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# Annual Review 2001

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## About TNO

**This is TNO's mission: to apply scientific knowledge with the aim of strengthening the innovative power of industry and government.**

**TNO collaborates with clients to develop solutions for tomorrow's challenges. This involves converting scientific knowledge into a form that business and government can use to tackle actual issues. These new applications often have a technological basis and are either adopted by business and government or commercially exploited by TNO itself.**

**TNO is an independent knowledge company employing more than 5,400 people working in 14 institutes and some 30 companies, spread over dozens of locations at home and abroad. In 30 knowledge centres close collaboration with the Dutch universities contributes to the development of new knowledge.**

**TNO is a public organisation operating at the interface between government and the business world. In its development of knowledge, TNO is funded by government. Two thirds of TNO's activities take place in the market in the form of contract research, consultancy, policy research, testing, approval and certification and the sale of products and licences.**

TNO in 2001

# Preface

The past year has seen a dual agenda for TNO, with the organisation actively pursuing its strategy for 1999-2002 while formulating the new strategy for 2003-2006. Our aim for this next strategy period is to see TNO get its knowledge to the market faster and to develop into a research and technology organisation of European standing. To do this we need to concentrate the focus of our activities by reducing the number of technologies in which we are active to around 150 and grouping these, in turn, into five broad core areas.

In financial terms, we can report that the turnover in 2001 was up on the year before, rising by 7.3 percent to EUR 514.5 million. Including exceptional profits and losses, the result was EUR 3.0 million, down EUR 4.3 million on 2000. The fall is attributable to changes in the market and the costs of reorganisation incurred during essential improvements to operations as well as investments in the formation of institutes. In the course of the year under review, measures were taken to ensure a structural improvement in the result. This aim is underpinned in a policy formulated in 2002 that introduces further improvements in how the organisation operates. As a public organisation, TNO's aim is not profit maximisation but a reasonable result that enables continued investment in new knowledge.

The year 2001 saw TNO enter into collaborative arrangements with a select number of institutes abroad as

part of the formation of SAFE – Safe Food in Europe – and with the German Wilhelm Karmann GmbH in the field of vehicle safety.

The TNO Board of Management would like to take this opportunity to express its appreciation to all employees within the organisation for their commitment over the past year. A great deal of hard work has been done to make a contribution to the innovation of businesses and government bodies in the Netherlands. We also value highly the contribution made by the members of the works councils and the central works council to strategy development.

At the end of 2001 TNO said goodbye to Professor Dr P. Folstar, who had been a member of our Board of Management since 1994. He has been appointed director of the Netherlands Genomics Initiative at NWO (the Netherlands Organization for Scientific Research) with effect from 1 January 2002. We would like to thank him for all he has done for TNO over the years.

*Delft, 17 April 2002,*  
TNO Board of Management,

J.A. Dekker, M.Sc., chairman  
E.Th. Gubbi, M.Sc., vice-chairman  
E.I.L.D.G. Margherita, M.Sc.

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TNO Annual Review 2001 is an abridged version of the Dutch 'TNO Jaarverslag 2001'.  
In matters of interpretation the Dutch text will prevail.

# Key figures

in EUR x million (unless otherwise stated)

	2001	2000	1999
<b>TNO (TNO Organisation including group companies)</b>			
Government funding turnover	160.4	154.2	144.5
Market turnover	354.1	325.3	295.9
<b>Turnover</b>	<b>514.5</b>	<b>479.5</b>	<b>440.4</b>
Net turnover 1)	439.8	409.5	370.6
Added value 2)	358.8	338.7	305.6
Operating result before exceptional depreciation tangible fixed assets	- 1.6	3.1	9.1
Exceptional depreciation tangible fixed assets	- 12.2	-	-
Operating result	- 13.8	3.1	9.1
Balance of extraordinary income and expenditure	16.0	-	-
<b>Result</b>	<b>3.0</b>	<b>7.3</b>	<b>5.9</b>
Result as % of the market turnover	0.8%	2.3%	2.0%
Result after movements in appropriated reserves	- 19.8	2.5	1.3
<b>Number of employees (effective average)</b>	<b>5,074</b>	<b>4,997</b>	<b>4,700</b>
Net turnover per employee (effective average) in thousands of euros	86.7	81.9	78.9
Added value per employee (effective average) in thousands of euros	70.7	67.8	65.0
Personnel costs per employee (effective average) in thousands of euros	63.6	59.6	56.2
<b>Personnel costs</b>	<b>322.9</b>	<b>297.8</b>	<b>264.2</b>
Operating capital	70.8	12.6	21.2
Equity	214.6	209.9	206.9
Cash-flow	114.0	46.3	56.7
Investments	65.1	58.9	75.8
Current ratio	1.63	1.09	1.17
Solvency	0.56	0.54	0.57

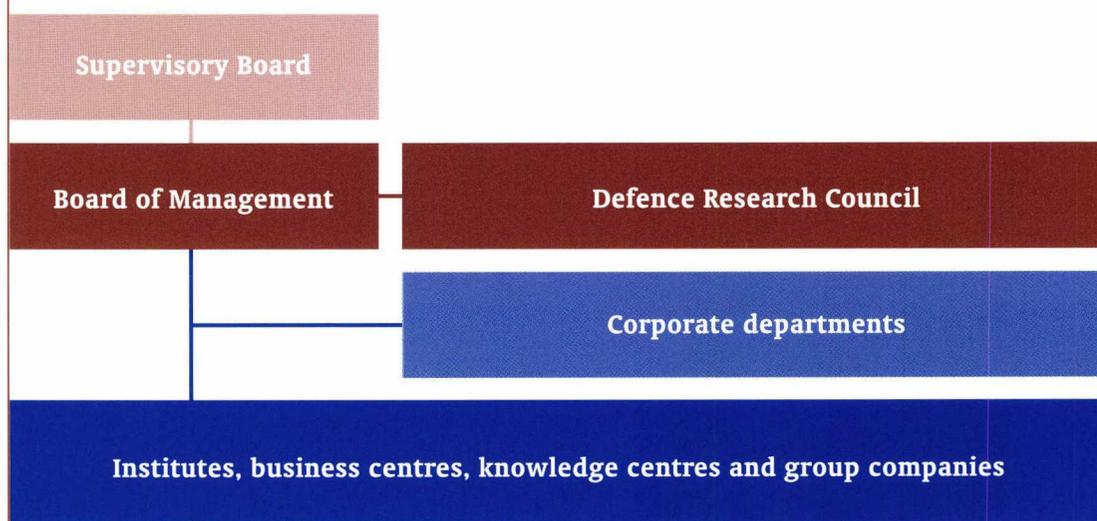
in EUR x million (unless otherwise stated)

	2001	2000	1999
<b>TNO Organisation</b>			
Government funding turnover	160.4	154.2	144.5
Market turnover	306.3	295.1	279.6
<b>Turnover</b>	<b>466.7</b>	<b>449.3</b>	<b>424.1</b>
Operating result before exceptional depreciation tangible fixed assets	- 5.4	1.8	9.6
Exceptional depreciation tangible fixed assets	- 12.2	-	-
Operating result	- 17.6	1.8	9.6
<b>Result (excluding result for group companies)</b>	<b>- 1.4</b>	<b>6.5</b>	<b>5.1</b>
Result (excluding result for group companies) after movements in appropriated reserves	- 24.2	1.7	0.5
Operating result TNO institutes	0.1	2.0	8.4
Result TNO institutes	- 0.9	1.8	9.0
Number of TNO employees (effective average)	4,587	4,659	4,518
Average term of work in progress and debtors in months (TNO institutes)	3.7	3.8	4.5
<b>Group companies</b>			
<b>Turnover</b>	<b>54.9</b>	<b>36.2</b>	<b>21.1</b>
Operating result	3.8	1.3	- 0.5
<b>Result</b>	<b>4.4</b>	<b>0.8</b>	<b>0.8</b>
Number of employees (effective average)	487	338	182

1) Net turnover = turnover - direct project costs

2) Added value = turnover + other operating income - external costs

## Organisation structure



# Management

## **TNO Supervisory Board**

(composition as at 1 April 2002)

J.M. Leemhuis-Stout, M.Sc., *chairman*  
Prof. Dr M.C.E. van Dam-Mieras  
Prof. Dr P.M.E.M. van der Grinten  
Prof. Dr L. Koopmans  
Dr H.J. van der Molen  
A.H.J. Risseeuw, M.Sc.  
Dr A.W. Veenman  
J. Vrolijk, LL.M.  
Dr J.A.J. Basten, *secretary*

## **TNO Defence Research Council**

(composition as at 1 April 2002)

E.I.L.D.G. Margherita, M.Sc., *chairman*  
Prof. Dr E. Backer  
J. Bezemer, M.A.  
E.A. van Hoek  
Prof. Dr L.F.W. de Klerk  
Ktz. W. Nagtegaal  
Sbn. P.M. van der Struis  
Gen.maj. P.M.A. Vorderman  
Prof. K.F. Wakker  
Cdre. J.M.W. Willems, M.A.  
Prof. Dr R. de Wijk  
Gen.maj. W.H. Zoomers, LL.M.  
R.P. Perié, *secretary*

## **TNO Board of Management**

(composition as at 1 April 2002)

J.A. Dekker, M.Sc., *chairman*  
F.Th. Gubbi, M.Sc., *vice-chairman*  
E.I.L.D.G. Margherita, M.Sc.  
Dr J.A.J. Basten, *secretary*

# Report from the Board of Management

## Strategy

2001 was the third year of TNO's current strategy period; the end of 2002 will see the start of the next four-year period (2003-2006). The strategic plan for this period is now ready and has been submitted to the Minister for Education, Culture and Science. By virtue of its timing, 2001 was a year in which the current strategy demanded a great deal of attention while writing the new strategy required the additional time of management and employees alike.

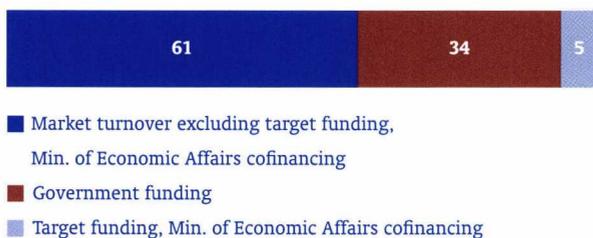
### Current strategy

The current strategy for 1999-2002 spans fourteen core areas and has the following dual aim: to increase market turnover with the current level of government funding to such a degree that TNO's impact on the innovative capacity of businesses is intensified and to help government bodies develop policy. TNO also aims to boost the commercial application of its knowledge. In developing new knowledge, TNO works closely with universities and participates in the so-called Top Institutes in technology and in national and international research programmes.

Progress in the current strategy is measured each year. The progress reports for 2000 show that the actions set in motion in 1999 have already paid off to some extent.

### Figure 1 - Total TNO turnover

total 2001 EUR 467 million  
(TNO excl. group companies) – in percentages



Additional measures were implemented in 2001 to address developments in a number of core areas that underperformed against the plans.

We can see that at the close of the year under review the aim of the current strategy to increase market turnover is being achieved. The increase has been derived mainly from the business world and from countries outside the Netherlands. Progress has also been made on the objective to strengthen TNO's collaboration with universities and other organisations.

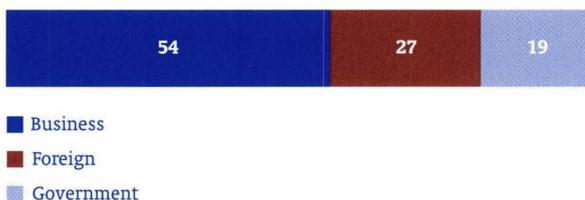
### Strategy 2003-2006

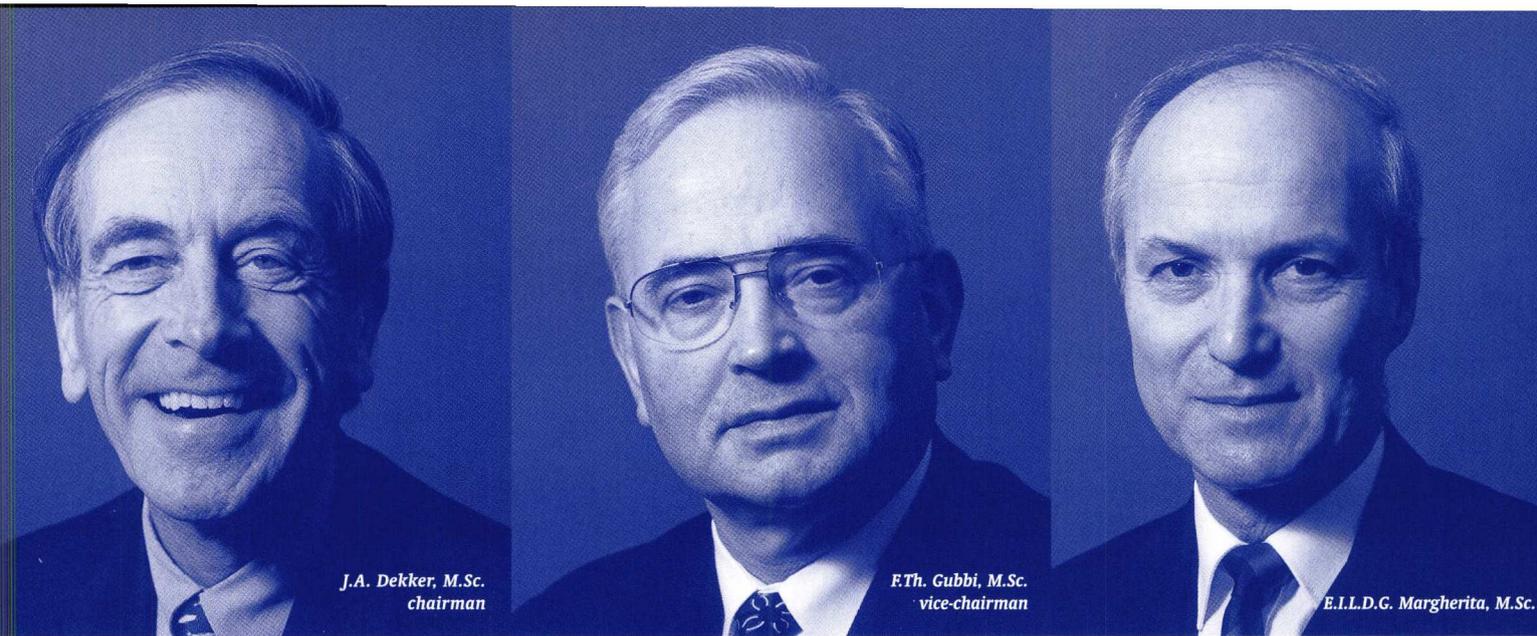
As a consequence of the terms laid down in the TNO Act, TNO is bound every four years to submit a strategic plan to the Minister for Education, Culture and Science. The plan for the period 2003-2006 was approved at the end of 2001 by the Supervisory Board and, for those parts pertaining to defence research, by the TNO Council for Defence. The strategic plan includes the objectives for the medium and long term along with a broad overview of the policy that will be pursued to reach them. The submitted plan will be discussed by the cabinet.

