TECHNOPOLIS

Evaluation Leading Technological Institutes

FINAL REPORT

Geert van der Veen
Erik Arnold
Patries Boekholt
Jasper Deuten
Jan-Frens van Giessel
Marcel de Heide
Wieneke Vullings

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1 Introduction

The Dutch Ministry of Economic Affairs has assigned Technopolis to evaluate the Leading Technological Institutes (LTI) initiative. This initiative was launched in 1996 in order to 'strengthen the innovation potential and competitive position of Dutch Industry'[1]. 'The Netherlands' research infrastructure needs strengthening in the area of fundamental research, specific on research areas that are relevant for strong, R&D intensive sectors in the Netherlands. Therefore it is decided that LTIs will be realised with a potentially international appeal. The LTIs exist for a limited number of areas and make use of existing strength in the knowledge infrastructure. LTIs do contribute to the innovation potential and competitive strength of the Dutch business sector mainly with the results of strategic fundamental research and by providing excellently educated researchers.' [2] In other words, LTIs should have their effect by bridging the gap between the research in the (public) Knowledge Infrastructure (KIS) and the knowledge needs of Industry.

Four institutes were launched in 1997/98:
1 Dutch Polymer Institute (DPI);
2 Netherlands Institute for Metals Research (NIMR);
3 Telematics Institute (TI); and
4 Wageningen Centre for Food Sciences (WCFS).

This evaluation marks the end of the second four-year period of support for the LTIs. It should provide input for the Ministry of Economic Affairs with regard to a new instrument as follow-up of the present LTI instrument.
A secondary goal of the evaluation is to assess the performance of the four individual LTIs in order to decide on their funding until the start of this new instrument in 2007/08.

Main questions for the evaluation as posed by the Ministry of Economic Affairs were:
1 What are the effects of the LTI activities on the **innovativeness** and (indirect) **competitiveness** of (Dutch) companies? (relevance and effectiveness of LTI-instrument)?
2 What is the effect of the LTI instrument on the **research infrastructure** and the **focus and mass** of public research in the specific LTI-areas?
3 What was the **efficiency** of the LTI instrument and the individual LTIs. How can the strategic and operational management of the institutes be qualified?
4 What are the (lasting) **network effects** stimulated by the LTI instrument, and what is the quality of **interaction** between Industry and public research infrastructure?
5 To what extent has **internationalisation** been part of the LTI instrument, and how was this organised?

For this evaluation numerous documents were studied (business plans, annual reports, financial statements, monitoring reports, partnership contracts, scientific reports, etc.), interviews were held with stakeholders (37 with companies, 16 with representatives

[1] Knowledge in action, 1995
[2] LTI Evaluation set-up, 2005; citing from 'Startbrochure TTIs.' 1997.

from public research infrastructure and three with other stakeholders including representatives from the Ministries)[3] and intensive discussions with LTI representatives were organised during site visits (in general two per LTI). Short background studies were made of foreign institutes that could be compared to LTIs, and quick scans were made of the areas/sectors of activity of the LTIs in the Netherlands. A scientific assessment of the LTIs using international expert panels was not included in this 2005 evaluation due to time constraints. The scientific value of the research could therefore only be assessed to a limited extent, and is based on the opinion of respondents we interviewed, and on secondary information. In some cases (e.g. with NIMR where a scientific committee reviews the scientific quality of the research annually) this secondary information is of excellent quality, in other cases no secondary information could be found.

Chapter 2 starts by sketching the policy background and the programme goals. It also describes how the programme goals as they were set at the start of the programme have evolved during the years.
The set up of the instrument is described in Chapter 3. Subsequently, Chapter 4 characterises the individual institutes and their surroundings, as well as the research programming mechanisms that are in place in the individual institutes.
The main evaluation questions are dealt with in Chapters 5 to 9. Chapter 5 deals with effects of the LTI instrument on the knowledge infrastructure, i.e. the Dutch (semi-) public research infrastructure. Chapter 6 discusses the effects of the LTI on the Dutch business sector. The network effects and internationalisation are described and discussed in, respectively, Chapters 7 and 8. The efficiency of the LTI instrument (in a broad sense) is the subject of Chapter 9. Chapter 10 summarizes the main findings and presents conclusions and recommendations.

More extensive information can be found in the Appendices to this report (some in Dutch).

[3] Appendix A provides a full list of interviewees.

