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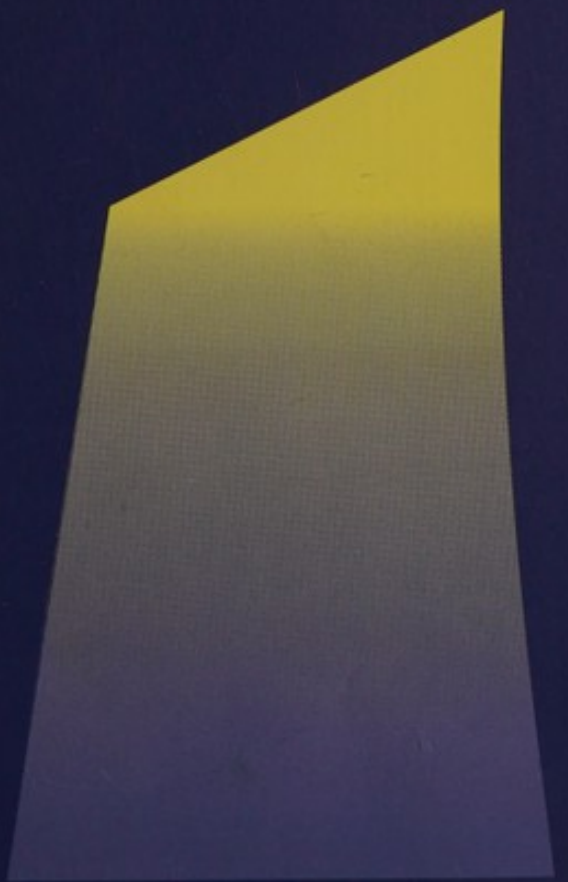
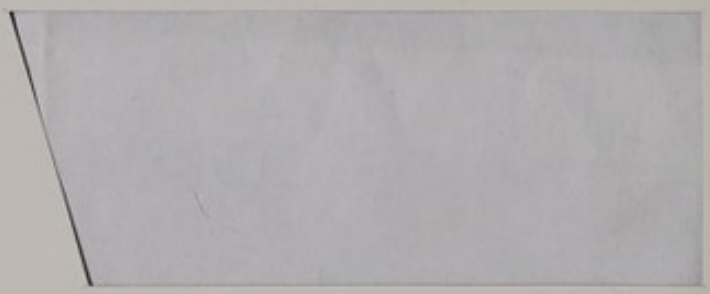
Knowledge *in Action*

Knowledge and know-how in the Dutch economy





Ministry of Economic Affairs
Ministry of Education, Culture and Science
Ministry of Agriculture, Nature Management and Fisheries

Knowledge *in Action*

Knowledge and know-how in the Dutch economy

Letter from the Ministers of Economic Affairs, of Education, Culture and Science and of Agriculture, Nature Management and Fisheries

To the Speaker of the Second Chamber of Parliament

The Hague, 21 June 1995

We hereby enclose the Strategy Document 'Knowledge in Action', implementing the Cabinet's new policy initiatives to increase the knowledge-intensity in the Dutch economy. The document is also a response to the recommendations of the Advisory Council for Science and Technology Policy on 'Technology Policy and Economic Structure' and 'Application of University Know-How'. The policy initiatives mentioned in this strategy document are developed along three lines. Firstly, the basic conditions for innovation will be strengthened. Secondly, efforts will be made to improve the match between supply and demand for knowledge. Finally, better use of promising emerging technologies will be stimulated. The package of measures is designed to increase the knowledge-intensity in our economy. Only then can the Dutch economy move onto a higher and more sustained growth path.

The Minister of Economic Affairs
G.J. Wijers

The Minister of Education, Culture and Science
J.M.M. Ritzen

The Minister of Agriculture, Nature Management and Fisheries
J.J. van Aartsen

1) This letter is published as Second Chamber Document 24 229, No. 1.

2) Technology Policy and Economic Structure, Advisory Council for Science and Technology Policy, April 1994, The Hague.

3) Application of University Know-How, Advisory Council for Science and Technology Policy, February 1995, The Hague.

Knowledge in Action

Knowledge and know-how in the Dutch economy

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Ministry of Economic Affairs

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Summary

It is becoming increasingly important for the Netherlands to provide good conditions to attract and keep businesses. After all, globalisation has increased the choice of business locations enormously in recent years, and this trend is certain to continue in the future.

A competitive climate for attracting businesses depends on many different factors: the macro-economic climate, the tax system, the infrastructure, etc. This strategy document covers just one of these factors: the knowledge-intensity of the economy. A developed country such as the Netherlands cannot compete purely on a cost basis. The key is to add value to products through optimal use of knowledge and know-how.

An analysis of the position of knowledge in the Dutch economy gives cause for concern. International competition calls for wider acces to and application of knowledge and know-how in developed economies. Yet in the Netherlands, the knowledge-intensity is shrinking rather than growing. Inevitably, this will be reflected in poorer economic performance and declining prosperity.

The Dutch government is seeking to reverse this trend through a substantial package of measures, explicitly designed to have ripple effects on a wide range of players in the economy. Businesses will be encouraged to step up their fundamental and applied research efforts; alone, in partnership with other businesses and in cooperation with research institutes.

In the latter case, it is particularly important that companies clearly define the kinds of knowledge and know-how they expect to need, both in the near future and in the long term. If the research and training system is receptive to those needs, businesses and institutes can improve standards of quality together.

This strategy document discusses the measures under three different headings: improving basic conditions for innovation, improving the match between supply and demand for information and finally, taking greater advantage of the opportunities afforded by new technologies. The following measures are involved:

- Improving basic conditions for innovation: higher levels of R&D spending, a research network that avoids duplications or gaps, and a better-educated labour force.
  The main measures to improve basic conditions discussed in this strategy document are (see Part 6):
  * Improved R&D tax incentives
  * Relaxation of depreciation requirements for innovative technologies transferred to the Netherlands
  * Tax incentives to improve the apprenticeship system and increase the number of trainee research assistants conducting research for businesses.
  * Additional government funding for advanced research in selected fields.
  * Additional government funding to update technical and vocational education and training.

  A higher return on investment in knowledge, through an improved match of supply and demand.
  Public research and education institutes will be encouraged to work more closely with the private sector for this purpose. The Ministry of Economic Affairs will also place a much

greater emphasis on cooperation between businesses and institutes, and between individual businesses, in its business-oriented technology schemes (part 7).

- Taking greater advantage of new technologies
  Additional government funds will be made available for the development of electronic highways and for an Ecology, Economy and Technology R&D programme. The existing Technology and Society programme will also be expanded (part 8).

1 Introduction

The Dutch government's main objectives are to create more jobs and bring down unemployment. It wants to be judged in terms of its success in attaining these goals. This calls for a strong and healthy private sector and integration of government policies in many different areas. The primary aim must be to increase and sustain the rate of economic growth. Only then will we be able to restore labour market equilibrium.

The government has introduced a sizable package of measures to reduce the regulatory and financial burden on businesses, in order to create a favourable macro-economic climate. To increase the flexibility of the Dutch economy, reform of the Economic Competition Act is planned and the `Functioning of Markets, Deregulation and Quality of Legislation' programme is already in full swing. Cuts in the direct and administrative costs of smaller companies will be announced, in order to make the most of their potential as the `jobs engine' of the economy (without, of course, ignoring the strengths of larger companies).

This strategy document adds another crucial dimension to these measures: that of increasing the `knowledge-intensity' of the Dutch economy. As such, it represents a development of the government Coalition Agreement, which states that `the Netherlands will concentrate on strengthening its economic structure and on production and services with high added value'. Why is this so crucial? The answer is related to world economic trends. Companies in industrialised nations like the Netherlands operate in a relatively high-cost environment. As a result, they have to profile themselves on world markets through the quality of their products and production processes, by steadily raising the amount of know-how embodied in them.

This is also an important factor in realising more sustainable growth. By realising more of our innovative and creative potential, we can strengthen the link between the economy and ecology, not just by tackling environmental problems, but also by making greater use of technological opportunities to create a sustainable economy.

This strategy document sets ambitious targets for improvement in knowledge-intensity in the Netherlands. We aim to, and in fact, must win a position among the world leaders. To achieve that, we must work on the basis of the idea that our industrial, technological, educational and science policies should be mutually reinforcing in order to succeed. Obviously, the aims of education and science policy go beyond that of strengthening economic structure alone. This strategy document emphasises the new joint policy initiatives launched by the Ministry of Economic Affairs, the Ministry of Education, Culture and Science and the Ministry of Agriculture, Nature Management and Fisheries to improve the knowledge-intensity of the Dutch economy, focusing on the relationship between the private sector and the public research system.
Obviously, the Ministers each have their own priorities in this joint campaign.

The Minister of Education, Culture and Science holds prime responsibility for coordinating most of the research and training system. He will therefore be encouraging the system to respond actively to the needs of industry (and other actors).

The Minister of Economic Affairs is mainly concerned with stimulating business R&D, more and more of which is being carried out in partnership with the public research system. (This does, of course, require that industrial needs are clearly defined.) The Minister of Economic Affairs therefore helps to set priorities for government-funded research.

The Minister of Agriculture, Nature Management and Fisheries aims primarily to stimulate innovation in the agricultural sector. In its policy paper `Dynamism and Innovation', the Cabinet recently stressed that the knowledge and innovation system is one of the most important tools for this purpose. As a follow-up to the paper, the Minister of Agriculture, Nature Management and Fisheries published a draft Knowledge Policy Plan.

Yet the challenges involved in improving the knowledge-intensity go beyond the brief of these ministries. Companies, education and research institutes, employees, trade unions and other government departments must also identify with these goals, and work towards them in their own activities.

The next section looks at the effects of globalisation. It is followed by a discussion of how companies can increase their own knowledge-intensity. Part 4 appraises the present situation, followed by a review of the measures that the government considers necessary.

2 Globalisation

Globalisation is one of the most widely-discussed issues in economic policy - for good reasons. Partly because of technological development itself, as well as the removal of national borders, companies have a growing international choice of locations for each of their activities: for head offices, production processes, final assembly or R&D. It is no longer enough for a would-be host country to create a competitive macro-economic climate. It must also provide the right conditions to attract or keep individual business activities.

These new opportunities will have a substantial impact. While nobody yet knows quite how substantial, many are convinced that we are in the middle of a new industrial revolution[1]. At present, one can only outline the consequences of globalisation in general terms.

Firstly, globalisation puts great pressure on the adaptability of national economies, by generating fiercer international competition and by increasing economic dynamism worldwide. An open economy like that of the Netherlands needs more effective social and economic responses in order to absorb the inevitable shocks and make the necessary adjustments as smoothly as possible. It was partly because of this that the Dutch government launched the 'Functioning of Markets, Deregulation and Quality of Legislation' operation, designed to bring the Dutch economy's adaptability back into line with the demands of the international economic climate. Greater dynamism improves adaptability, and also generates more innovation[2].

The impact of increased dynamism in the world economy goes beyond the private sector. For instance, (semi-) public research and training institutes face growing foreign competition now that companies can (and do) conduct R&D in other countries. There are also greater opportunities for international cooperation and coordination between institutes. Research institutes must therefore be able to respond flexibly to these changed circumstances.

Secondly, the national capacity to attract businesses is becoming increasingly important, as potential investments can be made at a growing number of locations worldwide. As competition between companies increases, so does competition between countries. The Dutch government has already introduced many measures to improve the business climate in various fields.
In view of the budget criteria for the third phase of EMU, it is also aiming for a substantial reduction in the collective tax and social security burden. Various measures will be announced in the coming months to improve the fiscal climate for businesses.
Physical planning, which also plays a role in attracting businesses, needs close consideration: the main factors are good access, good connections with the north-west European regional economic structures and the availability of enough good business locations in the right places at the right times[3].

To keep pace with international competition, we need to optimise our investment climate and improve the operation of markets (including the labour market) across the board. But on its own, this will not be enough. The third consequence of globalisation is that in a developed economy like the Dutch one, success will increasingly depend on activities embodying a high degree

1 See e.g. the Bangemann Commission, in which many top European industrialists are represented: Europe and the Global Information Society, Brussels, 1994, page 2.

2 See M. Porter: The Competitive Advantage of Nations, Free Press, 1990; SER/CED: 'Knowledge and Economy', The Hague, 1995; and also B. Dankbaar: Research and Technology Management in Enterprises: issues for Community policy, Brussels, 1994.

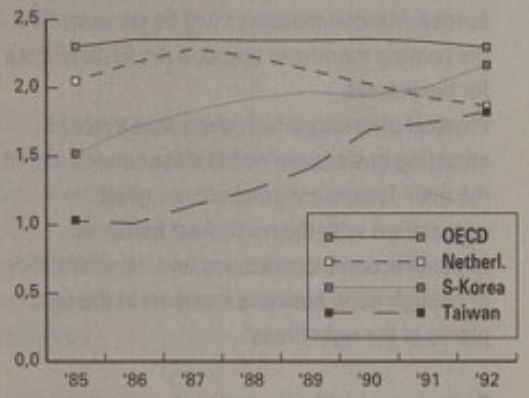
3 "Scope for Regions: Regional economic policy to the year 2000", TK 24060, No. 1.

of knowledge. We cannot (nor do we want to) compete in world markets purely on the basis of labour costs. The increased emphasis on knowledge applies to the entire private sector. High-tech industries need high-tech suppliers, and both need high quality commercial services. In other words, the competitiveness of our economy depends on the overall quality of our networks and alliances.