In the period leading up to 2006, TNO aims to get its knowledge to the market faster and to develop into a research and technology organisation of European

### Figure 2 - TNO's market turnover by category

total 2001 EUR 306 million  
(TNO excl. group companies) – in percentages





J.A. Dekker, M.Sc.  
chairman

F.Th. Gubbi, M.Sc.  
vice-chairman

E.L.L.D.C. Margherita, M.Sc.

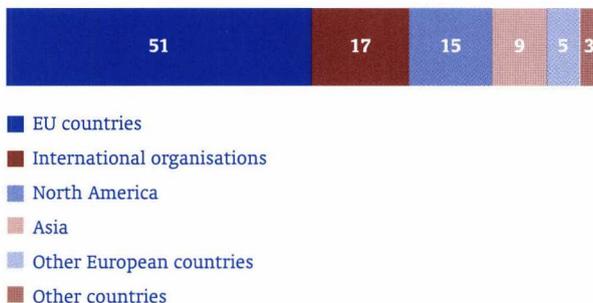
standing. This will enable the organisation to make tangible contributions to the development of the Dutch and European knowledge economies. To achieve this, TNO will need a stronger technology portfolio, not in terms of the number of technologies, but in terms of excelling in fewer. This is the rationale for reducing the number of technologies TNO offers to around 150. These technologies – at present still ranging across fourteen core areas – will be concentrated into five new core areas that are highly relevant to the major social themes of the coming years.

As of 2003 the five core areas will be:

- Quality of Life;
- Defence and Public Safety;
- Advanced Products, Processes and Systems;
- Natural and Built Environment;
- ICT and Services.

These five new core areas will enable TNO to send a clearer message about the fields in which the organisation offers solutions. Clustering into just five areas brings the added benefits of promoting greater collaboration between the institutes and enabling us to offer clients a greater concentration of knowledge than was previously possible.

**Figure 3 - Foreign turnover**  
total 2001 EUR 82 million  
(TNO excl. group companies) – in percentages



### Acquisition and collaboration

In February 2001 TNO's acquisition of Holland Metrology NV was concluded with the transfer of the shares by the Dutch Ministry of Economic Affairs. Holland Metrology NV is the parent company of the Netherlands Metrology Institute (NMI) and other holdings. Both parties will enjoy a stronger position in the market for the development and supervision of standards as a result of this acquisition and TNO will gain the chance to extend its activities in the field of certification. For the time being, NMI will maintain its own identity and structure. The company, which employs around 250 people, achieved a turnover of EUR 27.3 million in 2001.

The German research organisation IABG signed an agreement with TNO in July 2001 for a strategic collaboration that will benefit the Ministries of Defence, NATO's international programmes and the defence industry. TNO and IABG are highly skilled and have broad practical experience in system integration and providing technical support to the armed forces.

Food safety is a subject that commands a great deal of public and scientific interest. It is also a theme in which European collaboration is increasingly important – partly as a consequence of the growing internationalisation of the food market. TNO's expertise in this field is extensive and is being employed for current and future food safety in a consortium on the subject. This has been set up by TNO and a number of other European institutes. Operating under the name Safe Food in Europe (SAFE), TNO is collaborating with the French *Institute Nationale de la Recherche Agronomique (INRA)*, the British *Institute for Food Research (IFR)*, *Wageningen University and Research Centre (WUR)* and the Finnish research institute VTT. SAFE gathers and analyses information, sets up research programmes and informs consumers. This initiative sees the institutes involved responding to the establishment of a European Food Authority. TNO has also reached an agreement with

WUR to collaborate in the field of food research, with the two organisations harmonising their investment plans and activities. TNO will devote its energies to food quality, toxicology and nutrition and health while the *Institute for Agrotechnological Research (ATO)* at WUR will be focusing on the technological aspects of the production, processing and preservation of food. Other activities may well be added in future.

In December 2001 an agreement between TNO and Wilhelm Karmann GmbH was signed to seal collaboration in the field of passive safety in vehicles. As partners, they are now sharing their knowledge of development and testing and becoming a powerful independent partner for vehicle developers in car manufacturing worldwide.

TNO is participating in the four Dutch Top Institutes in technology. These are the Netherlands *Institute for Metals Research (NIMR)*, the *Telematics Institute*, the *Wageningen Centre for Food Sciences (WCFS)* and the *Dutch Polymer Institute (DPI)*. In the course of 2001 TNO held an evaluation of its involvement in each of the Top Institutes. While clashes sometimes occur due to similarities in their missions, the Top Institutes do offer a useful network and deliver good research. For these reasons it has been decided to continue the participation.

#### Technology policy

A healthy climate for innovation in the Netherlands is something to which TNO attaches great importance and rightly so, given that, together with increasing productivity, innovation was identified as an area in which the Netherlands should be investing its efforts, according to the 'Verkenning Economische Structuur' ('Exploration of Economic Structure') cabinet memorandum issued by the Dutch Ministry of Economic Affairs in 2001. A comparison with other EU countries shows that over recent years the Netherlands has been losing momentum in this area and, what is more, it appears that the demands being exerted by the knowledge economy on knowledge infrastructure continue to increase, especially with respect to the conversion of knowledge into innovation. In October 2001, TNO joined other organisations to draw attention to this issue. Together with VNO-NCW (*The Confederation of Netherlands Industry and Employers*), the *Netherlands Organization for Scientific Research (NWO)*, the *Association of Universities in the Netherlands (VSNU)* and the *Royal Netherlands Academy of Arts and Sciences (KNAW)*, TNO argued successfully for extra government investment in research by universities and knowledge institutions. These funds are earmarked for long-term research and are necessary to prevent the Netherlands falling further behind the United States and leading countries in the European Union. This is a situation that applies

particularly to research areas in which development is rapid, such as genomics, nanotechnology, ecology, neurosciences and ICT. The organisations' joint manifesto has been submitted to the three Dutch Ministers for Economic Affairs, Education, Culture & Science and Agriculture, Nature Management & Fisheries.

## Finance and operations

In 2001 turnover rose by 7.3 percent to EUR 514.5 million, in keeping with the objective set in the Strategic Plan 1999–2002. The result for 2001 was EUR 3.0 million, which means it has fallen a long way short of the objective stated in the strategic plan.

#### Turnover

The rise in overall turnover of TNO – the TNO Organisation and its group companies – was paralleled by a rise in the turnover of the public TNO Organisation (by 3.9 percent to EUR 466.7 million). The turnover of the group companies, which come under the subsidiary TNO Management BV, was up by around 52 percent. This strong growth is largely attributable to the turnover of the NMI and its subsidiaries, which is included for the whole of 2001 in the consolidated result (and from 1 July in 2000).

Market turnover rose from EUR 325.3 million in 2000 to EUR 354.1 million in 2001, a rise of 8.9 percent, bringing market turnover to almost 69 percent of total turnover.

#### Result

The result for 2001 was EUR 3.0 million, which puts it short of the objective and significantly down on 2000: by 59 percent, or EUR 4.3 million. The shortfall in the result is partly due to the institutes' reorganisations and relocations and partly due to productivity being too low; the consequence of too few contracts. TNO Management BV achieved a result of EUR 4.4 million, an increase of EUR 3.6 million on 2000.

#### Expectations

For TNO the year 2002 is a year of transition from the old to the new strategy period. It is expected that government funding will fall slightly and market turnover in 2002 will either remain steady or rise slightly. This forecast shows that TNO is not exempt from the decline in economic growth and the reticence of business to invest. With this in mind, management is paying extra attention in 2002 to raising productivity and will take advantage of opportunities to make cost savings.

## Personnel and organisation

TNO is developing into a professional and enterprising organisation working for both the market and government. In 2001 various initiatives were pursued to support this transformation. From its employees TNO expects professionalism, a high degree of commitment, a shared sense of responsibility and teamwork.

### Management development

Developing a market-oriented culture also places new demands on the line management. More is expected in terms of people management, operational management and entrepreneurship. To enable these adjustments, the Next Step action plan has been launched.

### TNO code

TNO's own Ethics and Research Platform formulated a TNO code in 2001. The cue for this was that ethical dilemmas are sometimes inherent in TNO's research, stemming at times from public acceptance of certain technological developments or TNO's independence in contract research. The TNO code was a topic of discussion during the formation of the new strategy. It articulates what stakeholders, such as clients and government bodies, may expect from TNO and its employees. The code embodies the fundamental values of integrity, independence, professionalism and social responsibility and as such reflects the standards and values TNO expects of itself and its partners.

### Quality management

For an organisation such as TNO quality management is a subject that is always on the agenda. The primary business processes of most institutes have ISO certification and in the year under review institutes made a start on updating the quality system in line with the new ISO standards. In 2002 TNO Work and Employment, TNO Inro, TNO Strategy, Technology and Policy and TNO Industrial Technology will gain ISO certification.

A customer satisfaction audit is used to periodically check the level of service offered to the client. This measures the client's satisfaction with how a project has been carried out both in terms of the substance of the project and the process followed.

### Staffing

At the close of 2001 TNO employed 5,430 people. This represents an increase of 4.8 percent on the previous year (5,180 employees) and corresponds to an average staffing of 5,074 full-time equivalents (fte) over 2001, a rise of 1.5 percent on 2000. The public organisation took on 575 new employees in the reporting year and 644 employees left

the organisation. Absence through illness in the year under review ran at 4 percent, in line with plans. The recruitment of new employees remains an issue of importance for TNO in view of the high regard we hold for young, talented, scientific high-flyers with management potential and employees with commercial skills. TNO's policy in recent years has enabled the organisation to maintain a position among the Top 20 employers considered most attractive to recent graduates from university and higher education colleges in a study by KPMG/Universum. In collaboration with the Dutch Royal Navy TNO carried out a special project in 2001 in which 20 talented engineers were able to spend eight weeks becoming acquainted with the theory and application of the latest technologies used by the Navy and TNO.

### Senior Research Fellows

In 2001 Professor Dr A.M. Havekes was appointed Senior Research Fellow by the TNO Board of Management. TNO bestows this title on employees who are exceptional exponents of innovative research. Louis Havekes' services to research into heart and vascular diseases while at TNO Prevention and Health have been tremendous. The focus of his work is the influence of genetic, environmental and behavioural factors on certain risks for heart and vascular diseases; not only in isolation but also working in unison. One result of this approach may be a treatment for obesity. His work is described on page 20 of this report.

The appointments of Dr G. de Leeuw of TNO Physics and Electronics Laboratory and Professor Dr J.S.H.M. Wismans of TNO Automotive have been extended for a period of five years. In total the Senior Research Fellows at TNO numbered seventeen as at 31 December 2001.

On 15 October H. Visser, BSc, of TNO TPD received the *David Richard Medal* from the Optical Society of America. He was awarded this prize for his innovative designs for optical instruments to be used in space travel. Over the past 15 years he has been especially successful in designing spectrometers for observing the Earth and the universe. Huib Visser has been a TNO Senior Research Fellow since 1994.

### TNO Service Recognition Awards

In 2001 three employees received TNO *Service Recognition Awards*: to M.R. van der Kraan, M.Eng., of TNO TPD for his work in encouraging an entrepreneurial approach at TNO, to R.J.G.M. Langeveld, M.Eng., of TNO Physics and Electronics Laboratory for his empathy with client problems and his entrepreneurship and finally to A. Zierikzee of TNO Prevention and Health for his years of effort in support of optimum facility management, his initiatives in the field of cost savings and efficiency and

his client-oriented approach. The TNO Service Recognition Award is granted not only for high quality work, but also for the particular merits of enterprising behaviour, market focus and fostering synergy.

### Knowledge development

Businesses, organisations and government bodies continue to turn their focus on the international arena and want to apply new knowledge ever more quickly. To help them achieve their ends, TNO invests in new knowledge. In 2001 a few new knowledge centres were opened and TNO participated in research programmes and four Top Institutes. With a view to participating, TNO is closely following developments surrounding the Sixth EU Framework Programme for research and innovation.

#### Knowledge centres

An excellent knowledge base is a prerequisite if TNO is to offer its clients the best support in applying new knowledge. Thus knowledge is not an end in itself, but a TNO resource enabling solutions, one that is developed in

close collaboration with almost all Dutch universities and the Top Institutes in technology. This work is financed in part by government base funding. TNO is collaborating with the universities in knowledge centres. There are currently 30 knowledge centres in which jointly funded research programmes are executed. In 2001 seven new centres were set up, and two were discontinued.