2 Policy background and programme goals

2.1 Policy background and rationale

In the 1995 government white paper 'Knowledge in Action', programmes were set up to contribute to the innovativeness and competitiveness of the Dutch business enterprise sector. In this white paper Leading Technological Institutes (LTIs) were introduced as *"top-research organisations in research areas that are relevant for strong, Dutch, R&D intensive sectors."* LTIs were to deliver their contribution to innovativeness and competitiveness, particularly with the results of **fundamental strategic research** and the education of well-trained researchers.

The LTI instrument does not have a legal document that describes its objectives and modalities. The 1996 government memorandum 'Towards Leading Technology Institutes'[4] lists the key characteristics of an LTI:

- A recognisable institute led from one position and, if required, physically concentrated;
- The LTI focuses on one coherent scientific area of fundamental-strategic research;
- This area is chosen in close consultation with knowledge intensive enterprises;
- The LTI harbours researchers and equipment of global excellence;
- This excellence forms an attraction for knowledge intensive firms and international top-talent;
- The LTI has a training component through PhD and designer courses;
- Enterprises should have a strong commitment to the LTI.

Thus, the main assumption for the impact of this instrument was that by stimulating scientific excellence in a focused area relevant for industry, concentrating public efforts on this area, and by increasing the influence of industry on the agenda setting of this institute, industry would acquire innovation capabilities which would lead to improved competitiveness. In addition, this 'pool of competence' would act as a magnet for international top talent and R&D investments.

The main thought in other words:

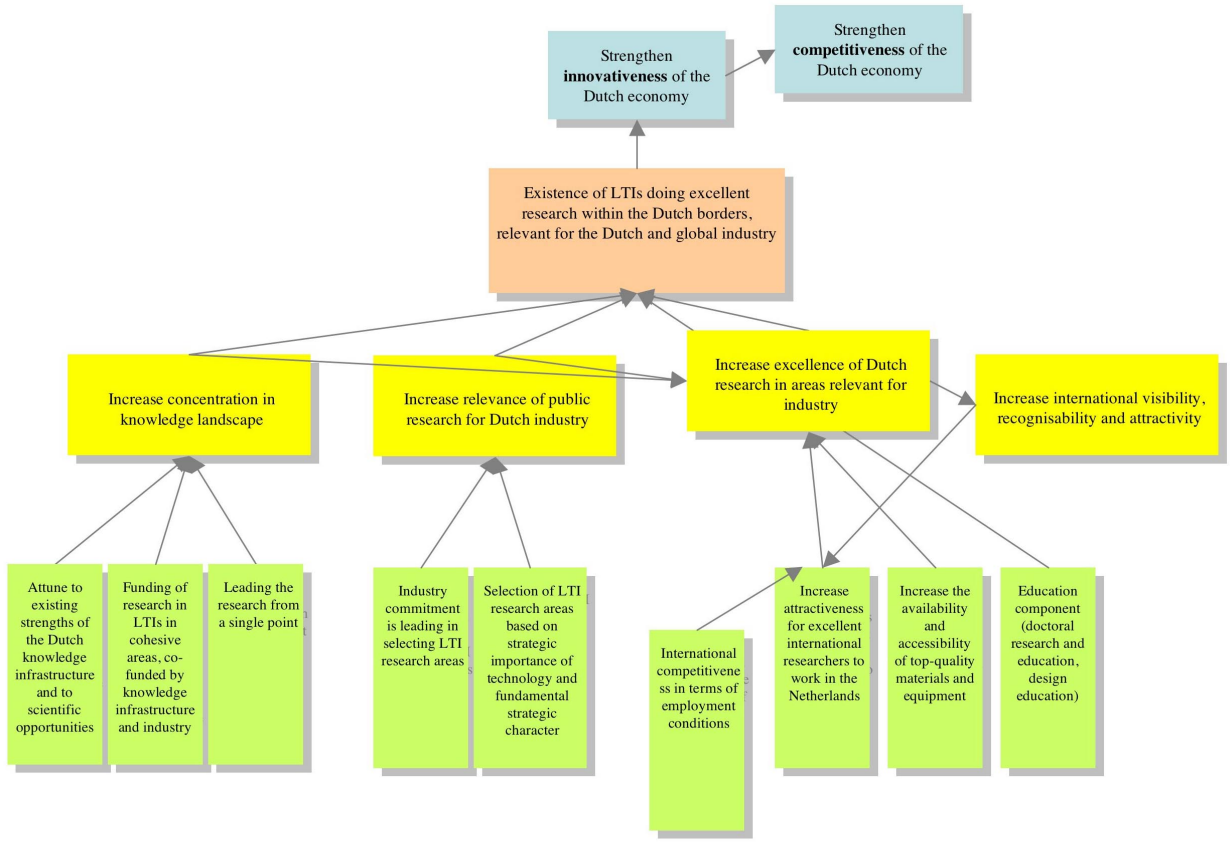
If the knowledge infrastructure performs excellent research in areas that are relevant for industry, industry will benefit automatically.

