why it is striving to stimulate innovation in all sectors of the economy.

The Ministry of Economic Affairs perceives the knowledge that is made accessible via space technology as strategically important for a competitive, knowledge-based economy. Full and easy access to this knowledge will allow many Dutch companies and institutions - especially those outside the space sector - to innovate and thereby strengthen their competitive powers.

The Dutch Technology Transfer Programme offers that access and helps companies and institutions to use the accumulated knowledge to create more competitive products and services. By paying constant attention to gathering and distributing knowledge, together with organisations like ESA and TNO, the Ministry wants to ensure that specific space technologies are available to as many companies as possible in the Netherlands, including SME's.

TNO – Knowledge for business

Innovation is vital. For businesses, for the Government, for the economic development of the Netherlands. The Netherlands Organisation for Applied Scientific Research TNO makes innovation possible by passing scientific knowledge to the industrial sector. Together with our clients, we are developing new applications that will contribute to the prosperity and welfare of the Netherlands and beyond.

In view of the rapid technical developments taking place, applying new knowledge faster and more effectively within Dutch industry is currently a very important challenge for TNO and its customers.

But also by making use of existing knowledge, companies can considerably speed up the development of new products and services. Especially SME's can profit from this. That is also the ambition of the Dutch Technology Transfer Programme: know-how and technology originally developed for space being made available quickly and effectively to Dutch businesses. Working together with the Dutch Ministry of Economic Affairs and ESA, this is a role for which TNO is perfectly suited.

Pierre Brisson (ESA): “Space technology can also be applied outside the high-tech sector”	4
Carl Müller (Smitsvonk): “Reliable igniters without vulnerable electronics”	6
Marc Willems van Dijk (ASML): “Space technology makes high-tech equipment lighter and faster”	8
Leo Roodhart (Shell): “Synergy between space technology and the extraction of oil and gas”	10
John Karemaker (AMC): “Space flight as a flywheel for the Portapres”	12
Gerard van Essen (TeleMetronics): “A mouse cooperates with two elephants”	14
Gerrit van der Wees (EZ): “The DTTP as intelligent mediator”	16
Eelco Rietveld and Godert van Hardenbroek (Formula Zero): “Environment-friendly motor racing with space technology”	18
Ron Willems and Peter Witteman (BO-EX): “Space technology presents possibilities for social housing innovations”	20
Len van der Wal (TNO Space) “An exclusive shop opens to the public”	22
The DTTP in the future	24

Space technology can also be applied outside the high-tech sector



Over the last forty years, Europe has invested tens of billions of euros in various space programmes. Pierre Brisson, Head of the Technology Transfer and Promotion Office of ESA in Noordwijk, says, "That money has been well spent. In the first place Europe has accomplished impressive feats in the field of space flight. Secondly, the Ariane launcher is not just a magnificent tool, it also provides Europe with independent access to space. Much of the know-how acquired from the space programme is also usable on Earth."

■ Can you give some examples?

Brisson: "There are plenty of examples, the most well-known being the microwave and the fuel cell. The airbag, too, is based on technology that originated from space research. We have also developed technology that warns parents if their child is motionless during sleep for a long period. This reduces the danger of SIDS. The solar-powered car that won the World Solar Challenge in Australia twice in succession has a battery that was developed especially for use in space. In the foreseeable future this battery will also be used in ordinary vehicles."

■ Even so, some people say that it should be possible to transfer technology to the business community faster.

Brisson: "In the Netherlands there is indeed some distrust here and there in the business community, especially among small and medium-sized enterprises. This is understandable. ESA is a large organization with highly advanced know-how, and small and medium-sized enterprises naturally

wonder whether they can approach ESA with their questions. Our Technology Transfer Programme has been running since 1990. We have already achieved a great deal, but we could do more. That is why the participation of TNO in the Dutch Technology Transfer Programme is a good idea. TNO is familiar with the Dutch market and has experience in the exchange of knowledge with the business community."

■ What can you do for a business in concrete terms?

Brisson: "When we come into contact with a new or existing business, we start by analysing their idea or problem. We determine whether we may have a possible solution in the European space sector, and if that is the case we can help to fund a feasibility study or market research. If these produce promising results, we contribute to the cost of developing a prototype. We can also mediate in the search for funding, if required."

■ So you do quite a lot for a business. Aren't you a bit too generous?

Brisson: "I don't think so. If a product proves to be successful, we make sure we recover our investment and we also share in the profits. We maintain contacts with all kinds of Dutch businesses, certainly not just with those operating in the high-tech sector. We are involved in housing projects, shipbuilding projects and the bicycle industry. In these sectors the notion still sometimes prevails that space technology may be distinguished and advanced, but that it is also fragile and expensive."

"At ESA and TNO we have a different view, and I can state that we speak from experience. Space technology is certainly not fragile. We cannot afford to take risks with a satellite or a manned space laboratory. And expensive? Well, it can be expensive, especially in the beginning. But that is what the DTTP is for."