In July 2001 an agreement was reached with Delft University of Technology for a *Knowledge Centre for Reactive Gas Dynamics and Explosion Safety*. This centre focuses on safety issues in the processing industry. Knowledge of explosions is used to reduce the safety risk to businesses, their employees and the environment and to also optimise processes and costs. Moreover, the centre has at its disposal facilities to conduct experiments. Another development with the Delft University of Technology has been the *Knowledge Centre for Aperture Synthesis*. This centre contributes to the development of specific technologies for astronomy, including an achromatic phase shifter that will aid the discovery of planets in other solar systems. Technological spin-offs from these developments can have a commercial application, for example in the

Table 1 **Overview of knowledge centres as at 31 December 2001**

<p><b>University of Amsterdam</b></p> <ul style="list-style-type: none"> <li>– Intelligent Autonomous Systems</li> <li>– Multimedia and Information Technology</li> </ul> <p><b>Vrije University, Amsterdam</b></p> <ul style="list-style-type: none"> <li>– Physical Activity, Work and Health</li> <li>– Cardiovascular Research</li> <li>– Geoscientific Research</li> <li>– Multiple Sclerosis</li> </ul> <p><b>Delft University of Technology</b></p> <ul style="list-style-type: none"> <li>– Aperture Synthesis</li> <li>– Computational Fluid Dynamics</li> <li>– Sustainable Industrial Product Innovation</li> <li>– Lightweight Constructions</li> <li>– Maritime</li> <li>– Reactive Gas Dynamics and Explosion Safety</li> <li>– Technical Geosciences</li> <li>– Transport and Logistics</li> <li>– Power Electronics and Electromagnetic Conversion</li> </ul> <p><b>TU Eindhoven</b></p> <ul style="list-style-type: none"> <li>– Building and Systems</li> <li>– Materials Technology</li> </ul>	<p><b>University of Twente</b></p> <ul style="list-style-type: none"> <li>– Separation Technology</li> <li>– Noise and Vibrations</li> </ul> <p><b>University of Groningen</b></p> <ul style="list-style-type: none"> <li>– Carbohydrate Bioengineering</li> <li>– Transport and Logistics</li> </ul> <p><b>Leiden University</b></p> <ul style="list-style-type: none"> <li>– Child Health and Pediatrics</li> <li>– Phytotechnology</li> <li>– Chain analysis and Environment</li> </ul> <p><b>Erasmus University, Rotterdam</b></p> <ul style="list-style-type: none"> <li>– Transport and Logistics</li> </ul> <p><b>Wageningen UR</b></p> <ul style="list-style-type: none"> <li>– Emissions and Assessments</li> <li>– Soil Management and Remediation Technology</li> <li>– Micronutrients</li> <li>– Protein Technology</li> <li>– Food Toxicology</li> </ul>
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semi-conductor industry. The remaining venture with Delft University of Technology has been the launch of the *Knowledge Centre for Technical Geosciences*.

In 2001 the *Knowledge Centre for Intelligent Autonomous Systems* was opened with the University of Amsterdam. This centre is principally occupied with warning systems for security and monitoring. The *Body@Work research centre Physical Activity, Work and Health* has also been set up – a collaborative venture between the Vrije University (VU), TNO Prevention and Health and TNO Work and Employment. In December 2001 an agreement was signed for a *Maritime Knowledge Centre*. This will be undertaken with Delft University of Technology, the *Royal Maritime Institute (KIM)* and the *Maritime Research Institute Netherlands (MARIN)*, a joint investment in maritime knowledge better able to serve the maritime market. Finally, the *Centre for Chain analysis and Environment* was set up with Leiden University in February 2001. A broad range of research subjects from simple products to complex processes are analysed ‘from cradle to grave’ at this centre. The analysis embraces social, economic and environmental aspects. The centre’s aim is to use the research results in product and system development and to inform government and business policy.

#### TNO Co-financing programme

Target funding by the Ministry of Economic Affairs takes place via the TNO Co-financing programme, whose aim is to foster innovative work with the business world. Depending on the degree of innovation, the programme funds between 50 and 90 percent of the costs. Since the programme’s launch in 1997 some 800 projects have been carried out with businesses and consortia. In 2001 the Ministry of Economic Affairs contributed EUR 24.6 million to the programme.

In the year under review, the co-financing programme was evaluated by an independent committee from the business world. This involved a customer satisfaction audit in which 340 participants from SMEs, large companies and sector organisations were surveyed. The large majority of the clients questioned rated the programme as good/very good. Moreover, some 64 percent of the respondents cited the threshold-lowering effect of the programme as its strong point: most respondents believed that innovations would not have happened without the programme. We can conclude that the programme is having a positive effect on the innovative power of Dutch business. This evaluation has motivated the Ministry of Economic Affairs’ decision to increase the budget by EUR 900,000 as of 2002. From 2003 an additional amount of EUR 500,000 will be paid. This total increase of EUR 1.4 million will apply until 2006.

#### Research programmes

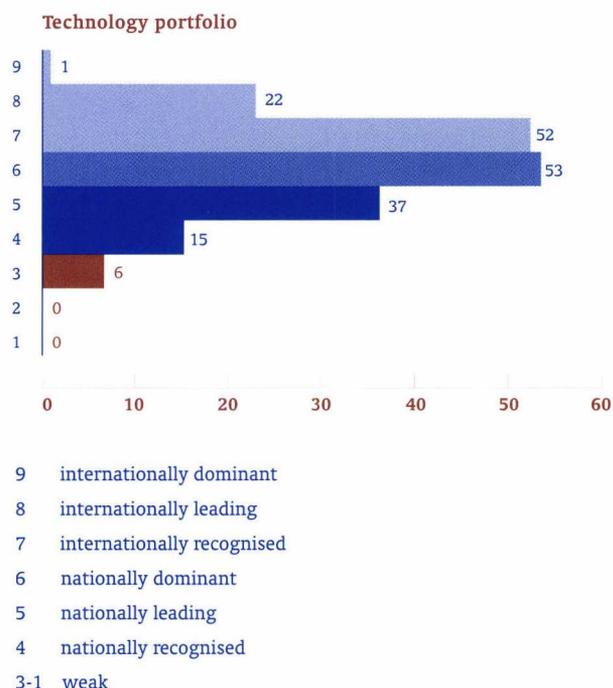
TNO participates in national and international research programmes. These include Dutch Senter and Novem programmes as well as the ICES-KIS programme, the Ecology, Economy and Technology programme (EET) and the Fifth EU Framework programme for research and development. TNO also participates in the research programmes of the four Top Institutes in technology as a way of increasing the impact of its knowledge investments. This is achieved by collaborating in consortia, by building networks with knowledge suppliers and users and by enabling national and international benchmarking of the knowledge position. These programmes also provide a way to raise funds for the further accumulation of knowledge. In 2001, with a view to future participation, TNO investigated the potential offered by the Sixth EU Framework Programme for research and innovation in Europe for the period 2002-2006.

#### Knowledge audits

TNO’s knowledge position is regularly assessed. This is important because it underpins TNO’s own evaluation of its role in the knowledge infrastructure. For this purpose periodic audits of the technology positions of the various institutes are performed. The audits are carried out by a committee whose international members are drawn from the science and business communities. In 2001 audits were held within TNO Nutrition and Food Research, TNO Inro and TNO Prins Maurits Laboratory.

#### Technology portfolio

The number of technologies in TNO’s portfolio in 2001 was 186. The average valuation of the technology portfolio rose from a score of 5.7 to 6.2.



## Knowledge application

Following favourable economic development in 2000, a reversal occurred in 2001. In spite of this, TNO's market turnover including group companies rose by 8.9 percent to EUR 354.1 million. The most significant market developments within each core area are mentioned below.

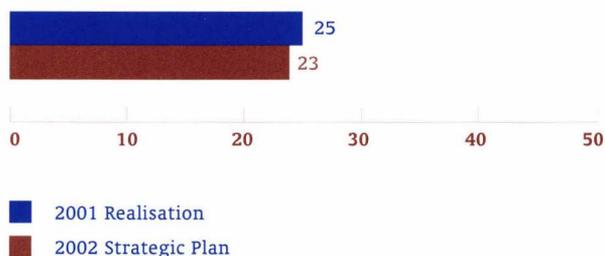
The rise in market turnover was due in part to our increasing ability to exploit market opportunities. Our stronger account management and better product-market combinations have been critical to this. They have involved new strategic partnerships in which we support our clients at the level of process and system innovation.

### SME

The TNO institutes provide extensive services to small and medium-sized enterprises (SMEs) through contract research, joint research, testing and approvals. The institutes of TNO Industrial Technology, TNO Building and Construction Research, TNO Nutrition and Food Research, TNO Environment, Energy and Process Innovation and TNO TPD, in particular, have broad client bases among Dutch SMEs. Many such businesses take advantage of financing options under the TNO Co-financing programme, the Senter's SKB regulation and the European Union's CRAFT programme. TNO also maintains contacts with a large number of SME interest groups and sector organisations like the 'Noord Nederland Technology' Centre with whom TNO collaborates in the north of the country.

### Product development and new production techniques

EUR x 1 m.

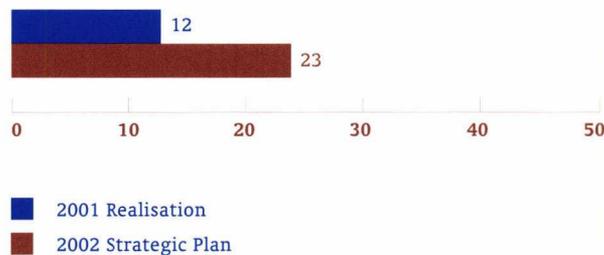


The growth in recent years of market turnover in this core area continued in 2001. Turnover rose by some 7 percent, with electronics technologies and sustainable product innovation in particular registering strong growth. A revision of this core area's technology portfolio in 2000 was followed by a reappraisal of the most important markets. TNO took the opportunity to choose high-quality sectors, in which the application of several competencies is required. This has been reflected in TNO's work for ASML on the development of new wafersteppers. For

Ericsson, TNO has conducted research into techniques for the rapid construction of moulds for magnesium parts. Other high-quality sectors relevant to this core area are medical equipment, transport systems, microsystems, plastic electronics, portables and wearables, rapid manufacturing and sports technology.

### New materials

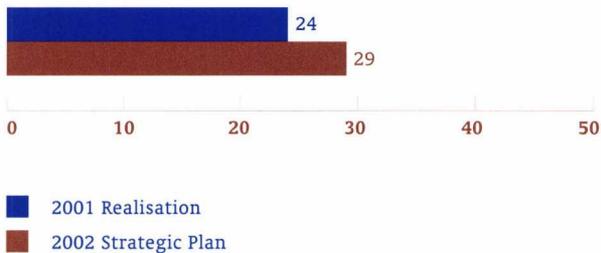
EUR x 1 m.



Following a stagnant period of some years, market turnover grew in 2001 by roughly 5 percent. This growth was achieved primarily in the domestic market. The focus of this core area is being sharpened and intrinsic renewal is a central aspect in line with the principle that the competencies of the market represent the chief driver of the area's activities, such as the field of process and system technology. This approach will enable us to offer clients more comprehensive and higher value product-market combinations. A key to this is the good collaboration currently enjoyed with TU Eindhoven in the *Material Technology Knowledge Centre* and with the *Dutch Polymer Institute (DPI)*. A few large projects have also been important: materials based on sustainable natural resources, plasma technology for surface modification, materials for noise reduction and sensors based on plastic electronics. The latter has included working with Philips on the development of semi-conducting polymers and with Aerospace and Vehicle Systems BV on the American Joint Strike Fighter programme, in which a part of the landing gear has been manufactured from a new composite material consisting of titanium and ceramic fibres. In collaboration with a number of industrial partners alternatives have been developed for the fouling-resistant coatings for ships that are currently less than environmentally friendly. Three types have been developed; one has already been granted a worldwide patent while applications to patent the other two have been submitted.

### Sustainable processes, use of energy and materials

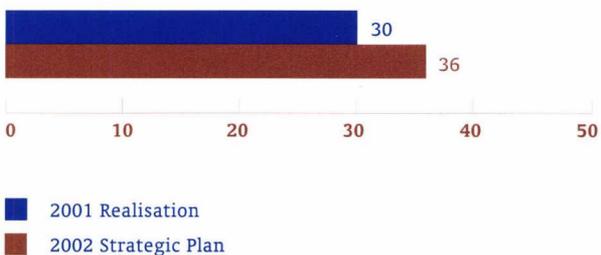
EUR x 1 m.



In this core area growth in turnover was a few percent, and was largely attributable to environmentally conscious technologies. During 2001 TNO's role as a process innovator gained substance with the development of integrated solutions and processes. This work spanned process control, safety and water use in the agro-food and food industries as well as in fine chemicals. One such development was a cooling installation using CO<sub>2</sub> as the cooling agent. Together with GTI and a number of component suppliers, work is underway on the commercialisation of this energy-efficient and environmentally friendly installation. Another example is the development of a system for recovering ammonia using membrane absorption which earned the TNO and Cirmac International BV collaboration the prestigious Kirkpatrick Honor Award.

### Defence

EUR x 1 m.

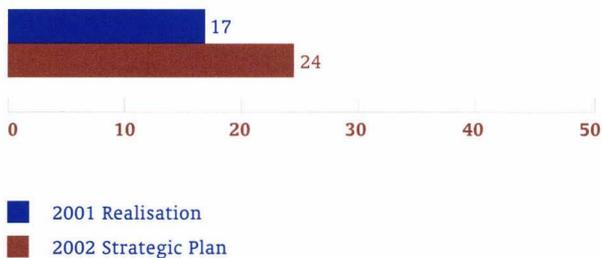


Supporting Defence with knowledge and technology increasingly requires a multidisciplinary approach. An area instrumental to this is the relatively new field of Modelling and Simulation (M&S). It is easy to imagine how simulators and highly realistic scenarios can be used to carry out and analyse virtual combat, involving not only individuals but also teams using various platforms and weaponry. In recent years, thanks to increased computer power, the possibilities for linking simulators in a net, generating realistic images and simulating mobility in varied terrain and weather and against diverse opponents

has increased greatly. This has created a situation in which a whole range of expertise is involved in creating the total package. Greater reliability is rapidly broadening the areas in which applications are possible: analysing operations, forming doctrines, evaluating resources and designing and selecting material are all candidates. It is the extent of this potential that underlies an initiative to stimulate and coordinate these activities. Important developments, such as building an image of the environment and executing commands, depend on good M&S capability. With the fight against terrorism a prevalent issue, protection against biological and chemical agents warranted plenty of attention. In this core area market turnover fell slightly.

### Information and communication technology

EUR x 1 m.