This has obviously been true for some time, but the issue is now becoming more pressing. The economic boom in many south-eastern Asian countries, and more recently in Eastern Europe, is making it harder and harder to compete on price alone. We therefore have to compete on the basis of knowledge. But here too, competition is becoming increasingly fierce: the OECD countries have lost the monopoly they held for decades on products and processes embodying high levels of knowledge.

If the Netherlands is to realise its own ambitions in these circumstances, it will have to put even more effort into competing through knowledge[4]. Yet recent research indicates that 'the knowledge-intensity in the Dutch economy is slowly shrinking'[5].

Total expenditure on R&D, Asian Tigers, as a percentage of GDP



In a mere 10 years, countries such as South Korea and Taiwan have doubled their R&D expenditure as a percentage of GDP, and this is already reflected in their products. Taiwan is currently investing as much as the Netherlands in the development of know-how, and South Korea the same amount as the UK. The south-east Asian countries couple this performance with high ambitions. The Taiwanese government aims to match current OECD investment levels by 1996. The Korean government wants its investment levels to equal those of Germany, the US and Japan in the same period. In other words, the south-east Asian countries have created a formidable blend of high levels of knowledge at relatively low costs.

4 See AWT, 'Technology policy and economic structure', The Hague, 1994; also the report of the SER's Committee of Economic Experts: 'Knowledge and the Economy', The Hague, April 1995.

5 M. Slabber and B. Verspagen: Stemming 2, 'The Dutch technology position and the impact of globalisation', MERIT, Maastricht, 1995.

3 Knowledge in the economy

3.1 The functions of knowledge

Knowledge is embodied in all kinds of social processes, products and services. This includes technological knowledge, but can also involve logistical and management expertise, language and cultural skills or social processes. Technology and knowledge is also embodied in economic products and services. For an economy like the Dutch one, it is extremely important that products and services embody a high degree of knowledge. Knowledge is therefore one of our most important resources and, if properly applied, also a sustainable one.

It is difficult to express knowledge in terms of statistics. We can provide data on R&D spending, but this risks equating knowledge with R&D. The knowledge relevant to the economy - i.e. that used to make economic transactions cheaper, better, more sustainable and more efficient - is much broader. Knowledge can be embodied in products, processes, complementary activities (marketing and communications) and services. The importance of the overall efficiency of economies - and of open economies in particular - makes the availability and application of knowledge an important factor in all economic activities.

A clear picture of the availability of knowledge in any particular country calls for more than R&D figures alone. For example, the growing importance of knowledge in the service sector is not reflected in R&D spending. In some parts of this sector, innovation and applied knowledge result less from R&D performed by these companies themselves than from the application of technological innovations developed in industrial sectors[6]. In public and personal services, technological innovation is determined largely by suppliers of production equipment. The specific needs of the service sector, in turn, influence technological development (bar code technology for the retail trade is a good example, as is tracking and tracing technology for the transport sector).

The fact that knowledge is more than just R&D is also shown by the following examples. Companies such as McDonalds, Swatch, CNN and Ikea have taken a large share of the market by being innovative, and by integrating innovations into broader concepts. This illustrates the importance of good marketing[7].
Another example is Stork, a company which selects its activities on the basis of the 'systematic interaction between groups of customers, basic functions and expertise'. It does not consider it necessary to manufacture the tangible products itself.
Process control is also important in the R&D-intensive electronics sector. Neways Electronics, for example, sees itself as strong in integrated projects, which call for knowledge of marketing, development and design, production, sales, and after-sales services in professional electronics[8].

R&D statistics are not, therefore, enough to measure knowledge. Many different factors determine a country's economically-relevant store of knowledge: they include investment in intangibles (education, R&D, software, in-company training schemes) and in tangible assets (embodied technology).

In Western economies, the growing importance of knowledge as a competitive factor is reflected in the level of investment in intangibles, which is

6 Soete and Miozzo, in TNO: 'Innovation in the service sector', Apeldoorn, 1992, page 27 et seq.

7 See D. Jacobs: 'Competition, partnership and innovation: a review of the problems', Ministry of Economic Affairs, 1994, page 35

8 Examples taken from B. Minne: 'Research, development and other intangible investments in the Netherlands', CPB, The Hague, 1995, pages 85-86.

rising proportionally faster than investment in tangible assets[9].

3.2 How companies acquire knowledge?

Mechanisms

There are many ways in which companies can bring their know-how levels up to scratch. The most important, obviously, is to recruit skilled personnel who will help to upgrade products and production processes, and who have access to the relevant worldwide store of knowledge. Businesses can conduct their own R&D, but of course, they can also farm it out, using services from outside their own organisation. This once again raises the question of whether this should be done at home or abroad. Knowledge can also be 'hired in' by temporarily bringing specialised services into the company. And finally, businesses can buy knowledge, by obtaining licences for patented know-how developed elsewhere. Investments in 'smart' products and semi-manufactures available in the market can also increase a company's knowledge supply.

There is no ideal way to acquire knowledge. The best method for an individual business depends on the size of the company, its sector, its activities and the availability of specific expertise in the national research and training system.

Large and small

The Advisory Council for Science and Technology (AWT) divides companies into three categories, distinguishing between their locations (domestic or multinational) and the markets they serve (regional or worldwide)[10].

Multinationals, since they have outlets in many countries and produce worldwide, can draw on worldwide stores of knowledge. They are not limited to a single country. However, the knowledge of local personnel is a major consideration for multinationals plan ning to locate in a particular country.

National export companies are also oriented towards the world market, but work from a domestic base. Although these companies, too, have a growing choice of profitable international locations, they are (still) more dependent on the domestic knowledge supply than multinationals[11].

Finally, there are the small and medium-sized enterprises (SMEs) with less than 100 employees (98% of all companies in the Netherlands). Some of these very definitely rank among the technology-generating businesses, as shown by the number of SMEs availing themselves of government technology-promotion schemes such as the Act to promote Research and Development (WBSO), the Business-Oriented Technology Stimulation Programme (PBTS) and the Technological Development Credit scheme (TOK).

However, by far the majority of SMEs are heavily dependent on the local and national knowledge supply. Finding the right knowledge is not always easy. Smaller companies often need help to locate the right sources, define their needs and to apply know-how. These businesses depend heavily on their 'day-to-day environment' - suppliers, customers, competitors etc. - for new ideas and the development of their own stocks of knowledge. They still make relatively little use of the network of Innovation Centres (ICs), Branch Centres for Technology (BCTs), (vocational) training, etc.

Larger companies increasingly contract out research, and moreover, expect smaller companies to take on orders involving a high degree of know-how. This process means SMEs have to make the leap from acting as 'jobbers' to

9 CPB: 'The Netherlands in Triplicate', page 59.

10 AWT, op cit, pages 58-61.

11 40% of export companies is currently considering the possibilities of locating their production abroad, Free University of Amsterdam/Fenedex: 'Global sourcing: a study of the relocation of activities by Dutch businesses', Amsterdam, 1994.

serving as 'co-makers'. Large companies generate new activities among SMEs, but in turn, become more dependent on the performance of their small business suppliers, which increasingly determines their competitiveness. In other words, the performance of smaller companies is becoming an increasingly important location factor.

The government's research policy will take account of the differences in the opportunities and needs of different businesses, as described above.

3.3 Knowledge in industry and in the service sector

We are told often enough that we are living in a post-industrial society. Yet where technological innovation is concerned, we still seem to focus mainly on industry. Is this an anachronism in our economic thinking?

The answer is 'No'. Firstly, there is considerable interdependence between industry and services. Large parts of the service sector are heavily dependent on industry, as shown by employment input-output analyses[12]. In 1990, Dutch industry provided 962,000 jobs, 800,000 of which were associated with intra-industrial sales[13]. However, other sectors also sell to industry. Some 530,000 service sector jobs depend on industry, along with 183,000 jobs in other sectors. So all in all, industry is considerably more important for jobs than the direct employment figures suggest.

Secondly, as already mentioned, many service sector innovations actually originate in industry. After all, this is where new technology is created.

Buyers of industrial products gain access to the knowledge embodied in those products (embodied technology). This is an important way to expand knowledge: it is the means of acquisition for an estimated 40-65% of the total available knowledge[14]. Service sectors, in particular, avail themselves of this source: some of the largest users of embodied technology include social and personal services, the construction industry, transport and storage, property and the banking and insurance sectors. So although service companies do not themselves create new technologies, their levels of knowledge can become quite considerable through innovations based on new (industrial) technologies. Such innovations, in turn, prompt new developments in industrial know-how. Developments in information technology provide very convincing examples of this interaction[15].
Finally, the geographical proximity of high-grade industries attracts services with the relevant know-how.

Two conclusions can be drawn. The first is that industry and services are so interdependent that for this reason alone, industry is more important than the figures suggest at first glance. Moreover, recent research shows that it is precisely the link between services and industry that is important for innovation.

These are all good reasons to work towards a competitive level of expenditure on knowledge in our own industrial sector, as well as making the best possible use of the store of knowledge abroad. In a fiercely competitive environment, where the strategic importance of knowledge is growing, we cannot afford to become too dependent on foreign innovation.
After all, innovations must be compatible with a company's existing knowledge and skills, and with the technologies already in use in-house. This is a question of tailoring innovation to

12 See CED, op cit, page 40.

13 Sales in the tertiary and other sectors accounted for respectively 55,000 and 107,000 jobs in industry.

14 G. Papaconstantinou, N. Sakurai, A. Wyckoff: 'Technology diffusion, productivity and competitiveness: an empirical analysis for 10 countries', EIMS Publication, Part 1, 1995.

15 This also relativises the clear distinction that is sometimes made between high, medium and low-tech sectors within industry. Although the differences between these sectors will continue to exist if we include the contribution made by embodied technology, they do become smaller; a low-tech sector can be highly knowledge-intensive by making extensive use of embodied technology.

individual company needs. The value added of incorporating new technologies in working methods and products lies primarily in the extent to which the companies in question can improve or add to the know-how they have bought in. They must have access to the assistance of research and training institutes for this purpose. If companies improve and intensify their efforts to acquire technological know-how (e.g. for environmentally-oriented product development), the knowledge-intensity increases and it becomes easier to expand international market positions.

4 The Dutch position

4.1 General

The strengths of the Dutch economy lie mainly in certain sectors of industry, notably the process industry and the agro-industrial sector[16]. These markets are growing relatively slowly. The Dutch position in these sectors can be maintained by combining a high level of applied knowledge with efficient products and production processes. All other relevant factors must also be watched, however, particularly the crucial need to control labour costs. World trade is growing fastest in sectors where products embody a high level of knowledge (e.g. semi-conductors, medical equipment, pharmaceuticals, etc). The Netherlands is under-represented in these sectors, which is why our production structure is vulnerable[17]. We could therefore seize many economic opportunities if, in addition to holding on to our strong sectors, we were also able to make the switch to a high-tech, high quality economic structure.

The competitiveness of industries in high-wage regions depends largely on quality differentiation in the market. The technology, quality or design of products must be distinctive enough to outweigh price as the determining factor for customers[18]. In the face of growing international competition, the structure of Dutch industry provides too weak a basis to win any sustainable strong position in the world market. A comparison of Dutch industrial exports in the 1980s with those of our competitors clearly shows that we have not yet reached the ideal situation described above.

Comparable world trade rose by an average of 7.5% during the 1980s, with 5.5% attributable to volume growth and 2% to price increases. The average growth in Dutch industrial exports was slightly lower, at 7%. But the main difference is found in the breakdown of this figure: in volume terms, Dutch industry certainly matched the performance of its direct competitors (with growth of 5.9%), but the annual increase in prices was only 1.1%. This is because Dutch industrial exports are relatively heavily geared towards markets where prices are rising less rapidly[19].

In the long run, excellent products will only remain competitive if, in addition to distinguishing themselves in terms of quality, their process and production technology receives constant attention.

Again, there is cause for concern here. Recent studies on production performance in manufacturing industry shed more light on this[20]. On average, productivity levels in Dutch companies are high in comparison with their competitors, but the gap is closing fast. Dutch companies pay relatively little attention to opportunities for continuous improvement in production process, for example in the 'design for environment' field. Investment in production R&D is low and advanced production technologies are being introduced only slowly. Furthermore, Dutch companies have made relatively little effort to integrate their production and commercial functions, which leads to a longer time-to-market. Finally, they work less intensively with suppliers and customers than their foreign competitors.

This again proves that competitiveness is not just a question of knowledge. It will take sophistication in products and production technologies to secure us a place among the

16 CPB: 'The Netherlands in Triplicate: a scenario analysis of the Dutch economy, 1990-2015', The Hague, 1992, page 280.

17 SER/CED, page 42.

18 See also T. Kumpe: 'Back to square one? Production, industry and society in completely free markets', Assen, 1994, page 19.

19 CPB: 'Dutch export performance since 1980', working paper No. 54, The Hague, June 1993.

20 A.T. Kearney and Knight Wendling: 'Producing in the Netherlands: Analysis of production performance in Dutch manufacturing', Ministry of Economic Affairs, 1994.

world leaders. In the next few paragraphs, we focus our observations on knowledge.

Total expenditure on research and development

Dutch R&D spending has been falling as a percentage of GDP since 1987, and has now dropped to well below the OECD average. We would need to invest around NLG 2.5 billion extra in R&D each year to climb back to this average. In recent years, the Netherlands has even slid below the EU average (figure 1). The decrease in R&D spending is due mainly to cuts in the private sector.