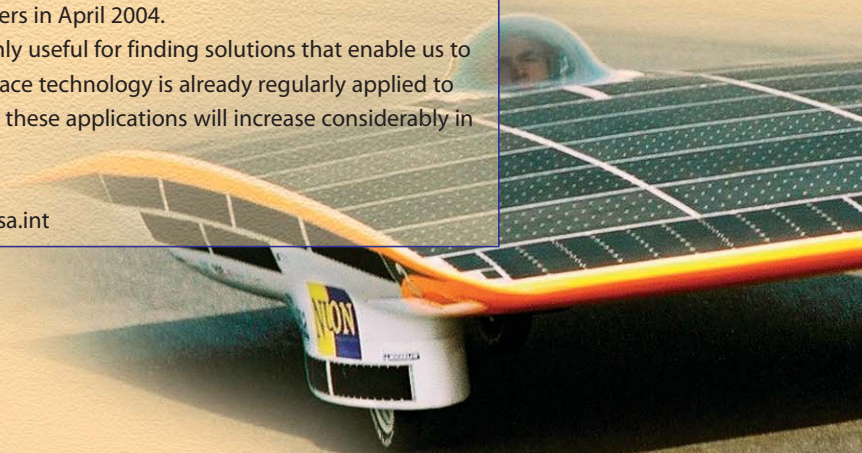


ESA: 40 years of experience in space flight and space technology

Over the last 40 years the European space organization ESA has acquired know-how relating to the building, launching and operation of satellites. In addition ESA sends astronauts to the International Space Station to conduct scientific research, such as the Dutchman André Kuipers in April 2004.

The extensive technical know-how thus accumulated is not only useful for finding solutions that enable us to work and survive in the hostile environment of space. ESA's space technology is already regularly applied to improve products and services on Earth. Expectations are that these applications will increase considerably in the future, in terms of both extent and importance.

More information can be found on the ESA website at: www.esa.int



Reliable igniters without vulnerable electronics



Carl Müller is the owner-manager of Smitsvonk B.V. in Zoetermeer. He says, "We specialize in electrical igniters for industrial applications and we have marketed a successful series of products. However, these products are coming to the end of their useful life, which is why we are seeking to improve them or develop something completely new." Space technology offers Smitsvonk new opportunities.

How did you come into contact with the DTTP?

Müller: "Several years ago we examined the explosion safety of igniters in cooperation with the TNO Prins Maurits Laboratory (TNO-PML). That project did not produce any significant results, although it did proceed smoothly. When TNO-PML suggested examining the industrial utility of an acoustic igniter within the scope of the DTTP, we jumped at the chance. We don't have a research department of our own and this presented us with the opportunity to develop a completely new line of products."

What is an acoustic igniter?

Müller: "This is an ignition technique developed for space flight, in particular for the ignition of rocket engines. Broadly speaking it involves igniting a gas by means of shock waves and pressure differences. The gas is allowed to flow through the installation and it auto-ignites. Whoosh! This system is reliable partly because no vulnerable electronics are needed."

Which terrestrial applications do you have in mind?

Müller: "There are several possibilities, ranging from gas cookers that can be lit without a spark or flame to igniters in hazardous areas. For the present we are investigating industrial applications for flaring installations to burn off gases, such as the natural gas pumped up by the NAM (Dutch Petroleum Company). At natural gas wells a pilot flame burns permanently, which means that precious gas is being wasted. With an acoustic igniter no pilot flame would be needed. The flaring installation could be ignited remotely and would ignite more or less automatically."



This looks like a product for which a market exists.

Müller: "That is what we are counting on, otherwise we would not have started the project. However, nothing is definite. We are working in three phases, starting with a simple test to ascertain whether further development is worthwhile. This phase is mainly at the expense of the DTTP. This is being followed by a more extensive test, to which we are making a greater financial contribution. If this is a success the final phase will begin, which involves bringing the product into operation. We have not yet reached that stage, but if the project progresses that far we will pay half the costs. Incidentally, without the financial support we would still have set up a research programme but this would have been less extensive and less thorough. That is the difference between our approach and that of organizations like ESA and TNO. We have between fifteen and twenty employees. We tend to try something out and hope that it works. The combination of our practical knowledge and approach on the one hand and the thorough approach of the space sector on the other provides for a good balance. Whether this will enable us to market a successful product has yet to be seen. Exciting times are ahead."

Berry Sanders, Marketing Manager of the Rocket Technology Department at TNO-PML:

Berry Sanders of TNO-PML admits that the initial contact with Smitsvonk B.V. was characterized by a considerable technology push. "Within the DTTP we propagate a strongly market-oriented approach. We prefer to respond to demands from the business community. This time the situation was slightly different. We have come up with the idea for the acoustic igniter and have developed this for the space sector, but we could also perceive uses in the industrial sector."

"The initiative therefore came from us, but this shouldn't be an issue if you consider that we have now set up a promising project together with Smitsvonk. Furthermore, we were building on previous contacts with Smitsvonk, so we were familiar with the business and its people. Perhaps things were not done entirely according to procedure, but at the DTTP we are not afraid to take the lead if something is really worthwhile."



Space technology makes high-tech equipment lighter and faster



Marc Willems van Dijk, group leader of Precision Mechanics at ASML in Veldhoven, says, "Although we didn't have much experience with composite materials, we realized that these materials offered us an opportunity to improve our competitive position. We therefore went in search of an organization with the necessary know-how."

What did you want to know specifically?

Willems van Dijk: "ASML supplies machines for the production of high-quality electronic components (IC's). Extreme precision is required for this process, and in order to make the machines attractive from an economic point of view, the process has to be fast as well. Consequently the materials used must satisfy a number of strict requirements. In this case we were concerned with a machine part that can move in all six degrees of freedom and can do this with great speed and accuracy."

Can you tell us more about the requirements?