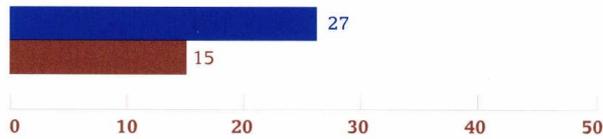


In 2001 there were signs of a positive development in market turnover. This was achieved in spite of considerable problems with staffing caused by the overstretched labour market, particularly in the first half of the year. The growth in market turnover was achieved in the Dutch business world: information processing, multimedia, knowledge systems, training and education; in government: security and telecommunications; and abroad: smart cards. Base funding assisted work on major projects in the area of tele-learning, information security, multimedia, future media in the home and intelligent autonomous systems for surveillance. In time these initiatives are expected to have a positive impact on market turnover. The TNO site in Twente that focuses on e-business got off to a good start in 2001.

In the year under review a contribution was also made to the implementation of the cabinet memorandum *The Digital Delta* through TNO's participation in the *ICT and Knowledge* taskforce set up by the Ministry of Economic Affairs. The taskforce is making recommendations for the accumulation of strategic knowledge pertaining to ICT. Furthermore, TNO also participated in the study for the Dutch Ministry of Transport, Public Works and Water Management on the vulnerability of the internet.

### Electronic and physical systems

EUR x 1 m.



■ 2001 Realisation  
■ 2002 Strategic Plan

In this core area 2001 saw a growth in market turnover of 16 percent. This has been achieved principally within the Instrumentation and Optical Instrumentation divisions of TNO TPD in the fields of Earth observation and space travel, process optimisation and control, electronics and embedded systems. A great deal of time was also invested in new nanotechnology initiatives. These successes mean that the objectives for market turnover for 2002 were already far exceeded in 2001. For the future, a couple of major projects due to be carried out using resources from base funding will be important for growth in market turnover. These are on high-resolution X-ray detection, measurement techniques for aerosols in the atmosphere and subsurface classification using sonar techniques.

### Nutrition and food

EUR x 1 m.



■ 2001 Realisation  
■ 2002 Strategic Plan

Growth of market turnover in this core area continued in 2001 with a 3 percent increase. Foreign markets accounted almost entirely for this growth. The British TNO Bibra developed well in 2001 across a number of fields, prompting greater attention to be paid to the organisation's collaboration and position with regard to TNO Nutrition and Food Research. The marketing focus was concentrated yet further on the sectors of agro-food and food, chemicals and pharmacology. The forming of thematic networks under the Sixth EU Framework Programme was also a focal aspect in 2001. The SAFE project on food safety is one example of this. In the field of genomics a couple of major studies were prepared for the forthcoming national programme. Themes of growing importance for the coming years are biomarkers and green chemicals based on genetically modified carbohydrates.

### Prevention and health

EUR x 1 m.

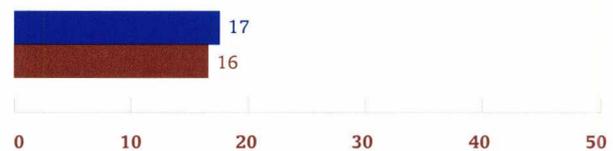


■ 2001 Realisation  
■ 2002 Strategic Plan

This core area achieved an increase in market turnover of 15 percent, attributable primarily to work undertaken for the Dutch business world. Foreign work and government contracts also played their part while research into the causes of heart and vascular diseases achieved considerable growth. In its marketing and knowledge development, TNO is looking to achieve a firm foothold in the university knowledge infrastructure. Furthermore, a study of the technology portfolio was carried out, which resulted in the consolidation of a couple of technologies and the grouping together of medical technology activities.

### Labour and labour environment

EUR x 1 m.



■ 2001 Realisation  
■ 2002 Strategic Plan

In this core area the growth in market turnover at the level seen in 2000 did not continue. A number of technologies were grouped together, sharpening the portfolio. The majority of market turnover was achieved through contracts for the government, social security institutions and other non-profit organisations. The Ministry of Social Services and Employment continues to be an important client with assignments on reintegration, knowledge infrastructure, occupational health and safety contracts and hazardous substances. In psychiatric healthcare a project was carried out for the Dutch health insurer GGZ Nederland, and the 'Work' programme was implemented in a number of institutions. This programme's aim is to improve collaboration between regional social workers, company doctors and general practitioners. An assignment with an international focus was a comparative study into the effects of the increasing flexibility of labour on working conditions in the European

Union. This is being carried out for the European Foundation for the Improvement of Living and Working Conditions.

**Transport and logistics**

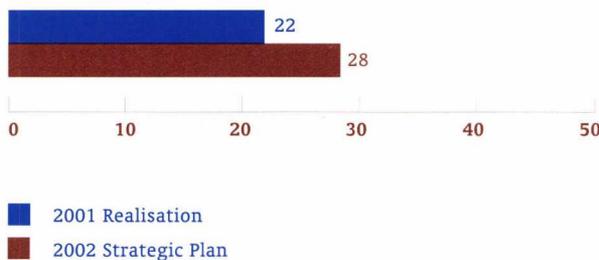
EUR x 1 m.



Following its stabilisation in 2000, market turnover in this core area grew once again in the year under review, by no less than 7 percent. Foreign turnover was primarily responsible and was achieved with crash safety activities. The way forward for TNO Automotive and TNO Inro has now been established, which has led to a sharper focus of the technology portfolio. Collaboration with partners forms an important part of the new strategy and one result of this has been the collaboration with Karmann. The TNO-wide consultation taking place within the TNO Traffic and Transport business centre has been given added impetus. On the international front, activity on the MADYMO software programme has been stepped up, with the package becoming reinforced with offices in Germany and France. In collaboration with DSM, Reynolds Aluminium and PD&E Automotive Solutions, TNO developed *Ecofront*, a front panel for cars that is safer from a pedestrian perspective. This design gained the *Automotive Engineering Tech Award*. Together with Engelhard Corporation and two European truck manufacturers, TNO demonstrated a selective catalytic system for the reduction of nitrogen oxide.

**Building and infrastructure**

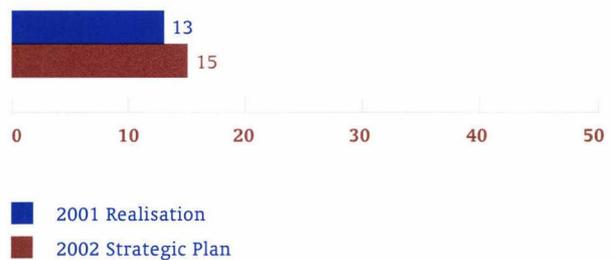
EUR x 1 m.



Market turnover in this core area fell by roughly 10 percent compared to 2000. While the technology portfolio was re-evaluated and slimmed down, a shift towards fire safety research occurred in the wake of a major fire disaster in the Dutch city of Volendam. This revealed that fire regulations are often difficult to understand and implement and that responsibilities are not apportioned well. In response to this, TNO Certification BV has introduced a fire safety certificate for buildings. As part of the *Next Generation Internet* (NGI), TNO took part in the EU *eConstruct* project, the aim of which is to make the next generation of internet technology accessible to Dutch SMEs in the construction world. This is being achieved through an international consortium of construction companies and a couple of knowledge organisations and system houses.

**Subsurface and subsurface natural resources**

EUR x 1 m.

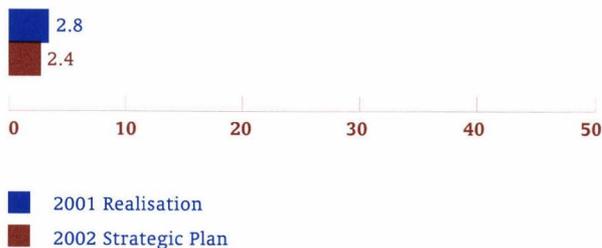


A rise in turnover of 10 percent would seem to indicate that the formation of TNO-NITG, the result of the merger with the National Geological Survey (RGD) completed in 2000, has borne fruit. This core area has both information and research functions. In 2001 its knowledge centres with the Vrije University in Amsterdam and Delft University of Technology developed well. At the end of 2001, it was decided that all information and research activities will be concentrated in the new TNO-NITG head office in Utrecht. This should enable more efficient operational management.

The DINO central database of the Dutch subsurface, managed by TNO-NITG, went online in 2001. This marks the first step towards three-dimensional public internet access to the data about the Dutch subsurface and its natural resources; with due regard for confidential data.

### Innovation management

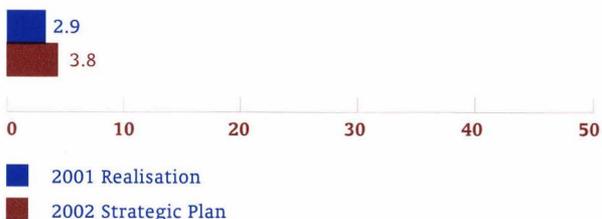
EUR x 1 m.



In this core area market turnover rose by 15 percent, reward for the reorganisations implemented in recent years. The growth in turnover is attributable mainly to government contracts. In 2001 the chief concern was to position TNO Strategy, Technology and Policy as an institute for improving strategic choice processes in the context of technological developments and society. Accents were laid on long-term developments and analysis at meso and macro levels. This involved making the necessary link between the sciences and social sciences for the desired change and innovation and the successful application of new technology.

### Public Safety

EUR x 1 m.



The growth of market turnover in this core area is going according to plan. TNO is involved in various projects and programmes in the field of public safety and can offer multidisciplinary solutions to complex problems. Activities are undertaken in areas such as crisis management, security of materials and personnel, risk analysis for calamities, tunnel safety, crowd control, information provision during disasters, tracking and tracing techniques and camera monitoring. In 2001 the core area's strategy was re-established. The products and services now available have been brought to the attention of the police and judiciary. TNO is also working on improving its profile with the emergency services, fire brigades and the Royal Military Police as well as collaborating with businesses on a variety of subjects.

With a view to the kind of knowledge that will be developed in this core area, a joint research programme is being set up with the *Netherlands Forensic Institute (NFI)*, the *Netherlands Institute for Fire Services and Disaster Management (NIBRA)*, the *Netherlands Police Institute (NPI)* and the *Police Education and Knowledge Centre*. Collaboration with the universities is also taking place.

### The commercialisation of knowledge

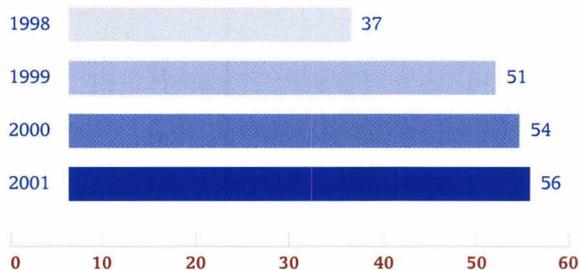
The knowledge developed by TNO is not only passed on to businesses and governments, but is also put to work for TNO. TNO does this in a number of ways, which include issuing licences for patents it holds, participating in companies that launch new technology on the market and certifying products and processes. These activities take place under standard market terms and conditions. The private companies are legally and administratively separate from the public TNO Organisation.

#### Patent portfolio

TNO attaches great value to protecting the inventions developed in the course of its knowledge activities. Important inventions can be exploited commercially and provide TNO with extra income. This requires legal protection. Employees are expected to signal inventions in an early stage so that their commercial value, uniqueness and potential for subsequent development can be assessed. This is only possible when inventions are not yet made public.

TNO has built up a portfolio of around 450 inventions for which it either holds the patent or has an application pending. In 2001 TNO added 56 new patent applications. Patent rights on inventions remain the property of TNO and, depending on the terms of the contract or collaboration, an invention can be used for one or more years exclusively by the client. This arrangement is based on TNO receiving a competitive level of remuneration for the added value that the patented results deliver. Other companies subsequently wishing to make use of the same technology can do so under licence to TNO. Revenue from patents and licences totalled EUR 3.6 million in 2001.

#### Number of registered patents per annum (patent applications)



### Activities

TNO also fosters new forms of activity by transferring the knowledge it has developed to new companies set up especially to take advantage of this type of spin-off. These companies are private businesses under the holding company TNO Management BV and are engaged in activities such as the development and manufacture of products, certification and consultancy. In 2001 these activities were extended with others, including interim management.

In 2001 TNO Certification BV introduced a fire safety certificate for buildings. The certification involves a check of both construction and non-construction aspects as well as the building's management and use. With the TNO certificate 'Fire-safe building' the owner can show visitors that the building's fire safety has been taken care of and can show government that the building complies with legal requirements. Certificates used to exist only for individual construction products and processes. This new certificate meets a need. In awarding certification, TNO Certification BV draws on the expertise of the Centre for Fire Safety at TNO Building and Construction Research. Experts there have years of experience in assessing buildings and construction applications, especially complex cases, for fire safety.

It is intended that the activities of TNO Automotive will, for the large part, be divested to private companies. It has been decided to create a TNO Automotive Holding BV to preserve and develop our profile in the market and enable us to enter into partnerships with domestic and foreign parties. Spurred by activities taking place in Germany and France, TNO Automotive Germany GmbH and TNO Automotive France SAS were set up in 2001. TNO companies already exist in the United States, Great Britain and Japan.

Under the name TNO Itsef BV a new subsidiary company was launched whose business is the assessment and evaluation of the security of information technology. Where appropriate, reference is made to existing standards. The company also provides services related to these assessments and evaluations. These activities were previously carried out by TNO Physics and Electronics Laboratory.

### Participations

TNO Management BV participates in businesses that launch new technologies and, in collaboration with the institutes, develops national and international activities in the field of research, development and services. TNO sees this as an important way of getting new knowledge to market in an appropriate form.

## Senior Research Fellow



*'It would be so good to be able to estimate the personal risks involved for heart and vascular diseases'*

**Professor Louis Havekes**, of TNO Prevention and Health, was appointed TNO Senior Research Fellow in 2001. He received this distinction for his internationally renowned research in the field of heart and vascular diseases. The aim of his work is to gain greater insight into the influence of genetic and environmental behavioural risk factors – not just individually but also in terms of the interplay between them. One of the outcomes of this research could be a treatment for obesity. In 1996 Havekes was appointed Professor of pathophysiology of the lipoprotein metabolism – defects that can occur in the body's handling of cholesterol and fatty matter.