Businesses perform just over half of total Dutch R&D: higher education institutes and (semi) public research institutes account for the remainder. The next two sections discuss R&D spending in these sectors.

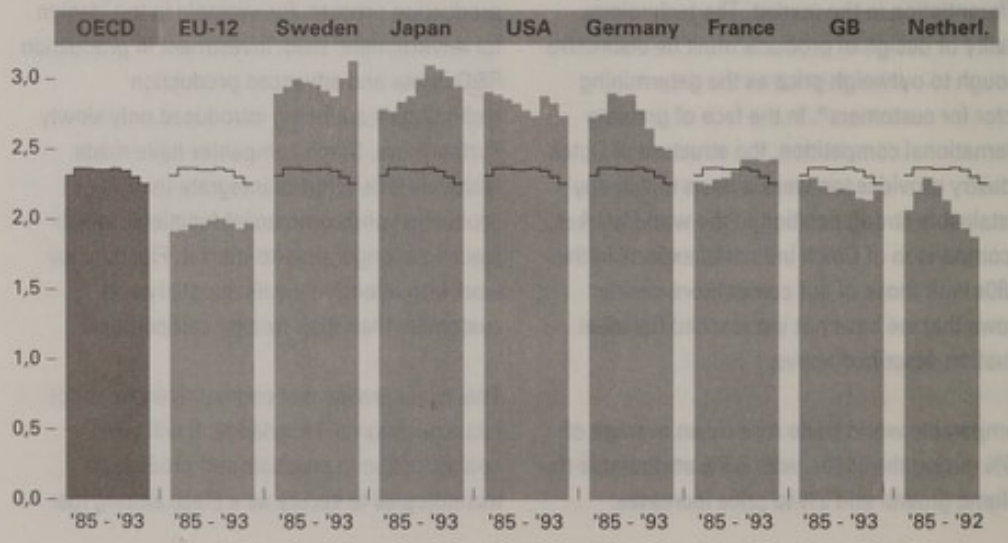
4.2 Private sector R&D spending

R&D expenditure

Private sector R&D spending in the Netherlands is trailing badly. It dropped from 1.4% of GDP in 1987 to 1.0% in 1992. For every guilder Dutch companies spend on R&D, the OECD countries now spend an average of more than NLG 1.60. In almost every branch of industry, Dutch R&D spending is lower than in rival countries[21] (figure 2).

Dutch R&D spending is concentrated in a small number of businesses: 50 companies account for some 90% of total industrial spending on R&D, and the biggest five account for as much as 60%. This small R&D base makes us vulnerable. The 'big five' companies almost halved their R&D spending between 1987 and 1993, from 0.9% of GDP in 1987 to 0.5%. Total

Figure 1
Total expenditure on R&D as a percentage of GDP



21 Compared with the average spending of Germany, France, the United Kingdom, Japan, Norway, the United States and Sweden, the R&D-intensity of the Netherlands in the 1981-1991 period was only higher in the petroleum, chemicals and food industries. Source: STEMMING 2, 'The Dutch technology position and the impact of globalisation', MERIT, Maastricht, 1995.

expenditure by the remaining companies was more or less stable as a percentage of GDP, but again, there were worrying signs: between 1988 and 1992, the number of companies engaged in R&D plummeted from 6,600 to around 4,300[22].

Output of industrial R&D: patents

In terms of patents, Dutch R&D output is relatively high: a high ratio of Dutch patent applications submitted per 100 private sector R&D employees. Patent output per private sector R&D employee also appears to be rising[23]. However, the Dutch share of patents awarded by the European Patent Office has been falling in recent years. After fluctuating between 2.8% and 3.0% between 1981 and 1990, it slipped to 2.5% in 1993. The same trend is visible in the Dutch share of patents awarded by the US Patent Office. This fluctuated between 1.2 and 1.3% between 1981 and 1991, but dropped back to 0.9% between 1991 and 1993[24].

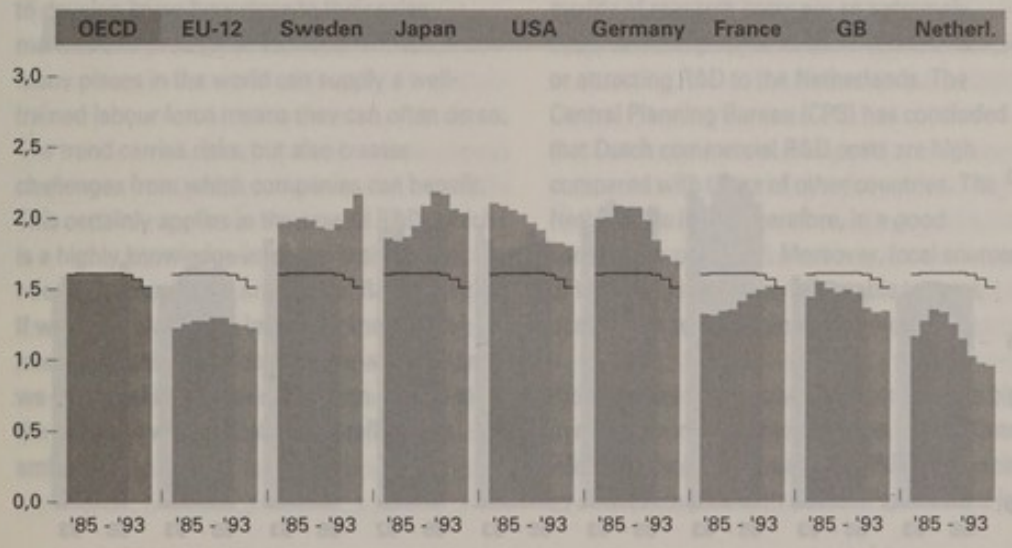
Acquiring knowledge through licences

Instead of investing in R&D themselves, companies can acquire licenses to apply patented know-how developed elsewhere. The licence payments are investments in expansion of the company's the store of knowledge. Unlike cross-border payments, payments for licences within the Netherlands are not measured.

Dutch companies purchase a relatively large amount of know-how abroad[25]. Their spending on the acquisition of licensed know-how reached some 0.5% of GDP in 1991, which is high in international terms. Together with Germany, the Netherlands is one of the leading countries actively buying knowledge abroad.

In terms of earnings from sales of technological know-how, the Netherlands holds a mid-field position. Countries such as the US and Germany earn more from the know-how trade. Like most countries, the Netherlands is a net importer of

Figure 2
Business expenditure on R&D as a percentage of GDP



22 E. Brouwer and A. Kleinknecht: 'Innovation in Dutch industry and services', Policy Studies on Technology and Economy, No. 27, September 1994.

23 A relatively large number of Dutch patent applications is generated by R&D carried out outside the Netherlands. Around 30% of Dutch patent applications to the EPO is generated by R&D carried out in other countries.

24 European Report on Science and Technology Indicators 1994, European Commission.

25 Over half of these types of transaction in knowledge consists of intra-concern trade (Bulthuis, Velt, Morsink (NEI), 1991.

know-how. The main net exporters are the US, Sweden, Denmark and the UK. All other countries have a technological balance of payments deficit. The Dutch and Belgian deficits are very high; in the Netherlands, the deficit reached approximately 0.3% of GDP (NLG 1.5 billion) in 1991[26]. Coupled with declining investment in R&D, this indicates growing dependence on foreign know-how.

4.3 Public sector R&D

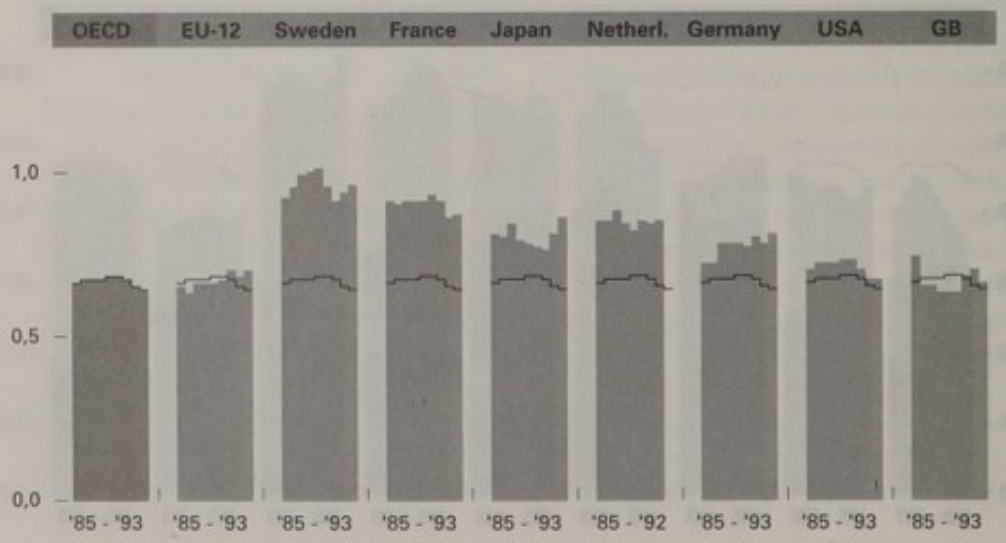
Public sector R&D spending as a percentage of GDP (0.85% in 1992) is relatively high compared with the OECD average (0.65% in 1992) and has remained more or less constant over the last decade (figure 3). A declining government share in R&D funding has been offset by the ability of research institutes to attract external resources. However, state funding of public sector R&D is steadily rising in many rival countries.

Public sector R&D is conducted by universities and public research institutes.

R&D spending by universities is substantially higher than the OECD average. The level has remained stable in the Netherlands, but has grown in the leading OECD countries. Moreover, the proportion of scientific and technical research conducted at Dutch universities is not high (around 38%). This figure is similar to that for Sweden (39%), higher than for Japan (31%), but substantially lower than that for countries like Germany (around 50%) and the US (some 60%).

Dutch (semi) public research institutes, such as the Netherlands Organisation for Applied Scientific Research (TNO) and the Large Technological Institutes (GTIs: the Netherlands Energy Research Foundation (ECN), the Delft Geotechnics Laboratory (GD), the Netherlands Maritime Research Institute (MARIN), the National Aerospace Laboratory (NLR) and the Delft Hydraulics Laboratory (WL)), perform relatively more R&D than their foreign counterparts: together with France and Germany, the Netherlands heads the OECD list. This position is stable.

Figure 3
Public sector expenditure on R&D as a percentage of GDP



26 OECD Main Science and Technology Indicators, 1994/2.

Data on scientific publications and quotations present a good picture of R&D output in the public sector: in terms of the different research areas, this indicates high quality and growth in activities.

Public sector R&D output: scientific publications

The number of Dutch scientific publications per capita is relatively high, and the Dutch share of world scientific publications is growing (from 1.6% in 1981 to 2.1% in 1993)[27]. In more specific scientific fields, the Netherlands scores particularly well in biology, medical sciences, geographical and environmental sciences. Its share in physics, chemistry, mathematics/information technology and engineering is relatively low[28]. In terms of the number of quotations of Dutch scientific works, the quality of Dutch scientific publications is good[29].

4.4 R&D in interaction with other countries

The transfer of R&D activities to and from the Netherlands is closely related to the general globalisation trend. To some extent, this is inevitable. It is vitally important, for both large companies and small technology-driven firms, to develop know-how close to their sales markets and production facilities. The fact that many places in the world can supply a well-trained labour force means they can often do so. The trend carries risks, but also creates challenges from which companies can benefit. This certainly applies in the case of R&D, which is a highly knowledge-intensive activity. We need to become a net importer of R&D activities. If we are to aim for an improved knowledge-intensity within the economy as a whole, then we must realise growth rather than decline in the activities which most clearly reflect that ambition.

It is therefore important to obtain a clear picture of the current R&D situation, both in the Netherlands and elsewhere. We start by considering R&D developments in the five largest Dutch companies, which jointly account for the lion's share of commercial R&D in the Netherlands. The 'big five' have reduced R&D spending in relative terms both at home and abroad in recent years. However, the foreign decrease began later, and has been far less dramatic than the domestic one.

Figure 4

R&D expenditure in the Netherlands and elsewhere by the five largest Dutch companies (as a percentage of GDP)[30]

Year	87	88	89	90	91	92	93
Big 5 - NL	0.9	0.9	0.8	0.7	0.6	0.5	0.5
Big 5 - abroad	0.9	1.0	1.0	1.0	0.9	0.9	0.8

Relatively speaking, there has been a net export of R&D. In 1987, the 'big five' matched every guilder spent on R&D abroad by one in the Netherlands. By 1993, spending in the Netherlands had dropped to just over NLG 0.6 for every guilder spent abroad. The level and quality of research costs are an extremely important competitive factor in terms of keeping or attracting R&D to the Netherlands. The Central Planning Bureau (CPB) has concluded that Dutch commercial R&D costs are high compared with those of other countries. The Netherlands is not, therefore, in a good competitive position[31]. Moreover, local sources of knowledge no longer seem able to meet demand for technological know-how[32].

Although the total knowledge output of the big five has shrunk less than the drop in their Dutch R&D spending would suggest, R&D outsourcing as such is coupled with a loss of specialised jobs

27 For every 100,000 inhabitants, the Netherlands has almost 90 scientific publications. This is a similar number to the United Kingdom and the US, and substantially more than France and Germany (around 60). Among the OECD leaders, Sweden scores highest with more than 120 scientific publications per 100,000 inhabitants. Source: MERIT. Data: ISI.