Willems van Dijk: "In general these requirements concern improving positional accuracy and acceleration. For the machine part in question we need materials that are light in weight so that we can keep the driving motor as small as possible. To achieve the required accuracy, the material also has to be sufficiently rigid, and it has to be stable over time with minimal outgassing. Outgassing is a process whereby some elements of a material gradually disperse into the surrounding atmosphere. Some composite materials have no or virtually no outgassing characteristics, and so we wanted to know more about these."

Is there a connection between the ASML machines and space technology?

Willems van Dijk: "In some areas certainly. For instance, in the space industry experience has been acquired with the use of composite materials in circumstances that are similar to some extent with the circumstances in which our machines are used. The mirrors on the satellites sent into orbit by ESA, for example, must not be allowed to deteriorate in quality due to outgassing. At ASML we are therefore interested in ESA's knowledge of coatings that protect against outgassing. In addition, we eventually want our machines to function in a vacuum, which makes the parallels with space even more obvious."

That explains the technical side of the cooperation with the DTTP. Is there a commercial aspect as well?

Willems van Dijk: "ASML is a commercial organization that has to hold its own in a competitive market. Our quest for knowledge on composite materials could therefore be seen as a necessity. When we started out our knowledge was virtually non-existent. We have now reached a stage in which we can state that the use of composites can consolidate the competitive position of ASML. Although there are alternatives, composites are gradually gaining prominence. We strongly suspect that these materials will be able to meet our technical requirements, so finding a commercially viable and reproducible production method has now become almost as important."

"Incidentally I was pleasantly surprised by the combined theoretical and practical approach of the people at the DTTP with whom I worked. As early as the feasibility study the possibilities for further research in the same field were discussed as well. As this is now well under way, I envisage excellent prospects for all parties involved."



Aldert Verheus, Sales Manager at the Centre of Lightweight Structures TUD-TNO (a cooperation between TNO and Delft University of Technology):

"A meeting of like minds." This is how Aldert Verheus of TNO Industrial Technology describes the contact between ASML and the DTTP. "ASML was looking for knowledge of composite materials. Our organizations met at a trade fair and we hit it off, especially when the cooperation with ESA and the DTTP emerged. Many parallels exist between the construction of machines for chip manufacture and space flight - for instance, working in a vacuum and in ultraviolet light and the use of lightweight materials in fast-moving components."

According to Verheus, ASML is an interesting contact for the DTTP. "This company possesses an overwhelming wealth of technological know-how. It really is very impressive, even for someone from TNO who is used to advanced technology. A feasibility study, financed partly by the DTTP, has now indicated that further cooperation in the field of composite materials looks promising. A large-scale research project has been approved, and we have great expectations of this."

Synergy between space technology and the extraction of oil and gas



Leo Roodhart is the manager of 'GameChanger' at Shell and focuses at a global level on innovations that may be important with regard to the extraction of oil and gas. Roodhart is also a member of the DTTP Steering Group. He says, "At Shell we are only too aware of the possibilities offered by space technology. Indeed, we cannot afford to ignore these possibilities."

■ Aren't space technology and oil and gas extraction totally different areas?

Roodhart: "On the contrary, there are many similarities. For instance, there is the remote control technology developed in space programmes and used primarily for operating satellites. Shell also works in places that are inaccessible or inhospitable, such as desert and polar regions and on the bottom of the sea. If we can control our equipment remotely, like the satellites that orbit the Earth, this is better for our employees and also cuts costs. The same applies to working in extreme conditions, in space as well as beneath the Earth's crust. The fireproof materials in space suits can also be used for our offshore activities. Furthermore we have a general interest in electronics, software and materials used in the space sector."

■ Can space technology also be used to detect oil and gas reserves?

Roodhart: "We are investigating the possibility of measuring variations in the Earth's magnetic fields to ascertain whether these indicate the presence of oil or gas. This project is currently in an experimental phase. Incidentally, from space it is possible to detect any leaks in productive oil fields."

■ Why have you become a member of the DTTP Steering Group?

Roodhart: "At Shell I am the manager of 'GameChanger'. This means that I am looking for innovations that could be useful to our company all over the world. The innovations resulting from space programmes are very promising, which is why we want to maintain close contact with ESA and TNO. The synergy advantages benefit all parties."

■ Even so, oil and gas extraction is not seen to be particularly innovative.

Roodhart: "It is true that we are sometimes rather conservative. However, for me this is an added incentive to get involved with the DTTP. You have to be prepared to stick your neck out sometimes. For instance, we have considered the possibility of applying technology used in space station supply flights to oil extraction projects. This technology for both manned and unmanned space flights is highly advanced and enables astronauts to function safely for long periods in the International Space Station. Taking this concept one step further, we came up with the idea of an 'Oil Shuttle'. To extract oil from oil wells in deep water, we could send a kind of large, unmanned submarine there, link this to the oil well and open the valve remotely. This would save billions of euros as no platforms or pipelines would be required. This was a worthwhile idea that was seriously considered by Shell, although ultimately it did not get the go-ahead. However, the idea is still being examined within the DTTP. If the concept proves to be technically and economically feasible, it will of course be reconsidered."



The DTTP Steering Group

The success of the DTTP is strongly dependent on the commitment of the various 'stakeholders', which is why a Steering Group has been set up with representatives from ESA, the Dutch Ministry of Economic Affairs and TNO. The Dutch business community is currently represented by a person from the Shell organization.