Exhibit 1 gives a hierarchical representation of the LTI objectives at the start of the programme, reconstructed on the basis of policy documents from this period[5].

[4] 'Op weg naar Technologische topinstituten', Ministry of Economic Affairs, 1996.

[5] source: Vooronderzoek Evaluatie Technologische Top Instituten; Eindrapportage; Technopolis BV; Amsterdam, mei 2005)

Exhibit 1 Aims of LTI-programme 1995



2.2 Positioning of the LTI instrument against comparable foreign initiatives[6]

The LTI initiative can be seen in the context of a pan-European trend to create 'centres of excellence' or 'competence centres' programmes and institutes. Competence centres use a combination of academic excellence with industrial needs and problems to focus joint academic industry R&D on areas of high innovation potential. As policy instruments, they typically focus on comparatively high-capability industrial and academic participants: typically medium-large companies and high-capability SMEs. Participants need increasing capabilities or 'absorptive capacity' in order to make use of the results of R&D.
Higher government subsidies are necessary as the traditional or 'Nelson-Arrow' market failure[7] (that companies under-invest in research) increasingly comes into play.

Linked and bilateral support tends to get 25–40%; pre-competitive collaborative work (such as the Framework Programmes) 40–50%; while competence centres tend to be

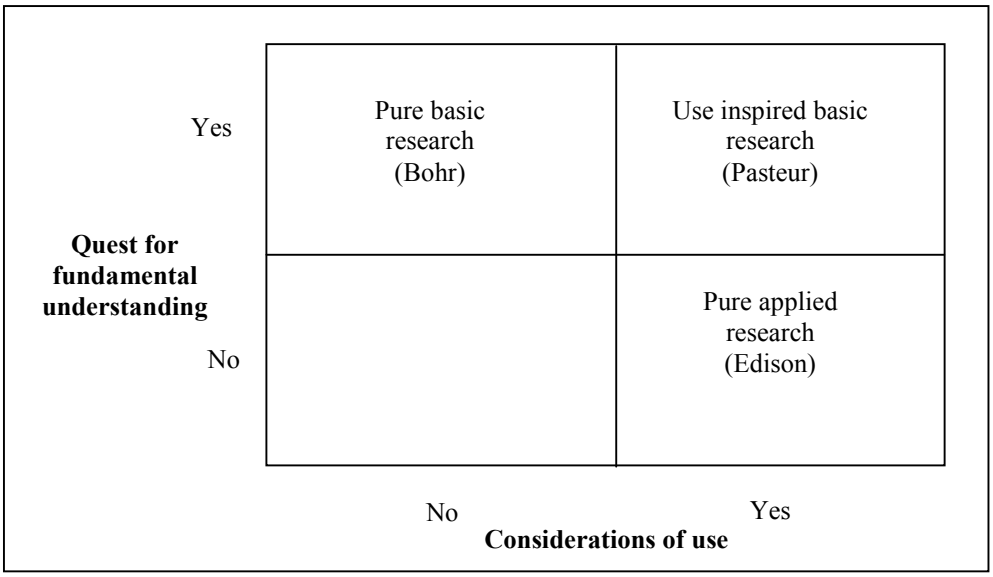
6 See Erik Arnold, Jasper Deuten and Jan-Frens van Giessel, *An international review of Competence Centre Programmes*, Brighton: Technopolis, 2004.

7 Ken Arrow, "Economic Welfare and the Allocation of Resources for Invention" in: Richard Nelson (ed.), *The Rate and Direction of Inventive Activity*, Princeton University Press, 1962; see also Richard Nelson, "The simple economics of basic scientific research", *Journal of Political Economy*, 1959, vol. 67, pp 297-306.

in the range 50–70%. Each of these instruments serves a somewhat different purpose, not least because it tackles a different **segment** of need.

The idea of (strategic-)fundamental research in the context of industrial innovation can sound paradoxical. But, as Donald Stokes[8] points out in his 1997 book *Pasteur's Quadrant*, much fundamental science is actually done with considerations of use in mind (Exhibit 2). His examples of the curiosity-driven Bohr, of Pasteur (doing fundamental research in order to understand and control disease) and Edison (with his ruthless empiricism, not much interested in underlying mechanisms) give a better sense of how research actually operates. Competence centre-type of instruments systematically devote more of their resources to Pasteur's Quadrant than other types of instruments.