28 European Report on Science and technology Indicators 1994, European Commission 1994.

29 Netherlands Science and Technology Observatory, Chapter 4.4, CWTS/MERIT, 1994.

30 MERIT, STEMMING 2, Maastricht, 1995.

31 B. Minne, op cit, pages 48-51.

32 G. Duysters and B. Verspagen: 'Internationalisation of technological activities', ESB 21-9-1994. The authors recommend the establishment of specialised research institutes in one or two areas.

at home. This may also have negative effects on the quality of the Dutch research and training system[33].

As mentioned earlier, the impact of globalisation is also being felt in R&D. This affects almost all OECD member states: the share of foreign-funded R&D is growing. The trend is particularly marked in the EU countries, where the percentage of commercial R&D financed by other countries climbed from around 5% in 1981 to almost 8% in 1991.

The Netherlands represents an exception. Here, the proportion of R&D financed by other countries is decreasing (from 8.2% in 1981 to 2.4% in 1991), and now stands at less than half the average for the EU as a whole[34]. This could suggest that the Dutch R&D climate is regarded as relatively unfavourable: existing private sector R&D is shifting elsewhere, while the amount of incoming R&D is shrinking[35].

Although the globalisation process is having a less than positive impact on the R&D sector, the international orientation of our knowledge networks is growing. Researchers have always focused on the international (scientific) forum. These ties remain very significant, particularly in basic and strategic research. This is why it is important that Dutch researchers are widely published and quoted.

Cooperation in foreign research projects and programmes is growing in the public research and education system. This is illustrated partly by the rise in income from foreign institutions. The foreign earnings of TNO and the GTIs doubled between 1984 and 1993, to approximately NLG 200 million (from 11% to 17% of turnover). In practically all areas of science, the proportion of publications with foreign co-authors has increased dramatically in recent years. As a result, Dutch industry is gaining access to international developments in knowledge and to the international stock of knowledge. International cooperation also makes high demands for the quality of Dutch contributions, and this has a knock-on effect on domestic activities.

4.5 Increasing knowledge through networks

Companies are becoming less and less able to develop all the know-how they need themselves. This is firstly because of the accelerating pace of technological development.
Not even the largest companies can predict all the changes and anticipate them in time. Perhaps even more importantly, technological changes are becoming increasingly complex. A growing number of interesting applications are being developed on the borderlines between different areas of science and technology, demanding interaction between companies from branches which previously had almost no contact. The expertise required for successful innovation can no longer always be found within a single company. As a result, the costs of developing know-how are rising, along with the risks. They will increasingly outstrip the resources of individual companies.

Companies therefore have to look for ways of working together. This has been recognised and accepted for some time. Now, however, companies are not only seeking commercial alliances, but are also increasingly developing know-how in partnerships with universities and (semi) public research institutes. Successful cooperation calls for mutual gain ('win-win situations'). For the universities, the benefits can be found in challenging new themes for scientific research, a better match between education and the labour market and (partly because of this), in further strengthening of their role in society and wider access to research

33 See SER/CED: 'Knowledge and Economics', page 53, The Hague, 1995.

34 OECD, Main Science and Technology Indicators, 1994/2, Table 16.

35 An analysis of the choice of international locations by US and Japanese commercial activities similarly shows that the Netherlands is more attractive for other types of business activity than for R&D. Out of the 45 new US and Japanese R&D labs in Western Europe, the Netherlands was able to attract only 5; in terms of the R&D employment associated with these labs, the Netherlands' share was even lower (Buck Consultants International: 'Foreign investment in Western Europe: a market analysis', Nijmegen, 1995). The Dutch share in new head offices, distribution centres and 'call centres' is much higher.

funding. For the (semi) public applied research institutes, working for external agencies is a matter of survival.

A good example of cooperation between companies and research institutes is the partnership between the University of Twente's Biomedical Technology Institute (BMTI) and industry. BMTI conducts research into products and systems at the leading edge of medical, chemical and engineering technology. Some of this work is carried out in joint research projects with companies such as Akzo Nobel, Medtronics, Philips Medical Systems, Cordis, NPBI, Oldelft, etc. Around 40% of BMTI's total budget already comes from non-university sources.

What is the position as regards interaction between the Dutch research and education system and industry? We can answer this by examining the extent to which companies are prepared to make a financial contribution to R&D conducted by higher education institutes and the (semi) public sector research centres. This will give an indication of how well R&D conducted by research institutes meets industrial knowledge requirements. We then go on to examine more qualitative developments.

Between 1980 and 1992, universities trebled their income from private contract research, which now takes up about a quarter of their research capacity. Companies account for a fairly small proportion of this (about 20% of total external income), amounting to some NLG 120 million. This means that companies fund between 4 and 5% of university research[36].

Research conducted by (semi) public institutes plays an important role in the Netherlands, Germany, France and the UK. In the Netherlands, companies account for a relatively large share of the R&D carried out by these institutes. The growing importance of interaction is also evident in this sector, since - based on data provided by the institutes themselves - contract research for industry has grown in recent years. In 1993, companies accounted for around NLG 350 million (over 30%) of the total turnover of TNO and the GTIs. MARIN, WL and GD were particularly successful in attracting private sector funding. A good example of improved interaction between public and private research was the transformation of the Maritime Research Coordination Foundation (CMO) into the National Institute for Maritime Research (NIM), making maritime research far more strongly market-driven.

Qualitative analyses show that comprehensive and differentiated relationship patterns have arisen in many areas.

The type of partnership chosen in practice depends on many different factors, including the relevant area of science and technology (such as pharmaceuticals or construction engineering), the existing research system, the intermediate structure, and the structure of the branch of industry involved. The dynamism of the latter structure is becoming an increasingly important factor[37].

The available data suggests an increase in cooperation between companies and research institutes. This forms a good basis for further efforts to improve and expand interaction between know-how suppliers and customers. However, various problem areas can be identified, suggesting that better cooperation is fairly essential. Although private sector funding of R&D in higher education and (semi) public research institutes has grown since the 1980s, this growth has been levelling off in recent years. Even now, only one in seven companies conducting R&D collaborates with higher education institutes or TNO[38]. The private sector, and the largest and smallest companies in

36 However, this figure is not backed up by the OECD statistics (which give a percentage of 1.5%). The OECD figure is based on data supplied by companies. Obviously the figures relating to contract research carried out by the universities on behalf of companies are affected by considerable statistical disparity, so that international comparisons are not possible.

37 Forum for Science and Technology, 'Towards improved application of knowledge in industry'.

38 A.H. Kleinknecht, J.O.N. Reijnen, J.J. Verweij: 'Collaboration in R&D', SEO, February 1991.

Varied examples of this include the aviation sector, the dredging industry and agriculture. The aviation sector involves a single, highly knowledge-intensive company which is part of a knowledge cluster consisting of a single faculty, one GTI and a single specialised training course at higher and intermediate vocational level. Cooperation is very close, with the Netherlands Agency for Aerospace Programmes (NIVR) playing a key role as a financing and programming body.
Dredging companies usually have a high level of know-how (particularly in terms of accumulated experience). Individual companies conduct some research themselves, but most of it is jointly contracted out, mainly to the WL and GD. Partly because of this, Dutch dredging companies are very competitive on an international level.
The agriculture sector has always had an extensive research, information and education network. The network includes many agricultural employers' organisations and extends to the level of individual farmers. In the recent policy paper entitled 'Dynamism and Innovation', the Minister of Agriculture, Nature Management and Fisheries re-emphasised the importance of knowledge networks.

particular, have a no more than modest opinion of the quality of the non-profit research institutes[39]. If we are to further strengthen cooperation between companies and research institutes, and give it a more structural character, we must remove these bottlenecks. The existing cultural differences between the aims of companies and research institutes will have to be taken into account here.

There is every need for improvement and expansion. The positive picture should not be allowed to conceal the obstacles to more extensive cooperation. The main reasons for a vigorous effort to realise this are the rapidly changing economic structures and the importance of scientific and technological know-how for the long-term Dutch position in these structures. To improve cooperation, companies must clearly define their short and longer term needs, while the research and education system must be open to, and answer these needs.

Sustainable networks will require far more systematic and strategic forms of cooperation than have so far been the norm. Large companies can generally create and maintain such networks, and clearly define the requirements, themes and areas which are important to them. For small(er) businesses, particularly those that work with established technologies, this is often not the case. Firstly, these companies have great difficulty in formulating their knowledge needs, and once they do, they find it hard to track down and tap the right sources of knowledge. Even if they succeed, applying and implementing the knowledge is no easy matter. These companies are therefore heavily dependent on the available network.

The government has focused considerable attention on this issue in recent years, partly in the form of intermediate organisations such as the Innovation Centres (ICs) and the Branch Centres for Technology (BCTs). Although a great deal of progress has been made, contacts with research institutes are not yet as good as they could be. Moreover, the vocational training system still needs to establish and strengthen its position in this network.

International cooperation

Cooperation in innovation goes beyond national borders. So far, however, Dutch companies have proved somewhat reluctant to work with foreign partners in R&D projects. In 1992, 600 Dutch companies said they had carried out an R&D project in collaboration with a European partner, 100 of them through the EU Framework Programme. There is significantly less cooperation with partners in the US or Japan. Over the years, 300 companies have taken part in international projects organised as part of the

39 Bureau Bartels, 'R&D Networks of Dutch Businesses', March 1994.

EU Framework Programme at least once. This participation has been concentrated in 4 of the 14 programmes. Very few companies take part in the other programmes. Business participation in international projects accounts for 26% of total alliances, which puts the Netherlands below the European average of 35%[40].

In addition to the EU Framework Programme, the Netherlands also plays an active role in the Eureka Programme, ranking third among the Eureka Member States in terms of participation. There are currently 22 Eureka Member States (with Poland and the Czech Republic due for entry in June).

4.6 Knowledge in people

Ultimately, knowledge lies in people. Without knowledge on the shop floor, new technological innovations cannot be designed, developed or applied. Similarly, the application of foreign technologies, or of know-how acquired in the form of embodied technology, requires knowledge and expertise.

The rise of the south-east Asian countries is also reflected in a dramatic increase in R&D-personnel. In 1970, approximately 13,000 people in South Korea were working in R&D. By 1991, the figure had increased fourteen-fold, to 132,000. This is equivalent to about 70 R&D-employees for every 10,000 members of the working population[42]. The number of R&D-personnel in Taiwan doubled within 10 years, to almost 78,000 in 1992; equivalent to 89 R&D-employees for every 10,000 members of the working population. This compares with only 49 in 1983[43].

The increasing importance of knowledge in the Western economies is reflected in the average standard of education of the working population, and in the growing number of R&D-personnel (researchers, technicians and support staff). However, the Netherlands goes against the general trend for R&D-personnel. In 1970, there were 113 R&D-employees for every 10,000 members of the working population (a high proportion at the time). By 1992 the level had fallen to just 93. This compares with a current total of between 120 and 145 in the top-ranking OECD countries[41].

A substantial rise in the Dutch knowledge-intensity calls for a working population capable of realising this. It is one thing to expand knowledge through investment, alone or together with others, or by purchasing it, but 'human capital' is needed to apply it. This applies across the board, both to university graduates and to those with secondary and higher vocational training qualifications. All these people will need to acquire enough knowledge in the course of their education about how innovation in products and production processes is realised and its significance for companies. Consequently, the latest technical developments and their possible applications must receive attention in secondary and lower vocational training, aided by modern equipment.

The overall quality of the Dutch educational system is reasonably good. However, there are also problems. The match between some courses and private sector requirements needs to be strengthened, the availability and use of technical equipment in schools must be improved and there is an increasing shortage of people with scientific and technical qualifications[44]. The latter point is a particular problem in higher education. Recent research has shown that in the future, there will be too few people with technical training available to meet industrial demand. Shortages of mathematics and natural science graduates are expected to reach between 500 and 1,100 in as little as five years time.

40 SEO: 'Innovation in Dutch industry and services', 1994; MERIT: 'Dutch participation in the European Framework Programmes 1988-1994', 1995. European Report on Science and Technology Indicators 1994, European Commission, 1994.

41 OECD, EAS (STIU) database. The number of R&D employees is shown in Full Time Equivalents (FTEs).

42 Korea Industrial Technology Association: Major Indicators of Industrial Technology, Seoul, 1993. Chapter 3.2 and Appendix 1. The number of R&D employees in terms of FTEs is not known.

43 National Science Council: 'Indicators of Science & Technology', Republic of China, Taipei 1994. Chapter III, tables 1-14 and 1-15. The total number of R&D employees in terms of FTEs is not known, but is thought to be about 70% of the number of R&D employees in persons.

44 SER/CED, "Knowledge and Economy", The Hague, 1995.

The shortage of construction and civil engineering graduates will be between 1,400 and 2,800, and that of construction and civil engineers with higher vocational training qualifications between 1,600 and 3,300[45].

This means that the number of graduates from higher vocational training courses in construction and civil engineering will have to rise between 30 and 60% in order to meet demand.

Education and industry have been trying to improve the match between education and the labour market, partly in response to the recommendations of the Rauwenhoff[46] and Van Veen Commissions[47]. One example of these efforts was the establishment of a qualifications structure for secondary vocational education and the apprenticeship system. This makes the training system more transparent, leads to vocational qualifications that are recognised in branches of industry and improves labour market entry.