Heart and vascular diseases are often the consequence of atherosclerosis: constriction in the blood vessels. When heart and vascular diseases occur, many different genes are involved. Risk factors are involved too, including high blood pressure, smoking, physical inactivity, obesity and diabetes. One of the main risk factors is a high level of cholesterol in the blood. Cholesterol is a fatty substance stored in lipoproteins – small globules with the fat on the inside and protein on the outside. The liver extracts the cholesterol from the blood with tools much like grabbers (receptors) and transforms it into cholic acids that are then expelled as bile.

Roughly speaking, three kinds of cholesterol exist: VLDL, LDL and HDL. The first two may be deposited on the walls of blood vessels, prompting the atherosclerosis process. HDL, by contrast, is able to pull the cholesterol off the vascular wall and transport it back to the liver. The receptors that humans have do not really work as well as they should, leaving humans with naturally high levels of VLDL and LDL in the blood. Havekes discovered that the protein apoE is essential for the removal of VLDL from the blood. Havekes has managed to isolate the apoE. 'Research into apoE very much determined my future career. In fact, after 23 years, apoE is still very much a central feature of my research. In recent years apoE has been revealed as a player in the emergence of Alzheimer's disease and blood poisoning. So there is still plenty of work to be done with apoE.'

Havekes has long worked closely with the Human Genetics department of the Leiden University Medical Centre (LUMC). 'I suspected that there was an important hereditary aspect to apoE. We went in search of patients with deviant proteins: the mutations. The first that we chanced upon was a patient with a deviant apoE, which we called apoE3Leiden. We were then able to show the actual cause of the change at DNA level. In this way, we found the apoE3Leiden gene. People with this gene have a raised cholesterol level because the liver is not able to absorb the "bad" VLDL well.'

In addition to various genes, all kinds of other circumstantial factors are involved in the development of heart and vascular diseases, each influencing the other. It is difficult to study the individual risk factors in humans because each case is different in terms of heredity and lifestyle. So Havekes and his colleagues decided some ten years ago to shift from human to mouse research. They would use genetically identical mouse species created by inbreeding. By giving a mouse the apoE3Leiden gene

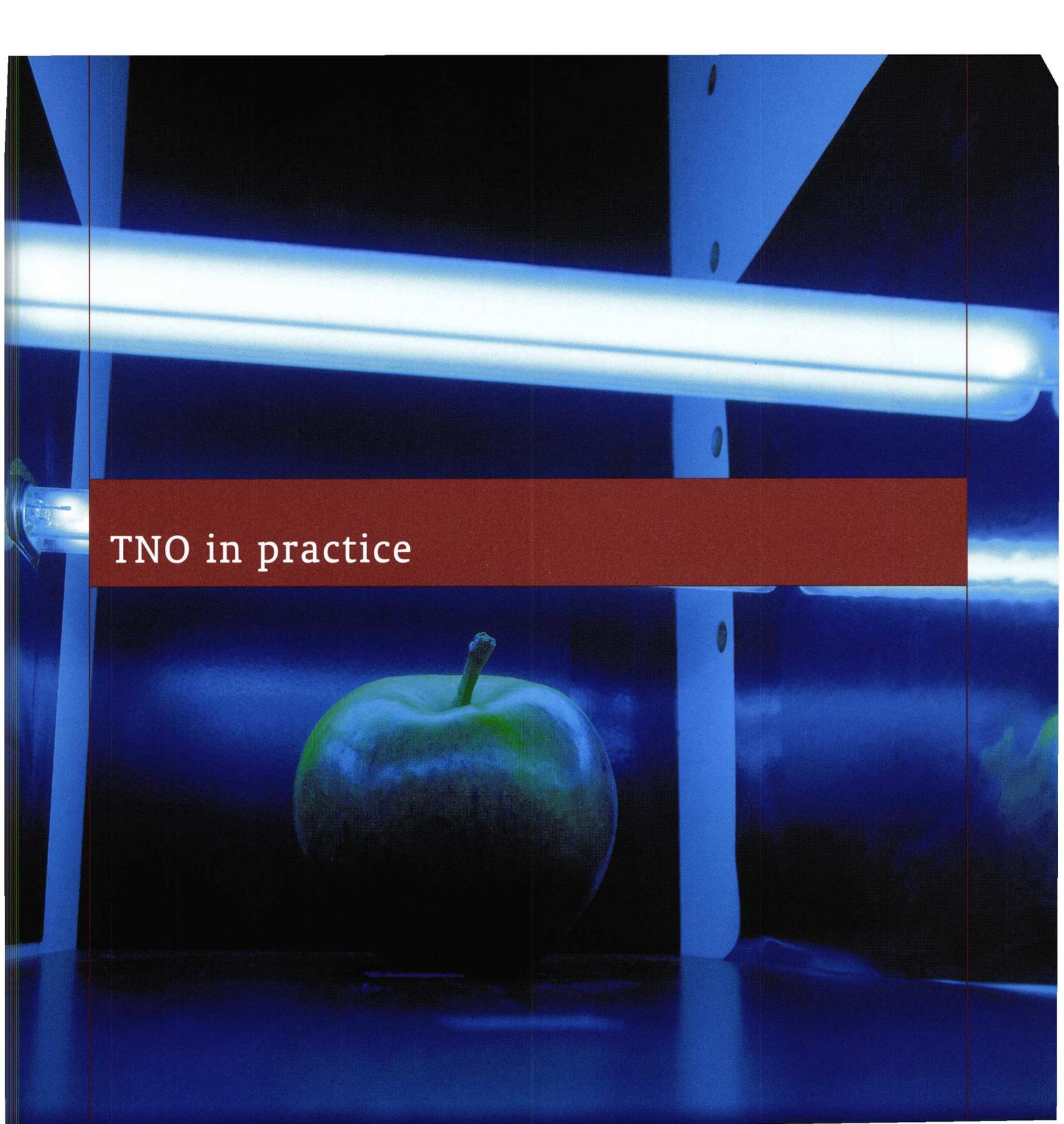
transgenetically, the team created a mouse with enough 'bad' cholesterol.

Louis Havekes' group has now created some sixty transgenic mouse species and now investigation has turned to other apo proteins, like apoC1, which is involved in the emission of fatty acids from the adipose tissue into the muscle. Havekes: 'We have shown a link between this apoC1 protein and obesity and diabetes. A lot of apoC1 in the mouse can significantly restrict the incidence of obesity. We are now trying to understand why and how apoC1 does this. Again the principle applies that if you know the underlying mechanism, then you may be able to find a treatment for excess weight, which is a big problem in our western society.'

Havekes strives for two objectives in his research. Firstly, an overview of the various risk factors for the development of heart and vascular diseases, in terms of both genetics and the environment. The second objective is to acquire greater insight into the interplay between the risk factors. 'This will provide a clearer view of the underlying biochemical mechanisms. This is a prerequisite in the search for effective treatment strategies to modify the deviation process in a beneficial way. It would be great if you could estimate on a person-by-person basis the risks of developing heart and vascular diseases. This would make it quicker to convince someone of the need to alter his or her lifestyle and age more healthily.'

The collaboration with the LUMC has further expanded in recent years, with the clinic and pre-clinic now more closely involved. In addition, the collaboration is an important factor in the setting up of a joint TNO-LUMC knowledge centre for heart and vascular diseases. Havekes' group has since grown to twenty-four researchers, twelve of whom are research assistants and six post-doctorates. A substantial part of the research capacity is taken up with contract research. 'This is principally work involving the apoE3Leiden mouse,' says Havekes. 'Our appeal to these industries is based on our mouse models and our reputation in the literature. It is therefore important to continue doing research so that our scientific level remains high. Industry likes to work with scientists and research institutes from outside their own field. They listen to us and we share their thinking process. That shows that we are a serious partner for the industry.'



A photograph of a green apple inside a refrigerator. The scene is lit with a strong blue light from a horizontal tube light at the top. The apple is centered in the lower half of the frame, resting on a dark surface. The background shows the interior of the refrigerator with some shelves and a window on the right. A dark red horizontal bar is overlaid on the image, containing the text "TNO in practice".

TNO in practice



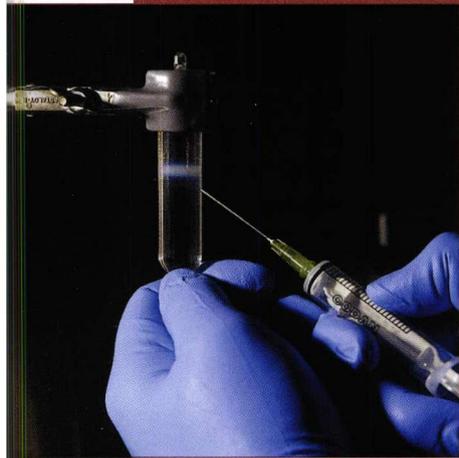
## Koersk submarine: Sawing for the salvage operation of the century

An exploding torpedo probably caused the fatal damage to the Koersk submarine. The advanced Russian vessel was crippled with all hands on board. A Dutch consortium of Mammoet and Smit International appeared to have the expertise to salvage the ship. An essential part of the operation was to saw off the nose of the submarine, the location of the remaining torpedoes. It would not be safe to work in the vicinity of the nose, nor to raise it to the surface.

For Smit International, TNO had already investigated the best technique for cutting up sunken ships. Sawing appeared to be the best option and the Koersk brought a new dimension to that research. This was not the shell of a ship but a 2 cm outer shell, 8 cm of rubber and a 'pressure skin' of 5 cm of rock-hard steel. Field tests in the Netherlands and Russia showed the Russians that the principle worked. To prevent jamming, TNO opted for a circular saw. The researchers calculated the required sawing capacity, the wear to the saw and likely problems. Hardmetal specialist Widia supplied the giant saw and Smit International gathered parts for the power system from all over the world. After trial efforts with the saw, it was time to go to work. The first sawing operation lasted four hours, the second ten hours and the third sixteen hours. At last the nose was free. The most important obstacle to the salvage had been solved; the Koersk could be raised.

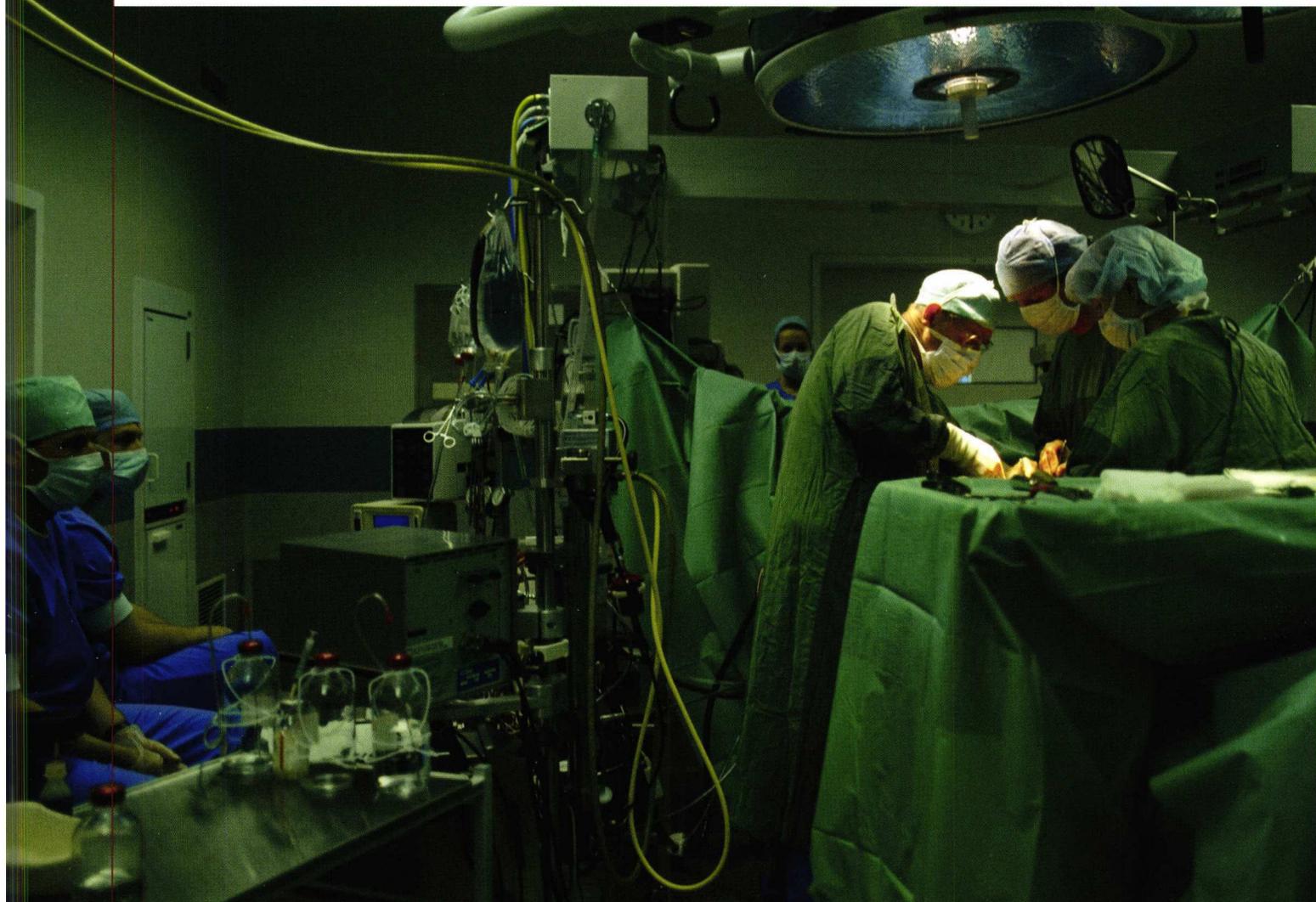


## Gene therapy for blocked arteries: **The blood flows freely**



Percutaneous angioplasty and bypass operations offer a future to many thousands of people in the Netherlands each year. These operations enable the flow of blood through arteries that were barely open. Yet in 30 to 50 percent of cases, surgery causes a reaction in which the arteries resume the process of closing up. There is no standard treatment, but in time gene therapy may offer a solution. TNO is working on the problem in its role as an 'established investigator' for the Dutch Heart Foundation, in a partnership that includes the Crucell biopharmaceutical company.