The Steering Group points out practical ways of adapting solutions from space programmes for commercial use on Earth, and identifies favourable market segments and customers. The Steering Group also gives its approval to proposed feasibility studies and the financing of these studies. The members further promote the DTTP within their own networks.

The Steering Group currently consists of the following members:

- Dr.ir. Gerard Blaauw, representing TNO
- Dr. Pierre Brisson, representing ESA
- Dr. Leo Roodhart, representing Shell
- Dr.ir. Gerrit van der Wees, representing EZ



Space flight as a flywheel for the Portapres



Blood circulation can undergo sudden changes. This is usually an adverse sign, especially for astronauts, who are in extremis. The availability of a continuous blood pressure reading is therefore of vital importance in space medicine. The extensive experience acquired with the so-called Finapres technique in the Amsterdam AMC (Academic Medical Centre) was introduced by physiologist John Karemaker to various space projects in which he participated. "It is interesting to observe that since other researchers have seen us use this technique in manned space flights, it has been more widely accepted on Earth."

What is so special about the Finapres technique?

Karemaker: "The TNO group that has worked at the AMC since 1984 has developed a method that not only measures blood pressure, but does this continuously, from heartbeat to heartbeat. If fast control of the blood pressure is disturbed, or if the blood pressure is in danger of getting out of control very quickly, it is important to be informed on a beat-to-beat basis. Previously arterial invasion was necessary for this, but blood pressure can now be measured with a finger cuff. The medical world had some reservations when the device was first introduced, but the fact that our equipment was taken up into space with the Space Shuttle during the European D2 flight in 1993 was a great help."

Why was the space sector interested? Is there something wrong with the blood pressure of astronauts?

Karemaker: "The absence of gravity causes all kinds of changes in the body. For instance, the blood that is below heart level when we walk upright (in the abdomen and legs) does not stay there but moves to the lungs and head. Space travel provides instant rejuvenation, as all wrinkles are smoothed out. However, problems arise with the control of the blood pressure. Approximately one litre of blood is ultimately removed from the blood vessels as it is not needed there. Furthermore, very little muscle power is required

to move in space, so the muscles of astronauts deteriorate rapidly if they do not follow a rigorous training regime. If we conduct medical examinations in space into the state of health of the astronauts, it is vital to have continuous information on essential aspects such as blood pressure and heart rate."

What was new about the Delta mission of André Kuipers?

Karemaker: "I suggested a project to ESA involving measuring blood pressure over a twenty-four hour period, also during sleep. This could be done with a device that was already on board the International Space Station: the portable version of the Finapres, called the Portapres. This was a special model commissioned by the French space organization CNES and built by TNO."

Can the Portapres be used on Earth as well?

Karemaker: "Yes, it can, and more and more are being sold. A business called FMS B.V. (a TNO spin-off) is currently producing the Portapres. The Portapres weighs approximately one and a half kilograms and can easily be carried in a waist belt. Two small finger cuffs are used for the actual measurement of the blood pressure. Incidentally research is still ongoing, with attention currently being paid to the development of the Cardiopres, which takes continuous ECG measurements as well."

For which ailments can the Portapres be used?

Karemaker: "Sudden fainting, also known as 'syncope', for example. This is a fairly common complaint, but it is not always caused by a serious disease. Even so, sufferers want to be sure that there is no serious problem. Using this technique we can now make a definite diagnosis for patients that experience this symptom regularly. We can also tell patients what they can do to prevent subsequent attacks. This is no longer science fiction. It is day-to-day hospital practice."



Peter van der Mark, Head of the Electronic Systems and Sensors Department of TNO TPD:

"Intensive cooperation with clinical researchers is essential in order to develop and market new medical technology. Space projects provide an excellent framework for this. Concrete measurement goals are set, and the space sector requires compact systems that meet strict requirements. This appeals to us greatly. Our long-standing cooperation with John Karemaker is a good example of this. Together we appear to be able to develop medical equipment that also meets terrestrial needs."

"Take the development of the Cardiopres. This is a portable instrument that takes continuous blood pressure and ECG measurements simultaneously. We have now delivered several flight models of this instrument to the French space organization CNES, which wants to use them on the ISS. Parallel to this we are working on the introduction of a variant that will be suitable for terrestrial applications. Several clinical groups have already indicated their interest in this advanced appliance, so this offers plenty of new market opportunities."

A mouse cooperates with two elephants



Terrestrial technology can be applied in space, and in turn knowledge gained from the application of such technology in space can be used on Earth. Gerard van Essen, manager of TeleMetronics Biometry B.V. in Heteren in Gelderland (The Netherlands), says, "There is constant reciprocity. We are currently working on a project to make animal testing on Earth more animal-friendly using technology from space research."

■ Can the knowledge thus obtained subsequently be reapplied in space?

Van Essen: "That is certainly possible. But first of all I would like to return to the beginning. It all started with animal experiments on Earth, more specifically physiological data readings. ESA conducts animal experiments too, but these are carried out in space. We were involved in a project to adapt terrestrial measuring methods for the ESA research. In the near future mice will travel into space with a chip implanted in their bodies. This chip is wireless and can be read remotely. Laboratory animals on Earth can also benefit from this, as it means that they are no longer attached to all kinds of wires and cables. Consequently they behave more naturally, which makes the results more accurate and thus more valuable. André Kuipers took this chip with him on his mission in a special box and tested it in weightless conditions. The first results look promising."

■ So are we now going back into space?