Exhibit 2 Types of research, according to Stokes



While competence centres are normally categorised as R&D funding instruments that aim to improve academic-industry linkages, they generally also have a less clearly stated ambition to alter the research culture of the universities: moving towards greater interdisciplinarity and making close co-operation with industry more acceptable. The extent to which competence centres are needed, as change agents within the university system, obviously varies, not least because there are many different kinds of universities. Nonetheless, this aim to change university-industry interaction by changing the way the universities work is something that most clearly distinguishes competence centres from other 'linkage' initiatives, which tend to take university norms and culture as 'given'. In the case of the LTI programme, changing the culture of the knowledge infrastructure has also been an important aspect of the instrument: more industry orientation, less fragmentation, creating excellence in a targeted area that acquires critical mass.

[8] Donald Stokes, *Pasteur's Quadrant: Basic Science and Technological Innovation*, Washington DC: The Brookings Institution, 1997.

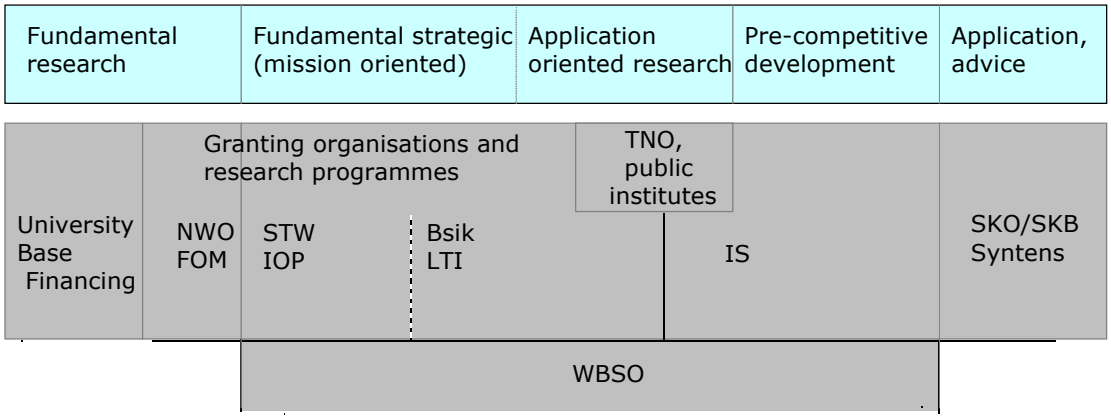
Competence centres should also be seen as a response to a the (seemingly paradoxical) trend that in the major parts of industry that depend on, and compete in, technology-intensive products and services, there is a movement away from conducting fundamental research in-house[9]. One of the reasons appears to be the traditional problem that it is hard to appropriate fundamental research results, so the economic incentives for doing it are low. Moreover, the breadth of the fundamental knowledge needed by industry seems to be growing, so that companies need new strategies for accessing world knowledge. Competence centres provide contexts in which companies can influence the direction and content of research that, in the medium term, they need, but that is more fundamental than they can afford to support.

Globalisation of industry has been accompanied by a willingness to conduct R&D in multiple locations – primarily within the 'Triad' of the USA, Japan and Europe. As a result of the growing interaction between large, multinational companies and the research and higher education sector, the shape and quality of the knowledge infrastructure becomes one of the factors influencing industrial R&D location. Competence centres can play important roles in ensuring not only that the research performed in the knowledge infrastructure has, over time, user relevance, but also that it is of high quality. These are necessary, but alone not sufficient, aspects of attracting and retaining industrial R&D activity.

2.3 Dutch context of the LTI instrument

In the Netherlands, the role of LTIs was seen as performing 'strategic-fundamental research' positioned in between one the one had academic research, which can be characterised as basic research or 'blue sky', and on the other hand applied research, which would typically be performed by contract research organisations such as TNO (see Exhibit 3).