Similar trends are found in higher vocational training. Reclassification of courses has improved transparency and the qualitative match between education and the labour market. One of the next steps will be the creation of core qualifications and final grades for technical training at institutes of higher vocational education. In universities, the curricula for technical courses are being planned in cooperation with industry.

The foundations have been laid, but further improvements can and must be realised. This certainly applies in the technology-sensitive sectors, where the steadily shrinking innovation cycle calls for high standards of training and, therefore, of the training environments provided by educational institutions.

Educational institutions cannot keep on buying the latest equipment, because of the costs involved. Although substantial investments have been made in new equipment in recent years, there is certainly still a need for upgrading. To meet the increasingly high standards, capacity utilisation of equipment must be substantially increased. This can only be achieved by intensive collaboration between education and training institutes.

Intake into the apprenticeship system has shown a marked decline in recent years. The system, combining regular education with practical training, is a large source of skilled labour for SMEs. The falling intake numbers will therefore ultimately result in a shortage of skilled workers in the SME sector.

4.7 Conclusions

The Netherlands is losing ground to other countries. Our R&D position in universities and the (semi) public sector is good. Although co-financing of public R&D by companies has increased in recent years, the growth is now levelling off.
In order to further strengthen this cooperation and to give it a more structural character, a number of problems will need to be solved.

Important improvements are needed in the themes and areas in which the public knowledge system is working.
They must be far more closely geared to research that is directly relevant to industrial competitiveness. Companies will therefore have to define their needs more clearly and the research and training system must become open to those needs.

Companies themselves are performing less R&D in the Netherlands, reflecting the general decline

45 ROA: 'Report on Labour Market Trends for Employees with Technological Skills', Maastricht, 1994.

46 'Training for the labour market: towards a workable system'. Report by the temporary advisory committee on education and the labour market, Alphen aan de Rijn, Samsom Tjeenk Willink, 1990.

47 'Vocational training by different paths'. Report of the Dualisation Committee.

in our investments in knowledge. There is a tendency among large companies to transfer R&D abroad. Coupled with the deficit in our technological balance of payments, this indicates increasing dependence on other countries. At the same time, we are not attracting enough advanced research into the country.

Medium-sized companies still compete too much on the basis of cost rather than know-how. Businesses must increase the embodied know-how of their products and processes. Small businesses must increasingly act as high-grade suppliers for major companies. Through growing investments in knowledge, existing small businesses must make the switch from serving as 'jobbers' to acting as 'co-makers'. New business activities must also be stimulated in sectors showing strong economic growth (innovative new businesses).

In education, the quantitative and qualitative match between research and the needs of businesses needs more attention on a permanent basis; collaboration between research institutes and companies must be improved. Research institutes must work together more often to use advanced equipment more efficiently. An ongoing point of concern is the decline in the number of technical students: a growing shortage of labour with technical skills threatens in the future.

In short, at a time when an economy like ours should be increasing its knowledge-intensity at full stretch, we are actually seeing it decline. If we are to achieve the many ambitions we have set ourselves, we cannot allow this to happen. The Cabinet's response to this need is broadly outlined in the next section.

5 Outline of government policy

The Netherlands must vastly improve its performance in the field of knowledge. Clearly, this puts a heavy responsibility on industry itself. The government cannot and has no wish to take over the role of companies in modernising products and production processes. Yet it shares a considerable responsibility for knowledge and technology, since the generation and application of knowledge has a positive effect on welfare and prosperity. Without government intervention, some of this knowledge would not be generated and society would not enjoy the benefits. Moreover, the government often plays a decisive role in the supply of knowledge developed in public sector research institutes. It is therefore responsible for ensuring that this knowledge can be used to the full for the benefit of society as a whole. Finally, the government must take account of the actions of other nations. Governments the world over are working to create favourable conditions for commercial activity, especially in the fields of know-how and technology. Not only companies, but also governments are competing to create the best possible climate to attract advanced, knowledge-intensive activities. The Dutch government must keep up with this policy-based competition.

We will ultimately have to pay the price for an economy which fails to perform adequately in the field of knowledge and know-how. Not today, and perhaps not even tomorrow. Yet the final reckoning is inevitable and, given the acceleration in worldwide technological developments, will come sooner than in the past. It would be a great mistake on our part if we were to be lulled into a false sense of security by short term economic developments.

The Dutch economy is lagging seriously behind in terms of knowledge and technology. To even reach the OECD average, we would need to invest more than NLG 2.5 billion extra in R&D each year. Levels of R&D spending in leading industrialised nations such as Germany and Japan are well above the average. To catch up with these countries, the Netherlands would need to invest over NLG 5 billion extra per year.

The Cabinet is extremely concerned about the weakness of the Dutch economy in this respect. It is therefore taking specific measures in this field, in addition to the more general measures mentioned earlier.
The amounts cited in this strategy document and in the appendices are indicative. They will become more precise and fixed during the decision-making proces on the 1996 budget.

As a first step, the Ministers of Economic Affairs, of Education, Culture and Science and of Agriculture, Nature Management and Fisheries will be joining forces to devise a more integrated approach to the problem. Further measures will target specific areas, in collaboration with the Ministers of Transport and Public Works, of Public Health, Welfare and Sport, of Defence and of Housing, Physical Planning and the Environment.

The Cabinet cannot solve the problems alone. Industry therefore needs to invest far more in the development and application of know-how. Together with the government, it will have to make choices to ensure the best possible deployment of public resources. Only with the commitment of all parties can we allocate our limited resources to benefit the Dutch economy to the full.

The Cabinet wants to encourage industry to play an important role in the design and planning of vocational training, while preserving its broad societal aims. The private sector influence will entail commitments for the education system and for companies themselves. Industry can influence educational qualifications, but the relationship is not one-sided. There is interaction between education and business, as education and those who benefit from it make an important contribution to the development of the technological professions.

The Cabinet also wishes to substantially increase the influence of companies on research institutes, through both programming and financing mechanisms. It plans to modify the existing instruments for promoting cooperation between companies, and between companies and research institutes. As a result, companies must not only define their current knowledge requirements but must also develop a clear idea of the knowledge they will need in the longer term. And of course, they must share this outlook with educational and research institutes, and both sides must commit themselves to the choices made.

Finally, the Cabinet wishes to ensure maximum benefit from the development of new technologies with promising applications, such as communications and information technology. The development and application of environmental technology should be given an extra boost, in order reconcile economic and ecological interests more closely.

The government measures proposed in this strategy document depend on a public-private joint effort. It is extremely important that industry rise fully to the challenge. Only then will this package of measures mark a fundamental and significant step in the right direction. The Cabinet is therefore working to ensure that a substantial proportion of the proposed projects are (co)financed by the private sector; in some cases, this co-financing can exceed 50%.

Yet we cannot responsibly achieve everything in a single stroke. The knowledge factor will need to remain high on the agenda of both the government and especially industry in the coming years. The package of measures proposed here must act as a flywheel in generating an increase in R&D expenditure by industry. The recent recovery in private sector profits opens the way for this. Over the next few years, the effects of the policy described here will be tested. On the basis of this, new decisions may be needed on the additional deployment of resources and how these investments should be targeted. However, the solution of the knowledge question is not just a matter of more money. It is equally important to ensure more effective and efficient use of the existing research and education system, through improved cooperation and more effective guidance mechanisms. It is vital that industry, the research system and the government combine their efforts to reverse the negative trend in the field of knowledge in the Netherlands. The measures which the Cabinet is now proposing are an important basic step in this direction. These proposals are discussed in more detail in the following sections.

6 Basis for innovation

The following proposals are made in this section:

- *The WBSO budget will be increased structurally by NLG 100 million.*
- *Application procedures for preliminary studies and small loans under the TOK will be simplified.*
- *The government will provide additional support for new businesses set up to market high-technology products.*
- *Regulations governing the depreciation of innovative technology transferred to the Netherlands will be relaxed.*
- *Existing duplications in the knowledge system will be eliminated (in consultation with the institutes involved).*
- *NLG 55 million a year will be made available for a number of leading technological institutes.*
- *The independence of research institutes to dictate terms of employment will be increased.*
- *The efficiency and effectiveness of existing flows of funding for vocational education, training and company training schemes will be increased.*
- *A 'Technology and Vocational Education Innovation Fund' will be established, with an annual budget of NLG 15 million.*
- *Fiscal incentives will be introduced to stimulate employment of apprentices and research assistants.*

6.1 More investment in R&D

Part 4 showed that if the Netherlands is to achieve its ambitions it must at least increase its investments in R&D. The government's science, industrial and technology policy is geared towards creating better conditions for higher investment.

We must substantially increase both the level of private sector spending on R&D and the number of companies conducting research. If we are even to reach the average level of OECD investments, we will need to make an additional investment in R&D of almost 2.5 billion guilders a year; and if we are to catch up with the leading OECD countries, our additional investment will have to be increased by as much as NLG 5 billion. A substantial proportion of the necessary increase in investment must come from the private sector itself. After all, it is here that most of the expected return on these investments will be realised. To increase levels of knowledge within industry, it is worth expanding the number of companies performing R&D. One of the ways in which this can be achieved is if small and medium-sized companies which are currently technology-driven are encouraged to conduct or contract out research. We must also establish or attract more knowledge-intensive companies with a higher value added.

Technological progress is also of major importance for a sustainable economy. Investment in a knowledge-intensive society implies greater sustainability. This is not a matter of public investment alone. An evaluation of the Ministry of Economic Affairs' instruments showed that the R&D investments they stimulate do make a genuine contribution to the development of a more sustainable economy.

After all, motives such as cost savings through more efficient use of energy and raw materials play a key role in the development of new technologies. Thanks to the efforts of government and industry in this area in recent years, Dutch industry has won a leading international position in some environmental technology fields.

The Ministry of Economic Affairs has now taken initiatives to further strengthen the Dutch position in environmental technology exports. These efforts focus on specific areas, and on the supply of turnkey projects by partnerships[48].

To further encourage industry to conduct or contract out research, the government will extend the Act to promote Research and Development (WBSO). The proposed reduction in the burden on SMEs of NLG 500 million, which was set down in the government coalition agreement, also provides for an additional NLG 100 million for the WBSO budget. This will be applied to enlarge the first R&D tax bracket and to increase the percentage allowance of that first bracket. Tax allowances for the self-employed who perform their own R&D will also be increased. In 1994, more than 5,500 applications were submitted for WBSO allowances, some 75% by SMEs; in 1995, more than 8,000 applications are expected.

After a year's experience in implementing the WBSO scheme, the conclusion is that it is highly accessible and user-friendly. Incidentally, it appears that the proportion of software-related applications made under the scheme is not an accurate reflection of the potential within the market. The evaluation of the WBSO, which will be completed by the end of 1995, will therefore also examine ways to further increase the attractiveness of the scheme for these types of application.

To further increase the accessibility of Technical Development Loans (TOK) for SMEs, the application procedures for small loans and for a preliminary study for a loan will be simplified. Because technology start-up companies find it more difficult than ordinary start-up companies to access the capital market, the start-up of high-level technology companies will be given additional support by the Cabinet. These measures are more fully elaborated in the Ministry of Economic Affairs' policy paper 'Jobs Through Enterprise'.

To attract more knowledge-intensive companies to the Netherlands, the Cabinet will relax the depreciation regulations governing intangible assets transferred to the Netherlands. In relocating intangible assets, companies are highly influenced by the rate at which these assets depreciate when choosing which country to relocate to. More relaxed depreciation regulations will make the Netherlands more attractive to these companies. The Cabinet is setting aside NLG 50 million for this measure.

6.2 Transparent research system

The Government wishes to strengthen the influence of the demand-side on the knowledge infrastructure. However, this means at the very least keeping the innovative capacity of the knowledge infrastructure up to scratch, and where necessary expanding it. Responsibility for this rests with the government, whose task it is to maintain a consolidated system for conducting basic and strategic research. This will in turn act as a springboard for more applied research and university research and will give the Netherlands a point of contact with international scientific research. Another of the government's responsibilities is to create the basic conditions for an effective system for applied research.

48 'International markets with good prospects for Dutch environmental technology': ADL study commissioned by the Ministry of Economic Affairs, 1995.

To improve interaction between research institutes and companies (see next section), the research system must also be transparent so that companies know where to locate specific knowledge and experts. The government is to some extent responsible for this.

The mission statement of the various types of research institute should be used as a starting point to increase the transparency of the knowledge infrastructure[49]. Universities (including research schools) provide scientific education and perform basic and strategic research, as do the institutes for basic research. TNO, the Agricultural Research Department (DLO), the GTIs and other institutes perform applied research for industry and other sectors of society. Clear mission statements are not intended to ward off all competition, but mainly to underline complementary relationships. In a small knowledge-market such as the Netherlands, this helps to avoid inefficient competition and the ineffective deployment of (government) funds. In areas where synergies can be further encouraged, the Cabinet will, in consultation with the research institutes, take measures to further increase the efficiency and effectiveness of the research system, beginning with telematics, energy, geo-sciences and working conditions.

The government is also preparing to submit a request for advice to the AWT on coordination and cooperation between the different parts of the knowledge infrastructure. This advice will need to take account of the limited public resources available, the opportunities for collaboration and of risks such as improper and inefficient competition.