Van Essen: "That stage has not yet been reached, but this is the direction in which we are going. In the terrestrial study we are trying to combine physiological measurements with behavioural

measurements. This technique can also be applied in space – for instance, to measure the consequences of weightlessness. If this study is limited to measuring physiological consequences, this only tells half the story. If physiological and behavioural data are linked, this gives us far more information, which may in turn be important for manned space flights. We would be able to monitor the health of astronauts, partly by taking remote electrocardiogram (ECG) readings. This information could then be combined with behavioural characteristics, allowing sensible medical advice to be given, such as the recommendation that an astronaut should exercise. This principle is also applicable on Earth. For instance, people with a heart condition could be given a device that warns helpers as soon as something goes wrong or – better still – warns the wearers themselves before something goes wrong."

■ Your work with ESA and TNO via DTTP. How is this cooperation progressing?

Van Essen: "Very well. Our business is small, with only five employees. One of our employees has compared us to a mouse working with two elephants, and this is a fairly accurate analogy. For us, cooperation with others is a necessity. We cannot develop and market the technologies with which we work without the help of others, partly because such large investments are required. Fortunately TNO and ESA understand this. However, as a business we have to make sure that our interests are put across clearly. After all, a mouse and an elephant can only market successful products together if they both acknowledge and respect one another's interests."



First contact between TeleMetronics and the DTTP via ESA

Contact between a business and the DTTP can come about in various ways. In the case of TeleMetronics Biometry B.V., ESA formed the link. Len van der Wal, Programme Manager of the DTTP, says, "TeleMetronics not only has experience with advanced technology, it has also worked with ESA. When the idea arose that the TeleMetronics technology could be useful on Earth as well, Pierre Brisson, Head of ESA's Technology Transfer and Promotion Office, brought TeleMetronics and the DTTP into contact with one another. As Brisson is also a member of the DTTP Steering Group, the lines were short."

"We examined several ideas together, and the plan of working with small laboratory animals seemed to be the most feasible. The financial support offered by the DTTP proved to be an incentive. TeleMetronics is not a large business and cannot bear the costs of such research on its own. Together we hope to achieve good results and to create a product that enjoys commercial success and – also very important – contributes to improving the welfare of laboratory animals."

The DTTP as intelligent mediator



The microwave, the airbag and the fuel cell are all examples of terrestrial applications for space technology. However, these applications have now been around for decades. "Things have become rather quiet since then," says Gerrit van der Wees, Senior Policy Officer for Aviation and Space at the Ministry of Economic Affairs, and a member of the Steering Group of the Dutch Technology Transfer Programme. "This is a pity, because the possibilities are commercially interesting and will become even more interesting in the future."

■ How can we improve the transfer of technology?

Van der Wees: "The Ministry of Economic Affairs is convinced of the value of space technology to the Dutch economy. There are the research and development programmes (R&D), which are intended directly for the space industry, and in addition there is the spin-off. However, the amount of spin-off could be increased considerably. Small and medium-sized enterprises in particular often believe that innovative technology is too ambitious for them and could become a millstone around their neck. They are also afraid that technical feats will prove to be expensive."

■ That is not entirely incomprehensible.

Van der Wees: "No, not if they have to invent everything themselves. What they need is an intelligent mediator, someone who can make the technology accessible. The DTTP works on a demand-driven basis wherever possible and, because glossy brochures are not enough, we also pay regular visits in person. Incidentally, we sometimes notice that businesses don't make requests because they are

unaware of all the possibilities. In such cases we initiate the meetings ourselves. And expensive? The notion that state-of-the-art technology comes at a price is partly true, and we realize this, which is why we have various schemes within the DTTP aimed at supporting businesses during the initial phase in the application of space technology. For example, the small-scale feasibility studies conducted by the businesses themselves or by a third party have proved to be very effective."

■ You represent the Ministry of Economic Affairs in the Steering Group of the DTTP. What is the reason for this?

Van der Wees: "The Ministry attaches great importance to the transfer of space-developed technology and wants to keep a close eye on things. This is also in keeping with the policy of Mr Brinkhorst, Minister of Economic Affairs, who wants to turn the Dutch economy into an innovative knowledge economy.

The Directorate General in which I work has been given the name Innovation, and for good reason. If we want to safeguard the international competitive position of the Netherlands in the future, we will have to concentrate on the high-tech sector. For my part I would like to see the DTTP programme expanded, intensified and augmented in the future, because practice has now shown that this is a good way to bring different, advanced technological know-how to the attention of the business community."



Financial contribution from the DTTP

Businesses that want to adapt space technology for commercial applications on Earth are taking a certain risk. The DTTP can alleviate this risk by taking care of some of the costs involved in the initial research phase.

In the first place this often concerns an exploratory feasibility study. The DTTP can in principle provide half of the cash required for this. This usually amounts to sums of between 10,000 and 25,000 euros. For smaller studies the DTTP may even contribute a larger proportion of the costs. The DTTP can also help to finance supplementary studies - such as market research, for example.

Once the feasibility of a technology transfer has been established, and if more investment is required, the DTTP can provide further help in obtaining the necessary financing - for example, via the TNO Co-financing Programme or via subsidies from the Ministry of Economic Affairs or the European Union.