Exhibit 3 Positioning of the LTI instrument in Dutch innovation policy[10]



[9] Frieder Meyer-Krahmer and Guido Reger, 'New perspectives on the innovation strategies of multinational enterprises: lessons for technology policy in Europe, *Research Policy,* Vol. 28, No. 7, 1999

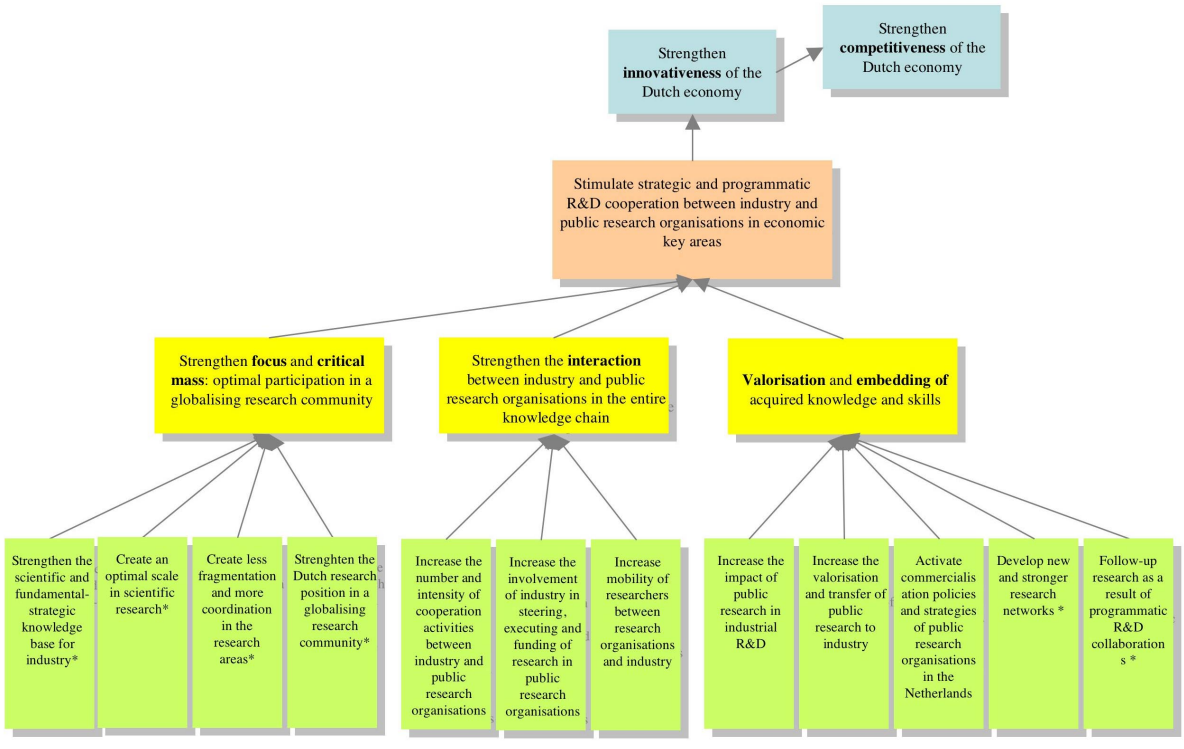
[10] Ministry of Economic Affairs, *Beleidsnotitie IOP 2003*, cited from 'IOP Evaluation 2005'.

In this regard the research performed by LTIs should not be focused on 'technological problem solving' for industry, but on creating strategic competences that can help industry to shift perspective and move towards new positions, which help to improve their competitiveness. The fact that the share public funding for LTIs amounts to approximately 75% is in line with this concept of LTIs positioned more 'upstream' than other policy instruments for applied research, which allow for around 50% government funding.

Almost ten years after the 1996 LTI memorandum, and eight years after the start of the four LTIs, policy thought on goals and objectives, the rationale for government intervention and the position of LTIs in the Dutch innovation system have somewhat changed. For instance, the globalisation of the economy and the concept of 'open innovation systems' have strengthened the international perspective. Also the discussions as part of the 'Lisbon' process have given rise to more attention for the application of research results in industry. The position of the LTI programme in Exhibit 3 moved somewhat to the right.

These changes in surroundings and policy thoughts have lead to an adapted Logical Framework on what the aims of a LTI programme should be (Exhibit 4)[11]. This has, however, not yet been translated formally into new policy objectives.