Knowledge Centres

In its recommendations, the TNO-Industry Commission states that TNO can challenge the universities to a more intensive cooperation by directing part of its basic funding to the universities in the context of strategic collaborative partnerships. The Netherlands Organisation for Scientific Research (NWO) could also make a financial contribution to this initiative.

The Cabinet standpoint on TNO's Strategic Report states that the Cabinet will adopt this recommendation and that the universities must play a more active role. This will help to further develop TNO's activities in this area. The Minister of Education, Culture and Science is currently holding discussions with the Technical Universities and TNO on how they can coordinate their financial and policy priorities to bring about the establishment of technological knowledge centres in collaboration with industry.
This will also be discussed with the GTIs, and the possibility of making broader use of GTI facilities for scientific and technological purposes will be considered.

The Minister of Agriculture, Nature Management and Fisheries will vigorously promote closer cooperation between agricultural research institutes and the general research system. This involves varying forms of cooperation in specific fields.

Leading Technological Institutes

Leading research in areas that are important to strong, R&D-intensive sectors in the Netherlands is making new demands on our research system. The companies involved are increasingly getting their knowledge from abroad. The Cabinet will therefore be establishing 'Leading Technological Institutes' focusing on a limited number of specific themes of potential international importance (making use wherever possible of existing strengths in our knowledge infrastructure). Companies can then contract out their basic strategic research

49 Which is established by law in some cases (universities, TNO, NWO).

needs to these institutes. The government will be making available a structural budget of NLG 55 million for this project.

These Leading Technological Institutes will satisfy a number of criteria. They will be recognisable institutes that are centrally managed, or, if desirable, concentrated in a single location. This will encourage a concentration of specific expertise in the knowledge landscape. Each institute will focus on a single cohesive area of basic-strategic research; an area that will have been selected in close cooperation with knowledge-intensive companies. They will employ leading international researchers and be given top quality equipment, and this should exercise a strong attraction for knowledge-intensive companies and top international researchers. The institutes will include an educational component in the form of PhD theses and design courses (under the supervision of university professors).

Flexibility and interdisciplinary activities will be key features of research work. To guarantee a match between the activities conducted at these institutes and industrial demand, substantial commitments will be expected from the companies involved, both in terms of funding and active involvement in the running of the institutes. The government will provide support in the form of long term basic funding. Regular monitoring will guarantee quality and flexibility, and will also help to decide whether or not to continue funding for the next five years. At present, the government is working with industry to select topics and themes around which Leading Technological Institutes should be established. The first Leading Technological Institute will be opened in 1996.

Boundary Conditions

There are various cultural differences between universities and industry which are linked to the functional differences in their aims.
Many researchers are more interested in basic and strategic research, and in the scientific merits of the work they do, than in its applications. Yet in the Netherlands as in other countries, interest in potential applications is gradually increasing among basic and strategic researchers. In fact, existing cultural differences are already frequently reconciled in the daily practice of interaction between companies and research institutes. This process can be accelerated through wider use of the `utilisation criterion' (potential applications beyond an individual specialist area) in addition to quality evaluation, as is successfully shown by the Technical Sciences Foundation (STW). This will increase attention to, and appreciation of the social and economic importance of scientific research.

However, the field of research will need to provide openings for this initiative. Practical criteria for the `social applicability' of scientific research, to be differentiated for each sector, will therefore be developed by a working party representing various bodies concerned with quality care and quality assessment. These criteria will then be introduced into the regular assessment of research.

It is extremely important for research institutes to be able to attract leading researchers and to be able to respond flexibly to external challenges. These aims have traditionally been part of the policy of the Minister of Education, Culture and Science, including with regard to conditions of employment. Research Institutes are increasingly taking their own responsibility for their personnel and employment policy. Yet further steps are needed, as indicated, for example, in the 1994 Higher Education and

Research Plan. The Minister of Education, Culture and Science will therefore be pursuing his policy to strengthen the independence of the Institutes, including the field of employment conditions, so as to increase their opportunities for integrated management.

6.3 An adequate supply of technical specialists

One of the basic conditions for a first-class economy is a first-class working population. It is the critical success factor in the application of knowledge, especially for technology-driven companies. It is therefore no coincidence that efforts to achieve a qualitative and quantitative match between education and the labour market have been a mainstay of policy for many years. A great deal has been achieved, but the work of improving education is never finished. We are always having to ask ourselves: are we training enough people, are we training them adequately and are we training them efficiently? We will therefore be examining whether our ambitions for vocational education can be achieved by introducing and further expanding market elements within the educational system.

The quantitative supply of labour with vocational qualifications must be brought into line with demand over the next few years. The apprenticeship system and the supply of graduates with technical training require particular attention. The apprenticeship system will be stimulated through additional tax incentives. In an effort to halt the decline in apprenticeships, the government is preparing a scheme which will reduce wage costs for apprentices with recognised contracts through cuts in wage taxes. A similar scheme is being prepared for PhD students or designers conducting doctoral research together with companies.

Vocational education must strengthen its position in the knowledge system over the next few years. The Ministry of Education, Culture and Science will be setting aside additional funds for this purpose over the next four years. The 1995-1999 Policy Agenda on Secondary Vocational Education proposes an innovation fund - BVE 2000 - in which NLG 70 million will be made available between 1995 and 1998. This budget will be spent on projects that are co-financed with schools, industry and other parties.

The Higher Vocational Education Innovation Fund (approximately NLG 70 million) is available for higher vocational education during the period 1994-1998. Colleges of Higher Vocational Education can apply for a grant from the fund for innovation projects which are being carried out in conjunction with industry (reflected in the form of co-financing).

It is difficult to devise general measures to increase the number of graduate technical specialists, since analyses at macro level suggest few points of application for policy. The problems facing this sector are highly specific, and there are wide differences between each discipline. Moreover, no policy measures are likely to have much effect while (as suggested by a recent Organisation for Strategic Labour Markets (OSA)[50] analysis) the salaries of technical specialists lag so far behind those of other employees with comparable qualifications. Herein lies an important responsibility for the social partners.

Existing vocational education, training and business training systems must be more effectively utilised and coordinated. Better use of existing facilities, including equipment, can be realised through better coordination of financial flows. This will lead to considerable savings, creating more opportunities to make timely investment in modern equipment. Together with the Ministry of Social Affairs and

50 OSA: 'Higher Education and the Labour Market', The Hague, 1994.

Employment, efforts are therefore being made to encourage cooperation between regular education and Vocational Training Centres (Employment Service) in order to enable an optimal deployment of equipment and other facilities.

New technological knowledge must be made to filter into vocational education more rapidly. The Ministries of Economic Affairs and of Education, Culture and Science are therefore devising a joint knowledge transfer programme to link planned investments in the research system with investments in vocational education. The government is setting up an 'Innovation Fund for Technology and Vocational Education' for this purpose, with a budget of NLG 15 million a year.
In developing this programme, priority will be given to linking vocational education with the areas being studied by the Leading Technological Institutes, with the Economy, Ecology and Technology (EET) Programme and with the electronic highways. Tying in with this last point, the government will be taking advantage of the development of the BVE network[51], which will be providing services for the BVE sector, to encourage industrial branches to make use of this information infrastructure in developing their training policy and their contacts with vocational education. In developing this programme, links may also be created with research stimulation programmes such as the Innovation-Oriented Research Programmes (IOPs) or forward-looking surveys (e.g. technology outlooks).

51 Internet connections between secondary vocational training schools will allow course material to be developed jointly and exchanged.

7 Matching supply and demand

The following proposals are made in this section:

- *the basic funding of TNO will be deployed in a more market-oriented way for the benefit of long-range research programmes. These programmes will specify which markets and (future) customers the research is aimed at.*
- *ECN will make a general assessment of a large proportion of its basic funding against the views of the parties involved.*
- *the share of the Ministry of Economic Affairs in the target financing of TNO will be used for programme financing, to which companies will be required to make a commitment.*
- *the target financing of ECN will be used for programme financing, with the involvement of market players as a condition.*
- *In the guidance and funding of agricultural research institutes, the Ministry of Agriculture, Nature Management and Fisheries will place greater emphasis on the creation of networks between these institutes and the private sector.*
- *the NWO will opt for a far more programmatic approach, focusing its basic-strategic research more on the construction and strengthening of the Netherlands' capacity for innovation.*
- *the Ministry of Economic Affairs' clustering policy will be broadened and institutionalised; a collaboration facility will be set up to absorb some of the existing instruments.*
- *The relevant stimulation instruments of the Ministry of Agriculture, Nature Management and Fisheries will be streamlined to form a framework scheme for innovative projects.*
- *the accessibility of the knowledge infrastructure for SMEs will be increased through the creation of new facilities and mobility programmes.*

As the analysis shows, collaboration on technological innovation projects is becoming an increasingly important way for companies to acquire knowledge. This involves collaboration with research institutes or with other companies, such as competitors, suppliers or contractors. It is the responsibility of the various parties involved to organise this collaboration. Yet partnerships do not get off the ground if neither party is willing to take the initiative. The government must therefore try to break through this deadlock by means of an active approach[52].

Better coordination between companies and research institutes will increase the dynamics of the knowledge infrastructure: research conducted by research institutes will be more demand-driven and the institutes themselves will be judged more on their market performance. This will substantially improve the (economic) yield of spending on public research.

The instruments of the Ministry of Economic Affairs will be geared more closely to stimulation of partnerships. This modification of the instruments in fact amounts to institutionalisation and expansion of the clustering policy.

7.1 Joint priorities in research themes

To ensure a better match of supply and demand between research institutes and companies, both sides must jointly decide which research themes should be given priority within public research. Institutions have already been set up for this purpose, at national level (OCV, see box), sector level (e.g. the NLRO) and at the level of individual areas of technology (Advisory

52 SER/SED, op cit, page 89.

Councils for the Technical Universities (TUs) and Research Schools, Platforms such as the recently established New Drugs Research Foundation, etc.).

The Consultative Committee for Exploratory Studies (OCV)

The OCV consists of influential figures from the scientific and business communities. The OCV applies three key concepts in its studies:

- Support structure: research that is needed for the training of researchers over a wide area.
- Core activities: research that is needed for the adequate functioning of profit and non-profit sectors.
- Social questions: research that is important for the quality of society as a whole.

Exploratory studies present the longer-term opportunities offered by research and define social and private sector demand for research. Using scenario analyses, the OCV develops options for science and technology policy, on the basis of which priorities can be set. It is not up to the OCV to select these options; that is the responsibility of government, the various interested parties, researchers and the organisations they represent. To increase the chances of implementation, the major research organisations are represented in the OCV. Companies and other social agents are closely involved in the survey to ensure a wide basis of support for its results.

It is important that a distinction between long term and short term objectives is maintained when priorities are set. The government and the private sector must continue to ensure that enough effort also goes into the realisation long term goals, such as sustainable economie.
It is therefore encouraging, partly because of the importance of attention to long-term objectives, that the Confederation of Netherlands Industry and Employers VNO-NCW and the Ministry of Economic Affairs, in cooperation with the Ministry of Education, Culture and Science, have recently started a study to identify private sector research needs. On the basis of this study, companies can set priorities for public research together with research institutes.

The joint identification of research themes is also extremely important for TNO and ECN in setting priorities for the build-up of long-term knowledge.
For this reason, the government will reorganise its basic funding for TNO and ECN, to ensure that the Ministers of Economic Affairs and of Education, Culture and Science also take account of the goals of a sustainable economy[53].

In its standpoint concerning TNO's Strategic Report, the Cabinet will adopt the advice of TNO-Industry Commission on this point. The deployment of basic funding will be linked to a long-range research programme for the development of knowledge, to be drawn up once every four years as part of TNO's Strategic Report.

This programme will specify the direction and content of the innovatory research, the objectives underlying TNO's build-up of knowledge in the medium to long term, and future markets and target groups (not only industry but also the government and other so cial groupings for which TNO conducts research). The programme must also anticipate trends in the strategic programmes which TNO will carries out with targeted funding. TNO will also clarify its relationship with the universities and other research institutes.

Every four years, the Minister of Education, Culture and Science will present his assessment of the integrated research programme, following consultation with his colleagues. Every year, he will give his approval to any changes in the programme in the light of developments within the relevant market, within the social sphere or

53 See also the AWT recommendations concerning the relationship between the government and the TNO, The Hague, April 1995.

within government policy. An assessment will also be carried out every four years to check whether TNO has met its basic funding objectives.

ECN will generally assess much of its basic funding in the light of the views of the parties that play a major role in long-term energy research: i.e. energy generation and distribution companies, the (supply) industry and energy consumers. The Ministry of Economic Affairs also operates as a market player by virtue of its responsibility for long term energy policy.

7.2 Joint investments in research

The chances of economic success are greatest if research is carried out in close cooperation between the researcher and the organisation or agency which eventually has to apply the results of that research. The government is trying in various ways to stimulate various types of collaboration in the field of research. To improve cooperation between (large) companies and the TUs, the government is currently working on a covenant (expected to be signed in September). This covenant will provide a framework for joint investments in research.

Similarly, the Agricultural University will consult business and public organisations more intensively, in order to realise an accurate definition of the problems in the agricultural sector and to promote co-financing of research.

Programme-based collaboration

Programme-based collaboration involves a long-range programme centred on a particular theme and covering a number of projects carried out by public and private researchers. The government is encouraging programme-based collaboration between research institutes and companies in various ways, e.g. through NWO incentive programmes, through Innovation-Oriented Research Programmes (IOPs) and through targeted funding of TNO and ECN.