Environment-friendly motor racing with space technology

FORMULA ZERO



Formula Zero B.V. is a joint enterprise by Eelco Rietveld and Godert van Hardenbroek. Rietveld is an industrial designer with a preference for ecologically sound products. "At the same time I have a passion for Formula 1 motor racing, although I used to be rather reluctant to admit this." Space technology is now helping to realize his dream of environment-friendly motor racing. "This really is possible," he claims.

■ I frankly find that hard to believe.

Rietveld: "We are going to prove that it is possible, and we also intend to show that ecology can be fun. At Formula Zero we have been working for about six years on the development of plans for a technique whereby no harmful substances are released during driving or during fuel production. The name Formula Zero is derived from this, with Zero standing for zero emission. In the foreseeable future we hope to establish a world record for the fastest accelerating vehicle that runs on fuel cells. We are using hydrogen technology for this."

■ Are you going to compete with the Formula 1 racing monsters?

Van Hardenbroek: "We are adopting a phased approach. The project begins with a go-cart, which has been given the working name of 'Spacecart', followed by an open formula car, and finally a full-size Formula Zero racing car. Our ultimate goal is to outstrip the Formula 1 racing cars, but of course we have not got that far yet – which is understandable, as conventional racing car technology based on the combustion engine is already about a hundred years old."

■ How did you come into contact with the DTTP?

Rietveld: "Via a TNO employee, who perceived the links with space technology and referred us to TNO Space. The parallels are clear. For instance, we devote much attention to safety and we work with lightweight materials and electrical components for high performance. TNO and ESA are supporting the Formula Zero concept and the development of the first fuel cell racing vehicle. We received funds for a feasibility study for the Spacecart, and this enabled us to draw up a product proposal. We have now approached a number of potential sponsors, not just for a world record attempt but for the entire Formula Zero project. These potential sponsors are parties interested in the hydrogen economy, such as automotive and energy companies, and include famous names like Daimler, GM, Shell Hydrogen, E.ON Benelux and various Dutch energy and technology companies."



■ Can you name any concrete products that have been developed as a result of the Spacecart project?

Van Hardenbroek: "We have drawn up a list of 115 possible innovations on the basis of the space technology transfer. In consultation with TNO and ESA we have selected two promising projects. For the world record attempt we want to use a lightweight hydrogen tank that is enveloped in carbon fibre according to a specific pattern. Similar tanks are already being used in space. We are now designing a quick coupler that enables this tank to be connected and disconnected with a single action. We are also incorporating electrical components that convert the energy released during braking into a power boost to aid acceleration. This know-how also originates from the space sector. Formula Zero is an amazing combination of technologies that can be applied both in space and on Earth."

Salem Mourad, Business Manager of Advanced Powertrains at TNO Automotive:

"Formula Zero was in search of new, environment-friendly technologies and ESA looks for projects in which space technology can be applied and demonstrated in terrestrial products. The Spacecart satisfies both requirements. Combined with TNO's advanced knowledge in the field of automotive technology, this has resulted in a practical application, namely a small, lightweight and environment-friendly race monster that continues to function well in difficult conditions."

"The Spacecart is more than just an amusing toy, as the technical know-how can be adapted for commercial exploitation. For instance, the idea of the electrical power boost can be utilized in the automotive industry. In addition, of course, the appeal of motor racing attracts the interest of businesses and helps to get the new techniques up and running."

Space technology presents possibilities for social housing innovations



At first sight space technology and social housing don't appear to have much in common. After all, who needs advanced technology in order to manage a block of flats? Ron Willems and Peter Witteman from housing corporation BO-EX in Utrecht take a different view. "We are open to innovation and experimentation."

■ What are the connections between social housing and space technology?

Quality coordinator Ron Willems: "BO-EX and ESA both house people. Of course, we have more tenants, and astronauts live under far more extreme conditions than the residents of an Utrecht suburb. However, in both cases the residents and their living comfort are the main priorities."

■ Can you give concrete examples of similarities?

Willems: "Research by the World Health Organization (WHO) reveals that the number of people with depressive symptoms has risen rapidly in recent years, faster than the rate of aging of the population. This generates a greater sense of insecurity, which in turn further fosters depression. A connection can be drawn here with the lack of light in homes and the view from the windows. We are conducting research in conjunction with the WHO, Philips and TNO in an attempt to resolve this situation. We want to find out more about the connection between depression and living environment, and we are looking for ways to create more artificial light in homes or to allow in more natural light. At the same time, more light often means that the house has a more open aspect in relation to its surroundings, and hopefully this will enhance personal safety and social contact between neighbours. However,

energy management is an important factor in this equation, as the larger the windows, the more heat is lost. A wealth of knowledge in this field has already been gained in the space sector, and we can utilize this knowledge. On a reciprocal basis our research findings may be of use to ESA, as a lack of light can also cause problems in manned spacecraft."

■ Are there any more parallels with space technology?

Project leader Peter Witteman: "We have had meetings with people from ESA and TNO during which I picked up some very interesting ideas. The building industry is rather conservative, its first priority being profit rather than new initiatives. New initiatives only cost money, at least in the early stages. However, at BO-EX we are occupied with social housing, so we are involved with people. That is why we are conducting research into more light in homes. But I am also interested in materials used in space flight, as these are lighter in weight than the current building materials and are more flexible to process. Therefore we have asked an architect to look beyond the limitations of the Buildings Decree and investigate whether we could use such materials in new building or renovation projects."