Cell migration and cell division are what cause the wall of the artery to thicken after percutaneous angioplasty. TNO believes that gene therapy may be able to change the cells of the artery wall in such a way as to stop the narrowing process. The technique involves placing pieces of DNA in the cells of the artery wall. This DNA 'codes' for the ATEBPTI protein, a gene patented by TNO that has therapeutic possibilities. This ensures that the cells can no longer migrate, thus making the first step to the arteries narrowing impossible. This principle has now been proven to work. Still, there is a long way to go before the technology reaches the patient. For example, a solution must be found for the gene's method of transport. The DNA is packed in modified common cold viruses, to which many people are resistant. Crucell and TNO are busy looking for ways to improve the viruses. That will bring the application one step closer.



Norwegian industry:

## Getting a grip on the oil reserves

How much oil is there in an oilfield and what is its future production profile? The question is simple, but answering it is not. Conceptually complex methodologies from various disciplines are required to make a sound estimate at an early stage. 'Uncertainty', working with decisions based on insufficient information, that is the core of the problem faced by oil companies. And each company approaches the problem differently. So how does a country like Norway, dependent on oil, gain a solid basis of aggregated figures on which to base its policy when its information comes from 14 oil companies all using their own approaches? The Norwegians want to know the level of income the country can expect from royalties and taxes. What is the employment situation offshore and what is the risk of the economy overheating? And does the Norwegian taxpayer consider the oil companies to be investing wisely?

A photograph of an offshore oil platform at night, illuminated by lights against a dark sky.

The Norwegians have been highly enthusiastic about the thoroughness and transparency that TNO brings to the decision-making process surrounding investments for oil and gas exploitation. This is why TNO is going to help improve the system of technologies that impacts on 'uncertainty'. This involves formulating best practices and organising workshops. Another element is a teaching programme in which e-learning and group courses complement each other. The most significant issue is the way in which various disciplines collaborate. The thing is to root out all uncertainties and then actively monitor them. TNO has software packages at its disposal to steer that process, culminating in a situation in which the uncertainties are effectively managed in space and time.



Military-civilian cross-fertilisation:

## Aerial photographs pierce heavy cloud cover

It's not just love that blinds, so does cloud cover. A cloudy sky hides oil being dumped, illegal timber being felled or illicit land use and arsenals from the photographic eye of the inspection services. A SAR radar creates pinpoint sharp images of the Earth's surface from a plane, regardless of the weather and light conditions. The experimental SAR system Pharus fits the bill for this kind of advanced radar. Indeed, the Ministry of Defence has been making regular use of Pharus images for test and demonstration purposes. For civilian purposes, Pharus is too expensive to buy and use. The weight and size of the radar system, for example, make for high flight costs. The civilian market requires a smaller, sharper, lighter and cheaper version. This is also crucial for the Ministry of Defence when SAR is flown in unmanned planes.

That is why TNO is now developing the MiniSar for both military and civilian applications – and thus enabling both markets to benefit from shared development costs. Standard components are another factor keeping the purchase price down. MiniSar will be so compact that it can hang from a motorised glider. The operational costs of the radar image must be competitive compared to those of an ordinary aerial photograph. TNO is building the first specimen before turning its knowledge over to the industry. There are potential markets all over the world for such applications, like cartography, dam security and the monitoring of roads and artworks. MiniSar even makes the deployment of planes in the construction of underground infrastructure a possibility: the system can map the deformations perfectly.





## Sustainable agriculture: **A broad spread of experience**



Sustainable agriculture is the future. It is therefore vital that knowledge and experience are spread and shared broadly if the supply of efficiently and sustainably produced crops is to be guaranteed for the longer term. But not all the questions that revolve around sustainable agriculture have been asked, let alone answered. So to find out what the issues are and how to deal with them, three large food companies, Unilever, Nestlé and Danone, have come together in a pre-competitive collaboration through the Sustainable Agriculture Initiative (SAI). They asked TNO, as an independent party, to help set up and organise this open platform. A key to this invitation was TNO's technology position in the areas of sustainability, nutrition and food.

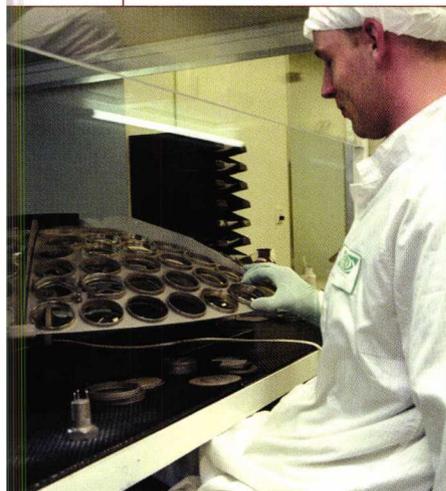
TNO developed a business plan and drafted a position paper that illustrated clearly the importance of sustainable agriculture, and the issues that are pertinent to it. TNO is also taking stock of those organisations throughout the world that are occupied with sustainable agriculture and those research results and practical experiences that are available. It is an inventory that is central to the common assessment and implementation of Good Agricultural Practices. The SAI regards this, in addition to communication, as one of the main tasks in promoting sustainable agriculture. First and foremost, it is a platform of and for the food industry and is open for other food companies to join. But other interested parties, like farmers, conservation and environmental organisations as well as governments, are warmly invited to contribute their opinions and enter into the dialogue. Initial signs point to significant interest in the SAI, which is expected to be launched this summer.

Pearle:

## Crystal-clear look at Pearle's operational process control

Rejected! That word was reaching the ears of the management at Pearle's spectacle lens factory more often than they liked. Production line wastage in polishing, colouring, hardening and adding reflective coatings to the synthetic lenses was too high and it became TNO's job to tackle it. Researchers were faced with an ideal opportunity to prove the value of their statistical process control methodology, designed with a view to optimising the operational process control. In other words, to gain more information from fewer measurements.

TNO's first step was to classify scratches and other faults. The researchers listed size, length, transparency and other characteristics to reach an unambiguous definition of faults. The customer's requirements were taken as the starting point for the quality requirements for the end product; the operator's opinions carried no weight. A production line analysis revealed the origins of the various faults and, in cases, the points at which they later disappeared, for example during hardening. Product control was now taking place at the most effective times and places; a check of certain unpolished lenses before they were treated reaped significant improvements. Pearle values TNO's approach highly; the fact that it does not revolve around a technique but starts with the process and searches for the most effective use of process and product measurements. This appreciation has found concrete expression in TNO's new status – as Pearle's strategic knowledge partner.





## Oudenrijn Road Traffic Control Centre: Keeping on top of traffic flow and safety



Video cameras and sensors in the motorway monitor the traffic flow. The information they gather arrives at the control centre, where operators use it to estimate the weight of traffic and safety on the road. They take action when necessary, setting a safe speed or highlighting arrows on the electronic information system above the road. They can also call in the police or emergency services if they have to. These operators optimise the flow and with it the most efficient use of the road network. As the system becomes more sophisticated, more cameras and monitoring are required, and the amount of data in the system increases. How can the operators continue to concentrate in the midst of this input? The flow of information must be efficiently streamlined if their job is to remain manageable.

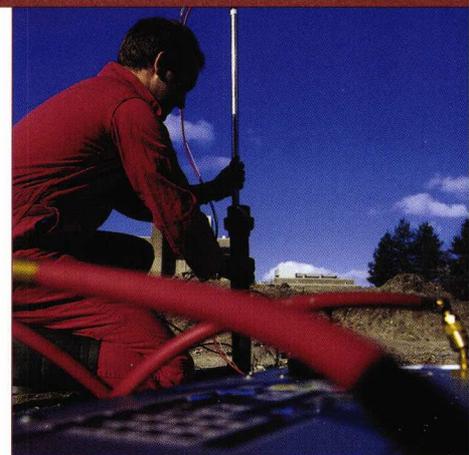
Traffic control centres are organised at present so that the sensor data is displayed on screens close to the operator and the video screens are further away. TNO has developed a workstation for the traffic control centre in the heart of the Netherlands in which all information appears on monitors close to the operator in the form of an overview. This makes it possible for the operator to grasp all aspects of a situation more quickly. Following on from this approach, TNO then introduced a method of team-oriented problem solving. All workstations are multifunctional and identical, so that all operations can be carried out from any workstation. Shared information is shown on a central overview screen. Thanks to communication and data exchange, operators can discuss the best solution for the traffic in their region. The design of the workstation is completely adjustable, and it sets new standards in terms of ergonomics, style and the use of materials. It is going to be of particular value to incident rooms, security headquarters and control centres.

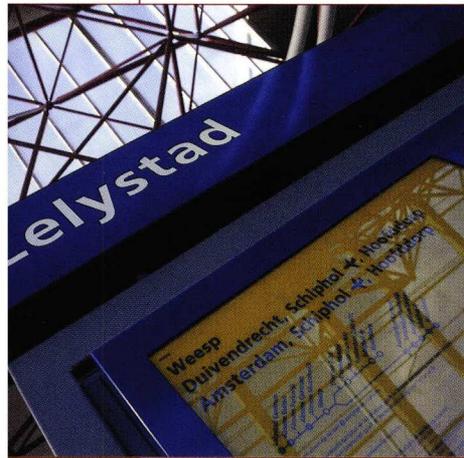


## Cost-effective decontamination: TNO active on Japanese soil

Environmental awareness in Japan is growing. It is providing the impetus for ever stricter environmental guidelines and one area these relate to is soil pollution. In the rapidly growing market for soil decontamination, clients have had just one, expensive option: have the site dug up and cleaned. Until now, Japanese companies in this field are exploring the world market for expertise in decontamination *in situ*. This form of soil decontamination uses microorganisms to degrade the pollution. It makes digging up the area unnecessary and can even take place under existing buildings. The method is cost effective and, moreover, suitable for biodegrading chlorinated hydrocarbons, which are widespread in Japan.

One of the largest construction and soil decontamination companies in Japan is the Shimizu Corporation. Impressed by TNO's strong international reputation in the field of *in situ* soil decontamination, the company has chosen to work in partnership with TNO. Contractual arrangements give Shimizu exclusive rights to TNO's knowledge related to the execution of such decontamination projects for a two-year period. TNO has negotiated a licence fee and a percentage of turnover. TNO will also provide paid consultancy and training courses. The transfer of this complex knowledge and the considerations involved in applying it are not a purely theoretical issue. It is principally a question of learning and weighing up factors in practice. A new and challenging aspect of the project for TNO is Japan's relatively fast groundwater flow.





Zuiderzee line:

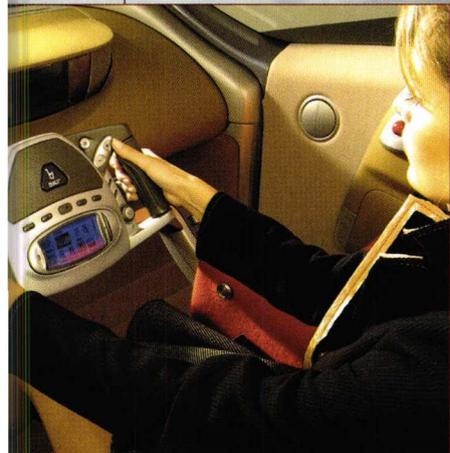
## The best way from A to B

An additional 43,000 jobs must be created in the north of the Netherlands by 2010. This makes improved access to the region essential and it will be achieved with the Zuiderzee railway line. Currently running between Amsterdam and Lelystad, the line will be extended to Groningen. TNO has investigated the impact such a line would have on the competitive position of the Netherlands. The distribution of activity and population across the region was also examined. TNO then created a spatial vision by weighing up all the factors involved. This included studying the consequences of various proposals

for cultural diversity, economic and social functionality, sustainability, attractiveness, and environmental and human indicators. This array of aspects was assessed on four levels ranging from local to international.

TNO concluded that the 'corporate' Netherlands stands to gain little on balance from the Zuiderzee line. The province of Flevoland would see the most benefit because the journey time from Amsterdam Airport Schiphol to Lelystad would be cut significantly. The city of Groningen too would be more accessible, yet would remain too far for commuter traffic. In practice, just how would the line improve a journey from Amsterdam to provincial towns? According to policy, as expressed in the Fifth Policy Document on Spatial Planning, a magnetic train or new HSL is not the best solution. That would be the 'Hanze Line Plus', a regular fast train that, except for the route between the cities of Lelystad and Zwolle, would run everywhere on modified existing rails. This version is relatively fast and affordable and would have the least impact on tranquillity and open space.





'Steer-by-wire':

## Steering safely with adjustable steering

The steering column? Ask a design engineer and it is the slanting, metre-long rod of steel in a car. It is a significant complication to one of the greatest challenges in car manufacturing: how to fit together all the systems in an aerodynamic and ergonomically sound chassis. An electrical solution would obviate the need for that potentially dangerous steel rod. This is 'steer-by-wire' and it consists of an electric motor for the steering wheel movement, an electric motor for the wheel movement and a controller connecting the two. This solution offers design freedom and the potential

to tailor the steering experience to the driver's preferences. The result is comfortable steering. It even becomes possible to correct the driver's steering, which enhances safety.

TNO is an expert at designing these control algorithms. Vehicle speed and orientation, tyre forces and skidding, steering angle and steering speed are just a few of the parameters that can be accommodated with such a controller. With various demonstration vehicles, TNO is proving that it knows how to use all these data to produce a smart, robust and safe control unit. Its intelligence lies in its adaptability. The algorithm is simple to adapt to represent power-assisted, unassisted and 'by-wire' steering. This makes it possible to assess the driver's experience in new concepts at an early stage. Ultimately, it is all a question of sensation and TNO senses that beautifully.