NWO's task is to finance challenging long-term research in the universities. The scientific quality of this research is a prime factor. In its latest policy plan, NWO announced that as well as focusing on this aspect, it would also be devoting more attention to innovation for building and strengthening the Netherlands' innovative capacity. In doing so, it will be pursuing a more programmatic approach. Were possible and desirable, experts from industry will be included in programme committees when the programmes are being established and carried out. NWO will be setting aside NLG 50 million for this initiative over five years, partly to encourage collaboration with external financiers in strategic areas of research[54].

The covenant

The covenant between three TUs, major companies and the government must provide a framework for strengthening cooperation between universities (supply) and industry (demand). It will include the following commitments:

- the TUs and the companies will jointly designate priority areas in which they wish to strengthen cooperation.
- the TUs will allow industry to direct the content of part of the research under certain financial conditions.
- the companies will clearly define their research needs and will make a financial commitment in exchange for directing the content of research.
- the government will use its instruments partly for the benefit of cooperation programmes to be agreed in more detail.

Furthermore, NLG 7.5 million of the funds allocated to NWO by the Ministry of Education, Culture and Science for incentive programmes with other ministries will be set aside each year for programmes in areas that are relevant to

54 NWO Policy Paper entitled 'Enrichment through Enriched Knowledge', April 1995.

companies. The first programme to be awarded a grant from this fund will be the Incentive Programme on Materials Research, in which - in addition to a substantial grant from NWO - the Ministry of Economic Affairs is also making a financial contribution.

The `steering' of research at TNO and ECN will also become more strongly market-driven. For TNO, this will mean an adjustment of targeted funding from the Ministry of Economic Affairs. The Ministry will encourage companies to clearly define their knowledge requirements. Companies will establish long-term programmes together with TNO. These programmes will be assisted by the Ministry's targeted funding for TNO, which will thus be directed at programme financing. Companies will be required to make a financial or other form of commitment to these programmes. Their involvement will depend on the nature of the research and on the structure of the relevant market segment; the closer the research is to the market, the bigger the industrial contribution will be expected to be. This change in the way research is steered will further increase TNO's market focus, notably towards large companies. This change ties in with TNO's recent Strategy Report, stating that TNO wants to work more closely with major Dutch companies. The new situation will be planned in consultation with TNO.

In its new-style targeted financing programme, ECN will be responsible for `rooting' programmes (or clusters of projects) in collaborative associations with industry (including the energy sector). As in the current targeted financing programme, these programmes will be long-term programmes. In the short term, a system will be devised for an objective assessment of programmes submitted. The assessment criteria could include the degree of inherent and/or financial commitment by industry (including the energy sector) and the degree to which they are rooted in strategic collaborative associations.

In the agricultural research system, the Ministry of Agriculture, Nature Management and Fisheries will vigorously promote interaction between suppliers and users of knowledge. Forms of co-financing could be a useful aid here. The Ministry will place greater emphasis on result-financing in its guidance and financing of agricultural research institutes. However, the maintenance of an adequate research and training system remains an important principle. Where relevant, the various interested parties will be involved in designing programmes.

Project-based cooperation

In recent years, the Ministry of Economic Affairs has placed increasing emphasis on cooperation in the instruments it employs. This has led to the development of the `clustering policy': i.e. the policy of encouraging strategic cooperation between high-grade technology companies and the public research system. In 1994, 12 cluster projects were approved, and the parties concerned are now laying the foundations for long-term, programme-based collaboration. The PBTS also gave higher priority to collaborative projects.

Sections 3 and 4 showed that companies will need to collaborate more and more often if they are to acquire the knowledge they need. The Cabinet will therefore be focusing its business-oriented technology incentive schemes even more strongly on promoting networks (clusters) in the field of knowledge development. This will basically mean expanding its clustering policy.

Criteria for the clustering policy (extract from a letter to Parliament from the Minister of Economic Affairs, dated 20 December 1994)

Collaboration projects must satisfy six criteria to qualify for a grant:

- They must represent a new strategic collaboration in the field of R&D between at least one company with a 'steering' role and one research institute.
- They must develop or apply some form of advanced technology (in international terms).
- They must be of sufficient size
- In principle, they must be capable of influencing or involving other companies
- The research institute(s) involved must possess a solid foundation of knowledge
- The project must be technically and economically feasible.

The Ministry of Economic Affairs will be establishing a single instrument for technological cooperation. This instrument will replace the PBTS, the IT scheme, the TU scheme and the Group Business-Oriented Technological Research scheme (BTOC). It will not be specifically geared towards the knowledge requirements of a single type of company, but will encourage a broad range of collaborative associations in the field of basic, industrial and applied research. The purpose of this cooperation instrument is firstly to increase cooperation between businesses themselves, in a range of technology fields. Obviously, this can also involve projects designed to strengthen cooperation within a single product chain, in order to contribute towards integrated chain management. The second purpose of the instrument is to increase cooperation between the private sector and research institutes in a range of technology fields. This will also help to generate a broadly-based commitment by companies to choices relating to publicly-funded research.

55 See also the AWT recommendations 'Technology and the Economic Structure', The Hague, 1994.

This collaboration instrument will lead to the abandoning of the specific areas of technology currently covered by the PBTS/IT scheme[55]. The abandoning of these specific areas of technology also ties in with the trend towards multidisciplinary research. The new scheme will be implemented by Senter. It is incidentally possible that the content and size of some R&D projects will make them unsuitable for the cooperation instruments. In (exceptional) cases such as these, the Ministry of Economic Affairs could find scope in its budget for these projects.

This general collaboration instrument will be supported by targeted initiatives. For instance, partners will be brought together through e.g. theme meetings. The diffusion and application of knowledge will be encouraged in several ways. In this case, the technology-specific approach will be retained, e.g. in the field of software technology, so that targeted and flexible knowledge can be brought to the attention of potential target groups.

Strong incentives to form clusters within Dutch industry and the research system will arise if companies involved in a project with, e.g. TNO or DLO, also design programmes with those institutes. This will result in a more long-range collaboration and greater strategic cooperation between the parties. Given the nature of this type of research, it will in general be given a bigger government subsidy than projects. Within the energy programmes managed by the Netherlands Development Corporation for Energy and the Environment (NOVEM), efforts will also be made to further strengthen existing forms of cooperation.

As announced in 'Dynamism and Innovation', the relevant technology incentives of the Ministry of Agriculture, Nature Management and Fisheries will be streamlined as part of a framework regulation for innovative projects.

International cooperation

Networks between companies should not be interrupted by national borders, certainly not in a country like the Netherlands, which is so closely linked to international markets. The government encourages international cooperation through the Eureka Programme and the EU Framework Programme. The Framework Programme adds value to national policy by investing it with an international dimension. It strengthens the transparency of the internal research market through the joint setting of priorities, through the allocation of its budgets by international tender, and through its emphasis on the creation of cross-border consortia and networks. Participating companies and institutes are thus forced to focus their sights on the international arena and to allocate tasks along international lines.

The number of Dutch companies involved in the EU Framework Programme must be increased over the next three years from 300 to 500. With this in mind, the Netherlands has already successfully argued for more commercially-relevant research themes and shorter procedures during the planning of the current Fourth Framework Programme (1995-1998). At national level, the EC Liaison Bureau is working with the ICs, Senter, NOVEM and regional institutes to attract more companies to the programme. The implementation of international programmes carried out through Senter and the EC Liaison Bureau will be streamlined. Appropriate steps to this end will be taken in consultation with these organisations.

In the meantime, activities to encourage Dutch companies to take part in the Framework Programme will be strengthened. Dozens of companies are now being assisted to formulate projects and identify foreign partners. The success of this initiative will become visible after the EU has carried out its selection of research projects at the end of this year.

Over the next few years, the Netherlands will continue efforts to simplify procedures and realise closer coordination of European and national policy.

To avoid inefficiency, the European Commission is striving for closer coordination of research policy between individual Member States, and between the Member States and the Commission. The Netherlands is in favour of this in so far as it does not lead to increased bureaucracy or more top-down `steering' of commercial research. In the run-up to the Fifth Framework Programme, the Netherlands will continue to give priority to increasing the relevance of research to the needs of users, focusing more strongly on themes of European interest, including in relation to international environmental problems, and encouraging greater involvement by companies. This last aspect means that research themes must be formulated in a less detailed way. This will be discussed with the other EU Member States.

The main underlying principles of the Eureka Programme are market-orientation and the bottom-up principle. In other words, it must be left to companies and research institutes themselves to take initiatives. National governments do no more than play an enabling role; in the Netherlands, this role is fulfilled by Senter. The Ministry of Economic Affairs co-finances Dutch participants in the Eureka Programme through the TIP scheme.

Cooperation must not be confined to Europe alone. The opportunities for co-financing research projects which Dutch companies wish to launch in collaboration with a partner outside the Eureka Programme, for example in the US or in Asia, must therefore be extended. Support

could also be provided for projects consistent with international programmes such as the Climate Technology Initiative (OECD/IEA).

7.3 Better diffusion of knowledge

As indicated in Section 2, the competitiveness of the national economy depends on the quality of our networks and alliances. That makes our smaller suppliers, for example, more important than any numerical indicators could suggest. After all, in intensive network relationships, the competitive strength of the company doing the contracting out will depend on, among other things, the performance of its suppliers (who are often relatively small companies).

To improve the performance of these suppliers, it is important first of all to ensure that the general conditions under which these companies are operating are as good as possible. A substantial part of the savings made by reducing the tax burden on SMEs, as agreed in the government coalition agreement, should therefore be used to stimulate technology. In specific terms, this is the NLG 100 million increase in the WBSO budget mentioned earlier. One or two new instruments which could help to further upgrade (the top layer of) SMEs are also discussed below.

Smaller companies usually rely heavily on external sources of knowledge. Knowledge must be both accessible and it must be supplied in the correct form. Yet despite the many improvements that have been made over the years (ICs, BCTs, the `Specialists in SMEs' scheme (KIM), etc.), these two aspects still represent an overly weak link in the process of innovation.

Further improvements are geared towards increasing the transparency of the knowledge market, improving the link between research institutes and companies, supporting the application of new technologies in SMEs and increasing the mobility of technology specialists. Efforts are also being made to encourage local and regional authorities to include knowledge networks in their own policies.

TNO will join forces with the Innovation Centres to offer small enterprises wanting to make the transition from jobber to co-maker a total package containing the various elements needed for an upgrading of this kind.

This package will include not only technical support but also e.g. management support (quality and operating standards). The Ministry of Economic Affairs will co-finance an experiment in which several dozen companies will be screened for this initiative. If it is successful, it will be continued and hopefully used to help some 50 companies a year. ECN will also be doing more to target smaller companies, and has concluded a covenant to this effect with the network of Innovation Centres.

Wider application of new technologies in companies requires that they become better-informed about technologies that are relevant to them, and the costs and benefits involved their application. To meet this need, the Ministry of Economic Affairs will instigate a feasibility allowance. This allowance will apply to broad themes relevant to SMEs that follow technological developments, and will therefore be very easily available. It will apply to companies that are planning to apply existing technologies (and not - as in the TOK preliminary study - for those wanting to enter into technology development).

The knowledge market cannot be made more transparent without a good system for information on research. Information is needed

on the content of research, its results and specialist researchers. The government is therefore encouraging the use of the National Research Database. Agreements have been made with research institutes to improve the registration of information on research. Two pilot projects are also being carried out in response to suggestions by the Forum for Technology and Science concerning the National Strategic Knowledge Pool (NSK).

Knowledge is transferred mainly through people. The Ministry of Economic Affairs and the Ministry of Education, Culture and Science are therefore introducing activities to increase the mobility of technology specialists. These include the successful KIM scheme. The government is currently considering whether this scheme can be extended to cover specific research themes.

In order to improve diffusion of emerging technologies, the Ministry of Economic Affairs will continue its knowledge-dissemination activities. This could include support for initial practical applications and demonstration projects. Software is one example of an emerging technology.

The PROMOTIE Programme is a complementary initiative by the Cabinet to stimulate research in SMEs. This programme allows companies to take on research assistants in the context of doctoral research (four years) or technological design (two years) to work on a problem selected by the company (SME) and under the academic responsibility of the university. Half of the overall costs of hiring the research assistant (gross pay and overheads/infrastructure) are reimbursed. The STW will be consulted on the further development of this scheme and on selection.

For SMEs, knowledge-transfer and network creation often have a strong regional dimension. Hence the promotion of regional networks of companies, research institutes and intermediary organisations forms the main point of departure for technology policy at regional level. The provincial authorities are increasingly acknowledging the need and usefulness of having their own technology policy, and are responding to this need in highly practical and varied ways[56]. Municipalities are also focusing attention on the basic conditions for high quality research activity. Cities such as Zaanstad, Hengelo, Enschede and Tilburg are all now 'profiling' themselves as centres of industry.

The aim of the 'Technology Policy and Regions' project, launched in early 1994, is to stimulate and anchor the further development and expansion of technology policy within regions through workshops, research and other forms of information exchange. The AWT was asked to advise on the significance of regions for technology policy. Its report is expected in mid-1995.