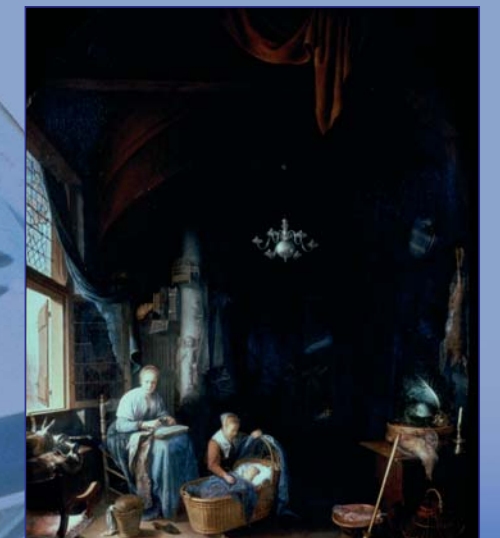
■ Are you looking for any specific know-how?

Witteman: "We are seeking a solution to the problem of cabling, as installers currently lay cables everywhere, through floors and walls. The houses would be far more practical for the tenants if this was done differently. It would also make things easier for us in the case of renovations and conversions. This cabling problem also exists in space flight, so we would like to utilize knowledge in this field. We are considering a system whereby cables for electricity, telephone and data communication enter the house at one central point. These can then be distributed around the house via the skirting-boards. These cables would be easy to relocate, and in the future wireless communication may even be an option. We are willing to stick our neck out for projects like this. We can't sit still because we have to consider the interests of our tenants."

Olaf Adan, Scientific Officer at TNO Building and Construction Research:

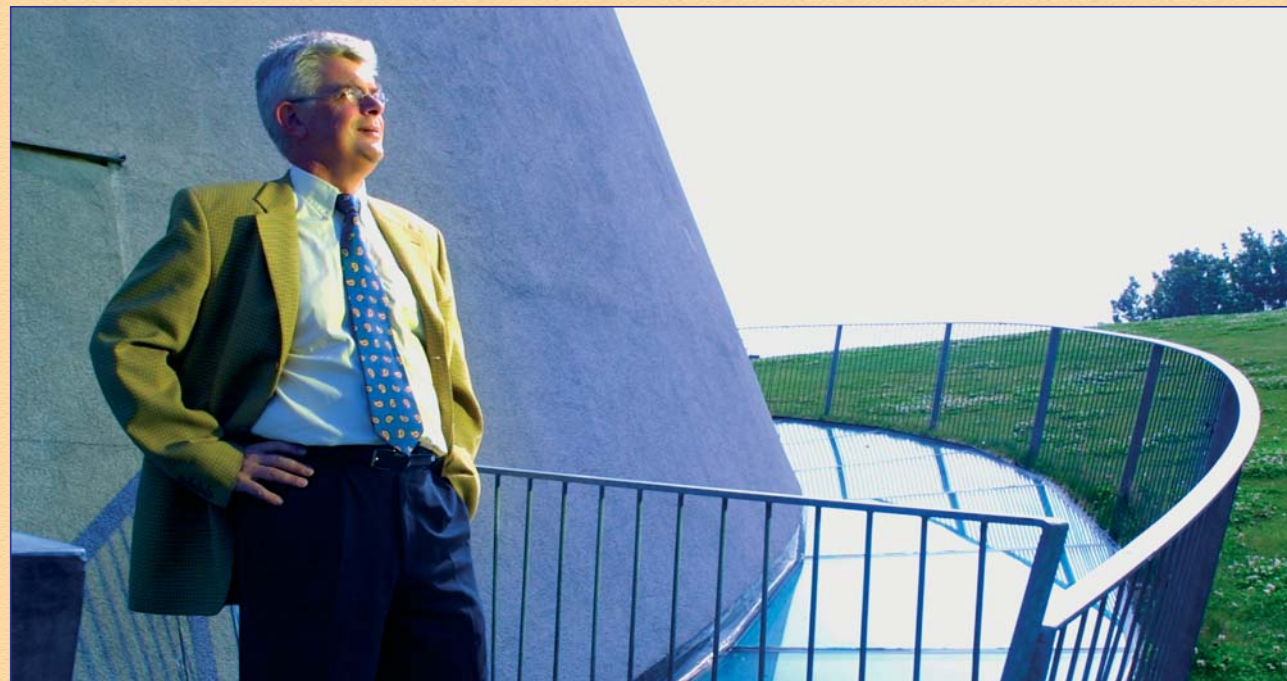
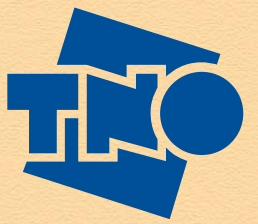
"I was already familiar with BO-EX as an organization that was open to innovation. When the DTTP and TNO Building and Construction Research needed partners for a project aimed at adapting innovations from the space sector for use in the construction sector, contact was soon established. That project, entitled 'EcoSpace', has now taken shape. We work with representatives from the building supply industry and with end users. This incorporates a broad range of organizations such as Philips, the World Health Organization (WHO), the pharmaceutical industry, installation and telecommunication companies, housing corporations like BO-EX, and of course ESA."

"This varied collection of interested parties has now decided to formalize EcoSpace, possibly in the form of a foundation. This is important, as it means that those involved genuinely support the project and want to make a concerted effort on its behalf. We will also be acting on a European Commission level. Among other things, we will participate in a platform to develop a vision of the urban environment in Europe in the year 2030 and to implement the necessary innovations."