## Post-war residential tower block neighbourhoods: **Sustainable, consumer-oriented urban redevelopment**

No less than 160 million Europeans live in large-scale post-war tower blocks. From a construction point of view these homes are often in good order, but they fall far short of meeting modern housing requirements. Neighbourhoods with these homes score badly on energy consumption, sustainability, social safety and diversity. What is needed is a gigantic trans-European redevelopment operation. Since March 2000, organisations from seven countries have been collaborating in the EU 'SUREURO' project. Housing corporations from France, Sweden, Finland, Denmark, Great Britain, the Netherlands and Germany, research institutes, consultants and an international construction company are sharing their knowledge and experience. From the Netherlands, the participants are the 'Wonen Centraal' housing corporation and TNO. The development of the appropriate management tools and models is creating a workable and inspirational approach to renovation.

TNO is responsible for SUREURO's scientific coordination and is developing the knowledge system that gathers relevant information for distribution among the participants and future users. Three hundred project members from all seven countries are working on this system within a web-based virtual organisation. The system forms the knowledge base enabling the housing corporations and their advisers to get down to work on the neighbourhoods. Priority is being given to the active involvement of residents and their having a say about their own homes. Another principle has been the desire to create a friendlier living environment with more social control and varied building styles. Partial demolition creates room for new buildings that break the monotony and attract new types of residents.



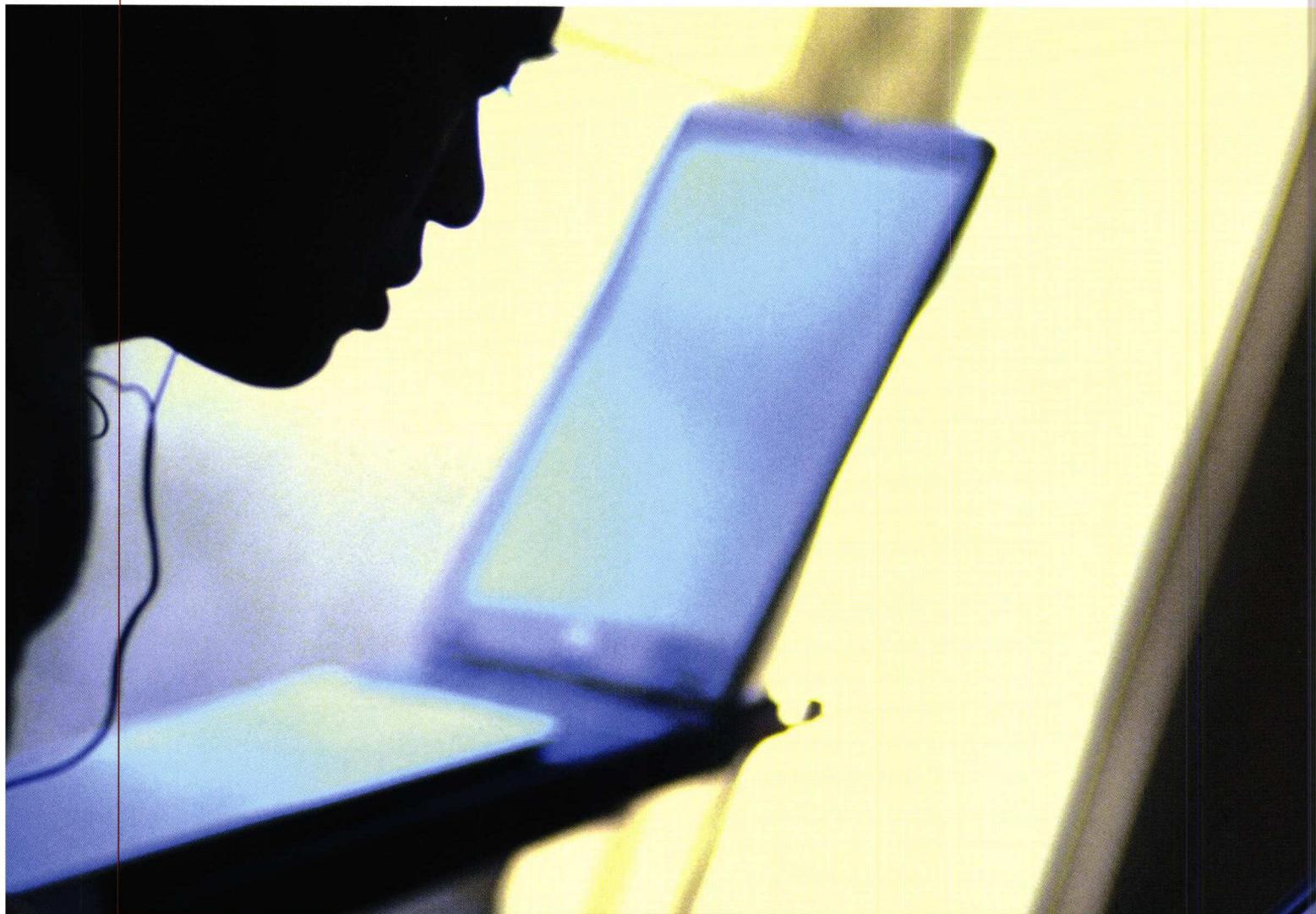


## New approach to safety: **Consensus on tunnel design**

Safety is a key feature of any major tunnel project in the Netherlands. Probability risk analysis, however, has been shown to be inadequate as an instrument for evaluating tunnel designs. This traditional methodology estimates the chance of a person dying while travelling through the tunnel and the risk of several people dying at the same time. Yet such information is of no use at all to the emergency services. They want to know what to do if an accident occurs tomorrow. Will people be able to save themselves? Will they need five minutes or half an hour? Or will they have to rely on external assistance? For each of the designs to cover the A2 motorway at Leidsche Rijn near Utrecht, TNO constructed a scenario analysis that addressed these questions in a structured way at an early developmental stage.

Researchers simulated the development of potential accidents through time for each of the four tunnel designs. The scenarios took account of detecting the calamity, raising the alarm, escape routes and using rescue services. As well as everyday traffic accidents, fire calamities with toxic and flammable gases and liquids were examined. This approach makes it possible not only to choose the best design, but within that design to optimise the use of rescue workers and choose the best position for escape doors and smoke ventilation. The inevitable residual risks also become clear. All parties involved now know exactly what needs doing and a design has now been chosen that meets with everybody's approval.

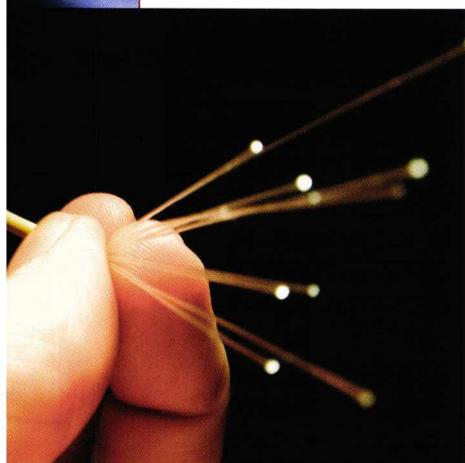




GigaABP:

## Applications for the next generation of internet

Across the country, digging is underway to lay the broadband glass-fibre networks for the next generation of internet. TNO is hard at work on applications suited to these networks. While secure payment solutions are close at hand, facilitating transactions and measurable service levels for electronic services are still proving problematic. Making small payments for information services is still too expensive for the service provider and too long-winded for the customer. As for the use of computer programmes accessed via internet, the customer is willing to pay the Application Service Provider (ASP) but wants reassurance that the price is reasonable given the agreed quality of the service.



The Giga-Accounting-Billing-and-Payment (GigaABP) project is seeking solutions to these obstacles. It involves establishing the desired service levels, precisely measuring use, and attributing it in a straightforward manner to the appropriate customer. Demonstration set-ups, such as an on-line video shop, enable the solutions to be shown graphically. For example: a user wants to view a certain film and indicates how much he is willing to pay. The supplier responds with an offer in which a low price is linked to more adverts being shown. When the user views, the actual use is measured. If the user turns the film off halfway through, he only pays half the fee – or none at all. The technology offers the choices; how they translate into services is a matter for company strategy, agreement and negotiation.



Metabolic fingerprint:

## Biomarker opens a world of possibilities

A little saliva, blood or urine on a test strip or exhaled air in a blowpipe and it's done; quickly, painlessly and cheaply. That's all it takes to find out if a person's cholesterol is too high, or whether they are at risk of osteoporosis. Perhaps it's a test of whether medication for arthritis is taking effect, or to find out whether a certain ingredient in a 'functional food' is going to work. The use of biomarkers makes a wide range of check-ups and diagnostic and prognostic investigations as simple as taking a pregnancy test. Once it is clear which metabolites – waste products – indicate the presence of which processes in the body, a world of investigative possibilities is opened up thanks to these 'metabolic fingerprints'.

The technology behind biomarkers, which makes it possible to identify the metabolic fingerprints, is somewhat less easier than that of a pregnancy test. It is a question of biological pattern recognition using mass spectrometry and Nuclear Magnetic Resonance (NMR) spectrometry. TNO has already proven that the principle behind the new technology is appropriate for such areas as testing for arthritis. The burning question now is how the food and pharmaceutical industries want to take the development further. TNO is able to identify biomarkers and carry out all sorts of test using them. The next step is to develop self-medication kits. Such kits would indicate to the user what effect medication or functional food is having, thus creating the option of making adjustments. And biomarkers could in principle make medical investigations significantly easier across a wide range of applications, – once the required metabolic fingerprint has been revealed.

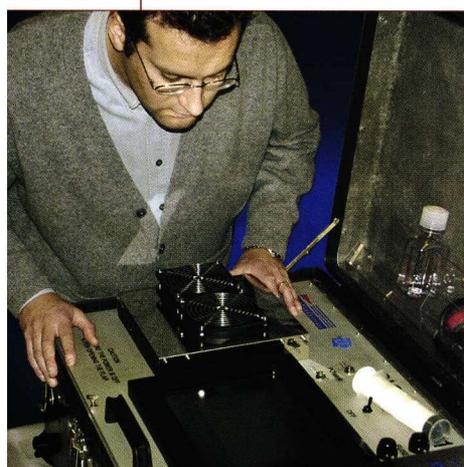


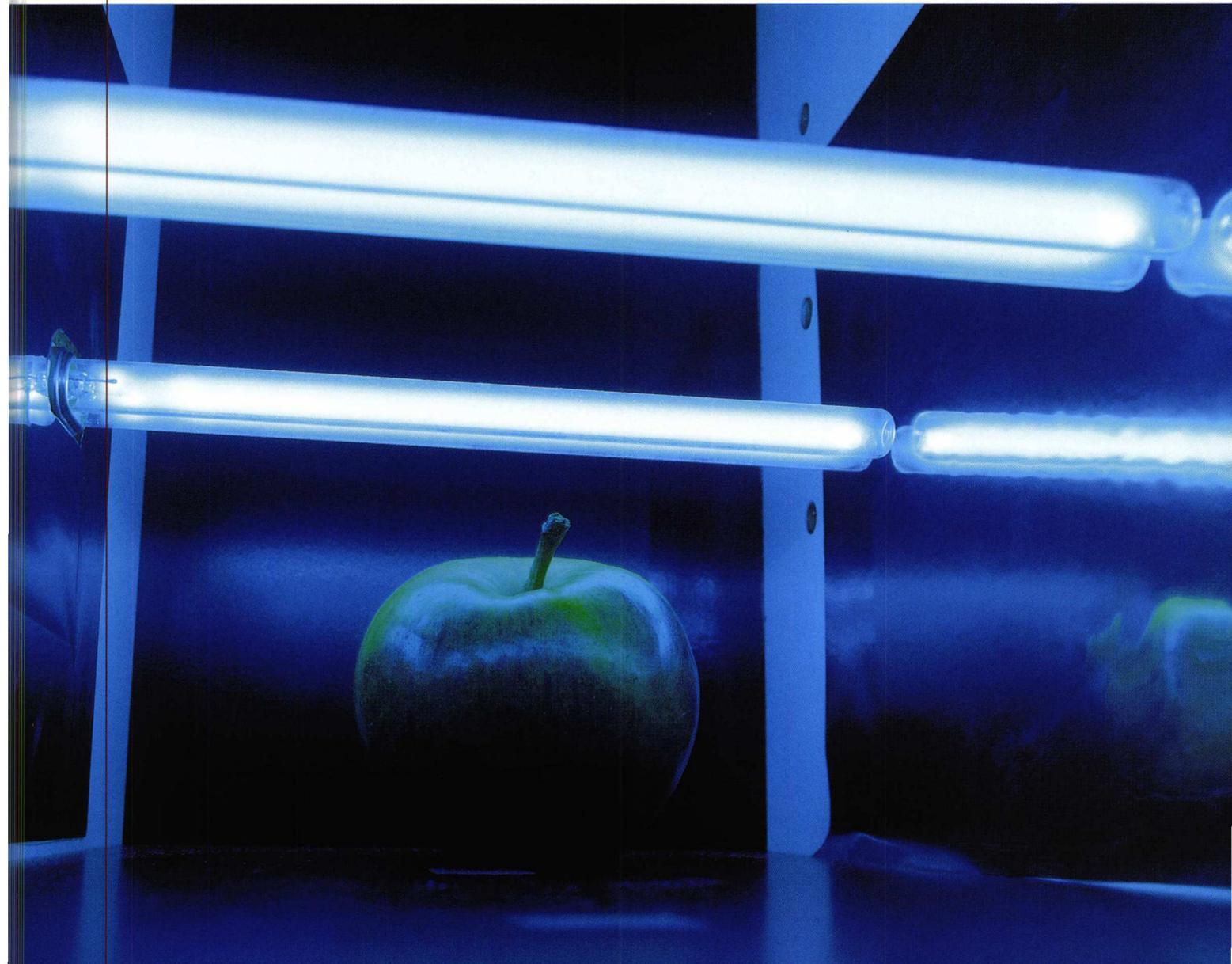
A laboratory the size of a briefcase:

## Monitoring the biological threat

The range of targets of terrorist activity has widened considerably. Any public gathering, be it in a sports stadium, at a pop concert or in the departure lounge of an airport or railway station can be a potential target. And the bacteria, viruses and biological toxins that used to be exclusive to the armed forces may also be part of the arsenal of extremist groups. In partnership with GIAT Industries, TNO is developing a compact instrument for bio-monitoring in the field to be used by Dutch and French defence departments. A civilian version of this briefcase-sized lab, one that is even smaller and lighter, is an obvious next step. While a bio-alarm system can warn of a threat and ring the alarm, this bio-monitoring system can go on to indicate the exact nature of the threat.