56 Consultium: 'Technology policy in the regions: a survey', The Hague, 1994.

8. The goverment's role as indicator and initiator

This section presents the following proposals:

- ***interesting demonstration projects will be launched and further deregulation will be introduced to encourage the use of the electronic highway. A structural budget of NLG 70 million will be made available for this.***
- ***a research and development programme will be launched to stimulate technologies with a high environmental yield and promising market opportunities (NLG 45 million).***
- ***technology will be more firmly aimed at addressing social issues.***

The government has a responsibility to nurture developing technologies with a potential for (large-scale) applications which are being hampered by regulations or other obstacles.

This can be illustrated by one or two examples. Firstly, existing regulations sometimes hamper potential applications, as in the case of the interactive services on the electronic highway. Yet they can also sometimes give an additional boost to new technology (e.g. environmental technology) or they may be needed to make certain applications possible (biotechnology). Secondly, the government sometimes has to intervene when the application of new technologies involves risks which may initially exceed the scope of the market sector (as in the electronic highway).

Thirdly, the commercial benefits involved in developing and applying new technologies can sometimes lag behind the social benefits (again, in the case of environmental technology).

Ultimately, the government also operates in the knowledge market, as both a customer and supplier of knowledge and information. The government can and must make its own knowledge and information more accessible to businesses and other users. While this paper quite rightly emphasises knowledge-intensity in the private sector, the government must also consider whether knowledge-intensity in the public sector can be increased, to enable it to continue responding adequately to the complex problems it faces.

The government must encourage the application of these technologies through the creation of

favourable conditions and, where necessary, through investment, often in conjunction with other parties. This currently applies to the following areas:

- communications and information technology
- the creation of a sustainable economy with the help of technology
- technology for addressing social issues.

8.1 The electronic highway

The debate about globalisation and networks would never have arisen without the tumultuous developments in information technology. These developments have given many companies a worldwide choice of locations for different activities and partners (even on the other side of the globe, if required). The quality of the information infrastructure thus becomes a deciding factor in a country's economic potential. It is therefore not surprising that entrepreneurs cite the information infrastructure as one of the two most important factors in attracting businesses[57].
Growth percentages in the information sector (between 4 and 8%) far exceed the average growth of GDP in countries with highly-developed economies. In the US, this sector has proved to be one of the biggest job creators in the past 10 years. By 1998, turnover in the European multimedia market will have increased around ninefold compared with 1994. Employment prospects are also good, with forecasts of 2,200,000 jobs being created in the European audiovisual sector between now and the year 2000[58].

All this proves that the information sector is expanding into a major branch of the global economy. The need to achieve a greater knowledge intensity within the economy therefore goes hand in hand with the highest possible ambitions in the field of information infrastructure.

In an important area such as information technology, the Netherlands is in a good position compared to its neighbours in being able to attract a large proportion of the current and expected growth and employment. For instance, we provide a home to several large international information technology and telecom companies, and have a relatively strong audiovisual and publishing sector. We also have innovative software and telematics companies, plus a high cable density.

On the other hand, we also have a number of weaknesses. New service suppliers still have too little access to our telecommunication and media markets. Partly as a result, we charge relatively high rates and the quality of our advanced telecom services is often not as good as it should be.

In the information sector in particular, the Netherlands wants to be among the European front-runners in terms of economic growth and employment. We will therefore need a first-class infrastructure offering optimum access to new services. At the end of 1994, the Dutch government launched the National Action Programme on Electronic Highways, aimed at making the Netherlands one of the top three European providers of information technology. Work on implementing this programme started this year. The first task will be to increase the role of the market in the media and telecom sector. The government will also stimulate the development and application of electronic highways by promoting attractive demonstration projects in the private sector and projects in the public sector (the government as 'launching customer', service provider and supplier of information)[59]. The Action Programme mentions various possibilities for funding of its implementation. The progress report presented to the Second Chamber of Parliament on 3 May 1995 states that the

57 Healy & Barker's Survey: 'European real estate monitor 1990'.

58 Commission of the European Communities: 'Growth, competitiveness and employment. Towards the 21st Century: means and challenges', Page 129, EC 1993.

59 Parliament was informed about progress in carrying out the National Action Programme by letter of 3 May 1995.

Cabinet will review the possibilities for instruments that can be used to step up the necessary investments in services and infrastructure. The government is setting aside a structural budget of NLG 70 million for this programme. The government will also study the possibilities for fiscal incentives. The Second Chamber will be notified of the details shortly.

8.2 Economy, Ecology and Technology

Economic growth and environmental protection are two sides of the same coin. After all, welfare and prosperity determine the quality of our existence. The Cabinet is aware of the scope for tension between the interests of economic growth and environmental protection, and sees technology the key to harmonising the two. The development and application of new technologies is not only crucial for solving the pressing environmental problems we face, but also affords companies the opportunity to penetrate new markets.

Against this background, the government is launching the EET research and development programme, which aims to develop and apply technologies with a good chance of success, a high environmental yield and excellent market potential. The research system will also be strengthened by the expansion of existing environmental technology know-how. A budget of NLG 45 million will be allocated to this programme on a structural basis.

The EET programme will focus on technologies expected to yield economic and ecological results in the foreseeable future (5 to 10 years). The main themes will be: reducing industrial water consumption and industrial waste, environmentally-friendly product development and cutting traffic and transport emissions. Research will also focus on technologies which can be applied in the longer term (10 to 20 years): e.g. the use of sustainable raw materials and sustainable energy. Prospective surveys will be used to stimulate R&D in this area.

As far as possible, EET activities will exploit the existing strengths of the economic structure and research system, and will aim to realise genuine breakthroughs and concrete commercialisation. These goals can only be realised if companies join forces, both with other companies and with research institutes: in short, if they work for sustainable development through sustainable partnerships.

8.3 Addressing social issues

Knowledge can make a major contribution to resolving social issues, and thus provides the government with an important key resource in the public domain. Consequently, the government wants to make better use of technology to address social challenges. Technology affords important opportunities to meet social needs in areas such as crime control, health care, physical infrastructure and construction. For example, the government plans to make optimum use of the vast possibilities offered by the electronic highway. The 'new style cable', in particular, can be applied for purposes such as fire and burglar alarms, alerting emergency services and correspondence courses.

In the future, greater emphasis must be placed on the demand-side when developing and applying new technologies to address social issues. Over the next three years, some 10 'technology scans' will therefore be carried out in the public arena.
A fixed feature of these scans will be a survey of technological developments in the front line of the market sector, both in the Netherlands and abroad.

Based on the results of the scans, the existing Technology & Society Programme will be extended to include another 5 to 10 projects. These will incorporate the system of market surveys, strategic conferences, action plans and implementation programmes which, by then, will have been thoroughly tested. In practice, this approach has been shown to have an important synergetic effect, since in addition to achieving its primary goal (solving social problems), it also creates good opportunities for industry by promoting innovative capacity and creating promising new opportunities in often untried export markets.

In the context of its science policy, the government will continue to promote the development of technological and scientific knowledge in areas of public interest. Current examples include NWO's IT and Law Incentive Programme and the Soil Research Programme.

9 Knowledge in action

Patterns in knowledge flows are changing: that much is clear from today's trends. Industry is contracting out more research. Through partnerships, more parties are tapping knowledge sources, while interaction between companies and public research institutes is consolidating the overall knowledge flow. These trends must be strengthened. At the same time, knowledge flows must also start to move faster.

This is our aim. It calls for higher investments in knowledge and a higher return on our existing investments. Only then can we increase the knowledge-intensity of the Dutch economy. And only then will the economy realise a higher, more sustainable rate of growth.

This strategy document discusses measures designed to help achieve that growth rate. This is an ambitious but essential goal, which cannot be realised overnight. Knowledge will remain a priority factor in the years to come, not only for the government, but certainly also for industry. The government measures are designed to act as a driving force for the generation of private sector investment in R&D. The effects of the policy announced here will be tested in the coming years. This may mean that new decisions are needed on the application and allocation of additional resources.

Appendix 1 Financial review

The strategy document 'Knowledge in Action' outlines a broad range of vital measures designed to increase the knowledge-intensity of the Dutch economy. The government's investments are not intended to stand alone but are mainly designed to encourage third party investments. Fiscal measures are obviously primarily geared to achieving this, but other measures (such as cooperation incentive schemes and revenue from technology budget increases) will also be developed in such a way as to encourage significant co-financing.

The Cabinet has already outlined a number of ways to fund the proposed measures in the Coalition Agreement: that is, through an increase in the technology budget for Cluster III (as part of moves to strengthen the economic structure), through fiscal measures aimed at reducing the regulatory and financial burden on SMEs and through funds raised by the redistribution of VAT revenues. Further funding will be released through a re-evaluation of the instruments deployed by the various ministries.

The financial review (see over) lists the measures on a multi-year basis and indicates where funding originates. The amounts cited in this strategy document and in the appendices are indicative. They will become more precise and fixed during the decision-making process on the 1996 Budget.

For the record, the figures given should be read as 'expenditure' (on a cash basis). The strategy document, and consequently also this review, only lists new policy instruments and instruments involving a change in policy. It should not therefore be regarded as a comprehensive review of expenditure relating to technology. This latest review will be presented in the 1996 Budget, in accordance with standard practice.

Appendix 1, continued Financial review*

(NLG million)	Expenditure on a cash basis 1996	19997	1998	1999	source
Basic conditions					
More investment in R&D					
- Technology start-up companies	+pm	+pm	+pm	+pm	Regular EZ funding
- Extending WBSO (WBSO)					
- Relaxed depreciation on innovative technology transferred to the Netherlands	280	280	280	280	500 mln reduction in tax burden for SME's / redistribution of VAT revenues
Adequate supply of technical specialists					
- Tax incentives to stimulate apprenticeships social ensurance element	(270)	(270)	(270)	(270)	
- Tax incentives to stimulate PhD students	pm	pm	pm	pm	
Vocational Education Innovation Fund	5	5	10	15	Increasing technology budget - Cluster III
Leading Technological Institutes	10	20	35	55	Increasing technology budget - Cluster III
Strengthening match between supply and demand					
Programme-based cooperation					
- TNO basic funding: programmed application of resources	110	110	110	110	Regular OCW funding
- TNO target financing (EZ) used for programme financing	pm	pm	pm	50	Regular EZ funding
- ECN basic funding assessed by market players					
- ECN target financing for programme financing	56,8	54,4	54,4	54,4	Regular EZ funding
- NWO incentive programmes	7,5	7,5	7,5	7,5	Regular OCW funding
	+pm	+pm	+pm	+pm	
Project-based cooperation	20	pm	pm	129	Regular EZ funding
	pm	pm	100	100	Regular LNV funding
Better diffusion of knowledge	pm	pm	pm	pm	Regular EZ/OCW funding
Indicating and initiating					
- Electronic highway	5	15	45	70	Increasing technology budget - Cluster III
- Tax measures for electronic highway	pm	pm	pm	pm	reduction in tax burden
- Economy, Ecology, Technology	5	10	25	45	Increasing technology budget - Cluster III
- Addressing social issues	pm	pm	pm	pm	Regular EZ funding
- Total tax incentives	280	280	280	280	500 mln reduction in tax burden for SME's / redistribution of VAT revenues
-	+pm	+pm	+pm	+pm	reduction in tax burden
- Total increase in technology budget	25	50	115	185	Cluster III

** Will become more precise and fixed during the decision-making process on the 1996 Budget.*

Appendix 2 Abbreviations

AWT	Advisory Council for Science and Technology Policy
BCT	Branch Centres for Technology
BTIP	Business-Oriented Promotion of Technology in International Programmes
BTOC	Business-Oriented Technology Research by Collectivities
BVE	Vocational and Adult Education
CMO	Maritime Research Coordination Foundation
CPB	Central Planning Bureau
DLO	Agricultural Research Department
ECN	Netherlands Energy Research Foundation
EET programme	Economy, Ecology and Technology Programme
EMU	European Monetary Union
EPO	European Patent Office
EU	European Union
EZ	Ministry of Economic Affairs
GD	Delft Geotechnics Laboratory
GDP	Gross Domestic Product
GTIs	Large Technological Institutes
HBO	Higher Professional Education
HOOP	Higher Education and Research Plan
ICs	Innovation Centres
IOP	Innovation-Oriented Research Programmes
IT	Information Technology
KIM	'Specialists in SMEs' scheme
LNV	Ministry of Agriculture, Nature Conservation and Fisheries
MARIN	Netherlands Maritime Research Institute
MBO	Secondary Vocational Education
NAP	National Action Programme on Electronic Highways
NIM	National Institute for Maritime Research
NIVR	Netherlands Agency for Aerospace Programmes
NLR	National Aerospace Laboratory
NOVEM	Netherlands Development Corporation for Energy and the Environment
NWO	Netherlands Organisation for Scientific Research
OECD	Organisation for Economic Cooperation and Development
OCV	Consultative Committee for Exploratory Studies
OCW	Ministry of Education, Culture and Science
OSA	Organisation for Strategic Labour Markets
PBTS	Business-Oriented Technology Promotion Programme
R&D	Research and Development

SER/CED	Socio-Economic Council, Committee of Economic Experts
SMEs	Small and Medium-Sized Enterprises
SZW	Ministry of Social Affairs and Employment
TNO	Netherlands Organisation for Applied Scientific Research
TOK	Technological Development Credit
T&S programme	Technology and Society Programme
TUs	Technical Universities
V&W	Ministry of Transport, Public Works and Water Management
VW&S	Ministry of Health, Welfare and Sport
WBSO	Research and Development Act to promote
WL	Delft Hydraulics Laboratory