Courtesy Mauritshuis

An exclusive shop opens to the public



The great wealth of technological know-how and experience that has been acquired in the space industry over the decades could be of great benefit to the business community. The question is how the two sectors can be reconciled. Len van der Wal, Programme Manager of the Dutch Technology Transfer Programme (DTTP), says, "We build bridges between European space technology and the terrestrial business community. These two very different worlds require an intelligent mediator."

■ How do you forge the links?

Van der Wal, managing the DTTP while working at TNO Space: "Space technology is like an exclusive shop opening its doors to the public. However, potential customers have to be bold enough to step inside, and they are sometimes deterred by the seemingly high threshold. Businesses often have the impression that space technology is complex and expensive, so they conclude that it is not for them. The task of the DTTP is to show Dutch businesses that space technology can offer practical solutions to some of the problems they face. We have to take the technology off the shelf, as it were, and demonstrate its usefulness. This is the only way to bring the two different worlds together. Incidentally, as we focus on customers in very different sectors, an extensive network is needed. This was a good reason for calling upon TNO to mediate between the European space sector and the Dutch business community. TNO has been doing this kind of work for years. We have the network, we have the technical know-how required to consult with ESA and the space sector, we know how to adapt advanced but often expensive technology for commercial production purposes, and we also know that being enterprising means taking risks."

■ So you are not always successful.

Van der Wal: "No, of course not. We enjoy regular successes but we also occasionally experience failure. For instance, the DTTP and a large multinational held intensive discussions concerning the use of plastics from the space sector in the automotive industry. Ultimately the company's requirements did not correspond to what we had to offer. That was a pity, but we managed to establish a good contact with the company and we may work together again at a later stage. That is what it is all about: building good relations and mutual trust. Sometimes we bring two businesses into contact with each other. This has no direct benefit for DTTP, but that is not what we are looking for. The reward often comes later - and if it doesn't, that's okay as well."

■ How can knowledge applied in space possibly be useful to a small or medium-sized enterprise?

Van der Wal: "Space programmes are regularly faced with problems that also arise on Earth. The difference is that in space the situation is often more critical. Errors or problems affecting safety, energy conservation or autonomous operation are out of the question. The solutions developed in the space sector can be applied in many other sectors, such as housing, traffic and transport, oil and gas, health care, equipment manufacture, the automotive industry, and so on. Incidentally, this type of work not only revolves around technical know-how but also requires courage and imagination. These characteristics are needed to deviate from the beaten track, identify opportunities and make the right connections."

■ What type of business receives your help?

Van der Wal: "In principle we act on behalf of all commercial users of knowledge. Large businesses and businesses operating in the high-tech sector can usually find their own way. For others, such as small and medium-sized enterprises and new businesses, things can be more difficult. However, a great deal can be achieved with a bit of common sense alternated with a healthy dose of imagination, financial support from ESA and the Ministry of Economic Affairs, and the contacts established by the DTTP. So don't be afraid to get in touch."



For more information regarding the DTTP please contact:

Ir. Len van der Wal
DTTP Programme Manager
TNO Space
PO Box 477
2600 AL Delft
Tel.: +31 (0)15 - 269 23 70
E-mail: vdwal@tpd.tno.nl

Dr. Pierre Brisson
Head of TTP Office
ESA/ESTEC
PO Box 299
2200 AG Noordwijk
Tel.: +31 (0)71 - 565 49 29
E-mail: pierre.brisson@esa.int



The DTTP in the future

The DTTP has developed a successful, market-centred approach to transfer space technology to non-space applications in the Netherlands. In just three years, the DTTP has presented some forty opportunities for technology transfer. Twenty-four of these opportunities have been turned into feasibility studies and implementation projects.

Thus, the programme has shown that an approach that is primarily focused on the non-space market enables the identification of a wide variety of potential technology recipients in the Dutch business community, ranging from large multinationals to small- and medium-sized enterprises.

Due to the positive results of the DTTP, technology transfer now constitutes a key area in the new Dutch Space Policy Plan ('Actieplan Ruimtevaart', November 2004). Therefore, ESA, EZ and TNO will continue the DTTP in the form of a second phase until January 2008. This second phase is intended to further intensify the scope of space technology transfer in the Netherlands. The terms and conditions of this second phase will be quite similar to the ones that were applied in the first phase. However, the objectives will be somewhat broadened in order to achieve the purpose of eventually becoming a national supportive technology transfer programme.

To achieve this, ESA, EZ and TNO intend to attract new 'stakeholders' to further strengthen the foundation of the DTTP and boost the business reputation and public awareness of the programme. The DTTP also intends to stimulate the development of new business and 'spin-off' activities based on space technology, for example through the establishment of start-up companies and/or joint ventures. Thus, the future DTTP will maintain a strong focus on the transfer of European space technology to the Dutch business community.

BR-231	October 2004
Published by:	ESA Publications Division ESTEC, PO Box 299 2200 AG Noordwijk The Netherlands
Editors:	Len van der Wal & Bruce Battrick
Design & Layout:	Jules Perel
Interviews:	Eric Le Gras
Portrait Photography:	Jaap Oldenkamp
Cover Photograph:	André Kuipers
Copyright:	© 2004 European Space Agency
ISSN:	0250-1589
ISBN:	92-9092-573-6
Illustrations courtesy of:	ASML, ESA, Formula Zero, Royal Cabinet of Paintings Mauritshuis, Smitsvonk, Springtime, TeleMetronics and TNO