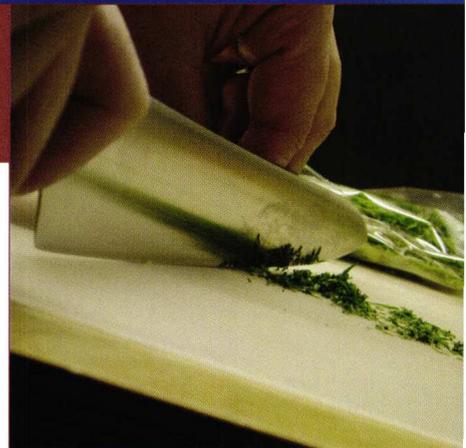
Taking an air sample, processing it, issuing a measurement and giving a signal is by no means a new process and it still takes around 20 minutes. The new development that forms part of the briefcase lab is that all these functionalities have been automated within one piece of equipment. In the military version of the equipment, there are two displays: one for scientific information and one for informing the user in the field. That may be a battalion commander who, having heard a signal, turns to the visual display to discover which bacterium or virus the troops might be exposed to. The information indicates the therapy or preventative measure that could neutralise the threat.





## High Intensity Light: Preserved in a flash

The modern consumer increasingly demands healthy, natural-tasting foods. Yet these foods must also keep for a long time. Mild preservation techniques such as High Intensity Light (HIL) can reconcile these seemingly contradictory requirements. Flashes of light from a xenon lamp 20,000 times the strength of the sunlight that reaches Earth kill microorganisms on the surface of the food within a few milliseconds. Ultraviolet light in particular causes fatal DNA damage to microorganisms. HIL will soon be suitable for the treatment of such foods as meat, eggs, vegetables and fruit, part-baked products and transparent liquids. TNO is currently researching the ultimate industrial applications for HIL in a large-scale development project with the engineering industry and an international electronics concern.



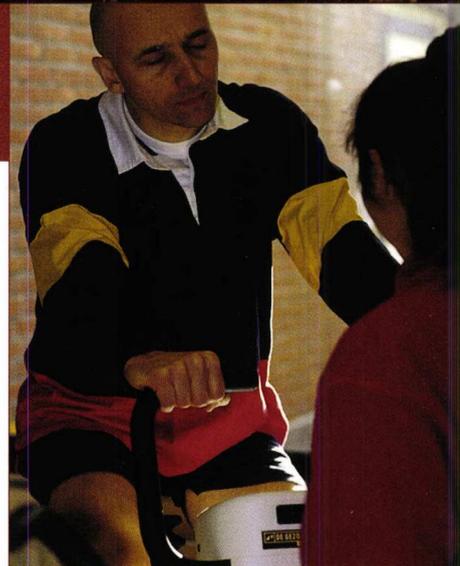
As well as treating foods, HIL also provides a way of sterilising packaging such as wrapping foil. This is particularly useful given that packaging has a great influence on a food's quality and storage life. HIL enables a food manufacturer to treat a product and its packaging simultaneously. TNO is assessing the implications of all this for product quality. What happens to the food's nutritional value, texture, and sensory and toxicological characteristics? What is the effect on microbiological perishability? It is likely that the first HIL production system will be operational in the Netherlands within two years.



## National Health Test: TNO pushes for more movement

You don't have to run a marathon, but you do need to get some exercise. Good health requires moderately intensive movement at least half an hour a day, five days a week. And there's proof. It reduces the chance of heart and vascular disease, diabetes, depression and certain types of cancer. Employees who get enough exercise have less absenteeism through sickness, fewer aches and pains and a reduced chance of burn out. The Netherlands Heart Foundation and the Ministry of Public Health, Welfare and Sport want to stimulate the working population to take more exercise. A necessary challenge since half of the target group is too inactive. At the same time, two in every three people do actually want to take more exercise.

TNO is not sitting still on this. In collaboration with the Pur Sang Foundation, TNO is carrying out the National Health Test. As part of this, thousands of adults in the Netherlands will test their fitness level on a hometrainer at a test centre. They will also complete a questionnaire about their lifestyle and physical activity. The test results form the basis of a practical, personal exercise recommendation. The participants are not the only people who stand to gain from the test. This initiative will also bring wider attention to the relationship between exercise and health. Furthermore, the data gathered will serve as the basis for scientific research, the results of which will be used to advise policy makers about exercise, health and employment. A key question is what moves the Netherlands to move? Another, more important issue is how do you help the people who want to exercise, to actually do so?

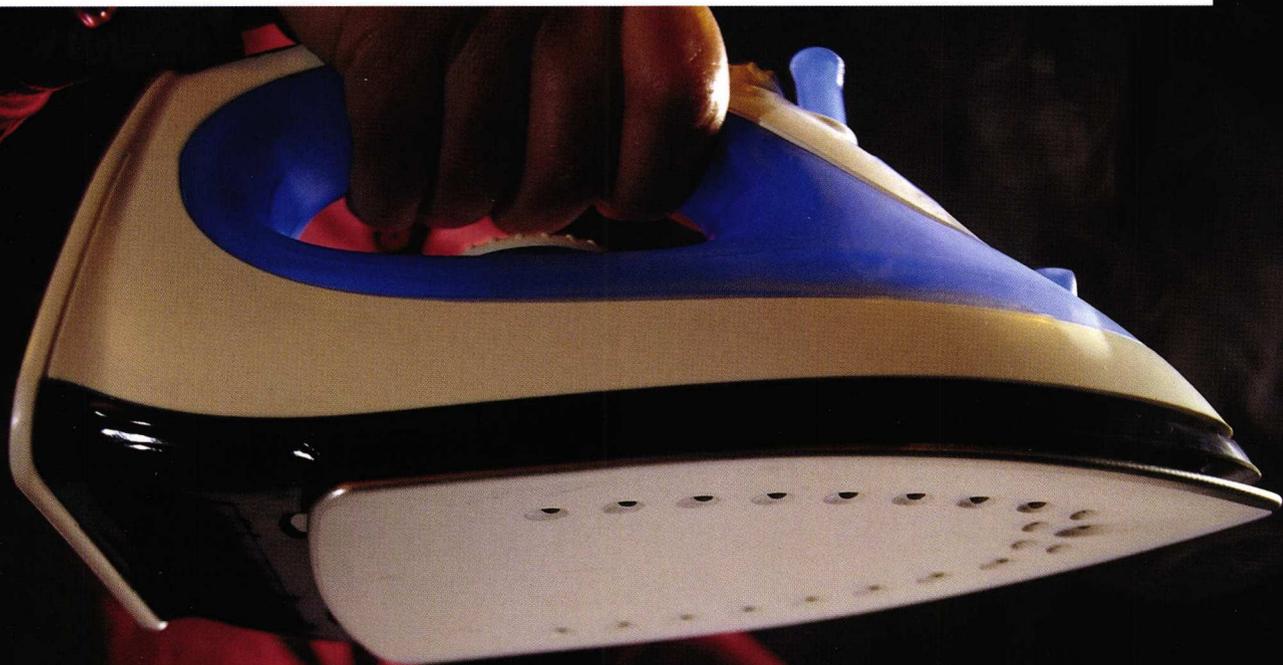


Planomers<sup>®</sup> :

## Plastics with ceramic qualities

It is every manufacturer's dream: to reduce the costs of materials and increase durability while not reducing the potential for recycling. Plastics manufacturers now use clay as a cheap filler for some applications but gaining additional quality and functionality requires an extra step. As one of the leading international players in nanocomposites, TNO has been developing a series of materials that can bond the favourable properties of clay to those of plastics by chemically attaching the clay minerals on a nanoscale into the polymer plastics matrix. As a result, the properties of cheap bulk polymers are starting to look a lot more like those of the much more expensive technical plastics. The benefits of the Planomers<sup>®</sup> are evident: a higher thermal stability goes hand in hand with better mechanical properties and an increased barrier value against penetration by gases and liquids.

Planomers<sup>®</sup> have a wide range of potential applications. Their thermal stability makes them perfectly suited for environmentally friendly and fire-resistant casing for electrical cable and electrical equipment. Since the clay plates introduce a ceramic strength into the plastics system, the plastic is less susceptible to fatigue. This considerably extends the lifetime of, for instance, the plastic pressure mould used by the sanitary ware manufacturer Sphinx. The packaging industry is showing great interest in the high barrier value that can be achieved by Planomer<sup>®</sup> plastic bottles and foils. TNO is developing the Planomers<sup>®</sup> so that they can be applied to a wide range of plastics and coating systems.





## TNO in figures

# Consolidated balance sheet as at 31 December 2001

after appropriation of result (EUR x million)

	31-12-2001		31-12-2000
<b>Fixed assets</b>			
Intangible fixed assets		290	189
Tangible fixed assets		196,106	237,135
Financial fixed assets		4,720	5,802
		<b>201,116</b>	<b>243,126</b>
<b>Current assets</b>			
Stocks and work in progress	16,052		20,498
Receivables	106,357		102,637
Securities	-		56,035
Cash	61,467		-33,104
		<b>183,876</b>	<b>146,066</b>
<b>Total</b>		<b>384,992</b>	<b>389,192</b>
Financed as follows:			
<b>Equity:</b>			
- General reserves	182,527		200,653
- Appropriated reserves	32,033		9,268
		<b>214,560</b>	<b>209,921</b>
<b>Investment funds equalisation account</b>		13,237	7,930
<b>Third-party interests</b>		63	-20
<b>Provisions</b>		40,008	33,025
<b>Long-term debts</b>		4,048	4,826
<b>Short-term debts</b>		113,076	133,510
<b>Total</b>		<b>384,992</b>	<b>389,192</b>

# Consolidated profit and loss account 2001

(in EUR x thousand )

	2001	2000
Turnover	514,502	479,454
Other operating income	8,943	16,264
<b>Operating income</b>	<b>523,445</b>	<b>495,718</b>
Personnel costs	- 322,927	- 297,807
Direct project costs	- 74,733	- 69,972
Other operating costs	- 89,542	- 86,563
Depreciation intangible fixed assets	- 43	- 278
Depreciation tangible fixed assets	- 37,458	- 37,461
Exceptional depreciation tangible fixed assets	- 12,229	-
Contributions issued	- 322	- 495
<b>Operating costs</b>	<b>- 537,254</b>	<b>- 492,576</b>
<b>Operating result</b>	<b>- 13,809</b>	<b>3,142</b>
Income from financial fixed assets	1,559	57
Income from securities	1,050	6,670
Interest received	3,007	2,607
Interest paid	- 3,736	- 4,489
<b>Result on ordinary operations before taxation</b>	<b>- 11,929</b>	<b>7,987</b>
<b>Taxation</b>	<b>- 1,053</b>	<b>- 744</b>
<b>Result from ordinary operations after taxation</b>	<b>- 12,982</b>	<b>7,243</b>
Third-party interests	- 21	17
Extraordinary profits	45,283	-
Extraordinary losses	- 29,308	-
<b>Result</b>	<b>2,972</b>	<b>7,260</b>
<b>Appropriation of results:</b>		
<b>Result</b>	<b>2,972</b>	<b>7,260</b>
Additions to:		
- appropriated reserves for civil operating risks	- 2,644	- 2,419
- appropriated reserves for defence operating risks	- 1,262	- 74
- appropriated reserves for knowledge investments	-	- 2,269
- appropriated reserves for new defence buildings	- 19,195	-
Withdrawals from appropriated reserves for civil operating risks	336	-
<b>Result after movements in appropriated reserves</b>	<b>- 19,793</b>	<b>2,498</b>
Changes in general reserve	19,793	- 2,498
	-	-

## Other information

### Notes to the consolidated balance sheet as at 31 December 2001 and the consolidated profit and loss account 2001

The Financial Statements for the year 2001 of Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek TNO, Delft, the Netherlands, are compiled in conformity to the financial reporting requirements as included in Part 9 of Book 2 of the Netherlands Civil Code and the guidelines for financial reporting as included in 'de Richtlijnen Financiële Verslaggeving TNO' from the Ministry of Education, Culture and Science.

The consolidated balance sheet as at 31 December 2001 and the consolidated profit and loss account 2001 are derived from the Financial Statements for the year 2001 of Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek TNO, which was approved by the Supervisory Board on 17 April, 2002.

### Auditors' report

We have audited the consolidated balance sheet as at 31 December 2001 and the consolidated profit and loss account 2001 of Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek TNO, Delft, the Netherlands, as set out on pages 44 to 45. The consolidated balance sheet and profit and loss account have been derived from the financial statements of Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek TNO for the year 2001. In our auditors' report dated 17 April, 2002 we expressed an unqualified opinion on these financial statements. The consolidated balance sheet and profit and loss account are the responsibility of the company's management. Our Responsibility is to express an opinion on the consolidated balance sheet and profit and loss account.

In our opinion, the consolidated balance sheet and profit and loss account are consistent, in all material respects, with the financial statements from which they have been derived.

For a better understanding of the company's financial position and results and of the scope of our audit, the consolidated balance sheet and profit and loss account should be read in conjunction with the financial statements from which the consolidated balance sheet and profit and loss account have been derived and our auditors' report thereon.

The Hague, 6 June, 2002  
KPMG Accountants N.V.

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## Credits

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<b>Production</b>	TNO Corporate Communication
<b>Text Bureau</b>	Lorient, Leiden, TNO Corporate Communication
<b>Translation</b>	CPLS text & copy, Eindhoven
<b>Graphic Design</b>	Onnink Grafische Communicatie BV, Oudenbosch
<b>Printer</b>	Den Haag offset, The Hague
<b>Photography</b>	
<b>Eric de Vries, The Hague</b>	
<b>Witho Worms, Almere</b>	page 9 and 20
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<b>Koen Gerritse, TNO-PML</b>	page 38

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ISBN 90 6743 899 5  
ISSN 1383 360X

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