Exhibit 4 Policy thoughts about LTI aims in 2005



* In technological/research areas that are strategically important for the Dutch economy

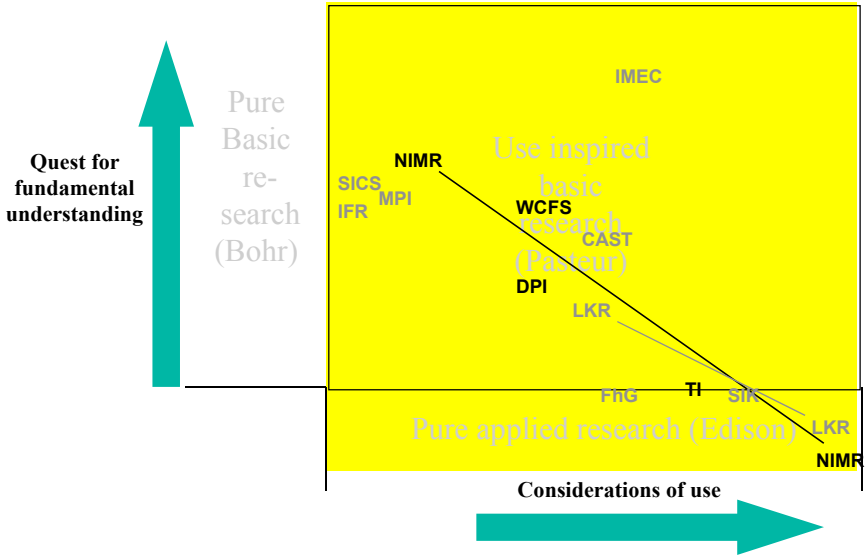
11 Vooronderzoek Evaluatie Technologische Top Instituten; Eindrapportage; Technopolis BV; Amsterdam, mei 2005

The difference with the first framework analysis is that now:
Scientific excellence and industrial focus are prerequisites for an improved innovative and competitive position (in the long run), but not sufficient in itself. Specific transfer mechanisms (valorisation) are needed as well.

In practice, as this evaluation shows, the LTIs have interpreted their positioning on this scale in very different ways (see Exhibit 5). This was partly determined by their surroundings (the type of industrial partners they involved (with varying R&D capabilities and time horizons), the research culture in universities, but it was also due to the programming modalities they chose to implement for their research activities.

Exhibit 5 The position of the LTIs (method according to Stokes).

(source: Technopolis assessment)



NIMR is ambivalent, with partly rather fundamental research and partly very applied research (and most in between), TI is application oriented, while DPI and WCFS are in the heart of the Pasteur quadrant. (For comparison the (estimated) positions of the foreign benchmark institutes are included.)

2.4 This evaluation

As the objectives of the LTI instrument have not been clearly codified and have been defined in rather broad terms, the evaluation of whether the instrument has fulfilled its goals is difficult to establish. The interpretation of what constitutes a 'good' LTI institute is ambiguous. Therefore, there is no clear yardstick whether an LTI institute complies with the instrument's intentions.

For this evaluation, achievements (both at programme level and at LTI level) are compared against both sets of (rather broadly defined) goals. In order to evaluate whether the LTIs and the programme have reached their goals, the original goals will be used. Furthermore, it will be evaluated whether the instrument and individual LTIs also have contributed to the 'new' goals, in order to see whether the LTI instrument is suitable for these new goals, and what lessons can be learned for the new instrument.

3 LTI instrument set up

3.1 Programme structure and modalities

The LTI programme offered financial support to four LTIs (after a call for proposals and a two-round selection procedure). The LTI instrument did not include regulations for structuring or organising an LTI. The government deliberately took a hands-off approach and left it open to the stakeholders to define their own governance structures.

The support was arranged in individual arrangements with each LTI and has the following characteristics:

- Support is provided for eight years, on the condition of a positive evaluation after four years. In 2002, after a positive mid-term evaluation the Minister decided to extend the subsidy period to a total of 10 years up to 2007 (with an evaluation moment in 2005), in order to allow the LTIs to make longer-term commitments. This LTI programme horizon of eventually 8+2 years was absolutely crucial in the success of the programme. If the commitment of the government had been for a shorter period, Industry and KIS would not have taken a similar risk by investing time and resources in the LTIs. For the success of a public-private partnership (PPP) it is necessary that the commitments (both formal and informal) of public and private parties have the same time horizon, which fits with the aims of the PPP.
  One of the goals of the LTI instrument was to refocus the public KIS research towards Industry needs. Since academic research tends to have a medium to long-term perspective, this goal cannot be reached in a short period. It appeared that it took quite some time for the universities to adapt to the needs of the LTI and to accept that a networked research community requires a certain degree of labour division and specialisation.
  Learning curves also play a role for Industry: it took 3-5 years in all LTIs to obtain a genuinely industry controlled programming process. This was also the period it took the successful industrial partners to set up a good internal knowledge transfer process (and some companies have not yet succeeded in doing that).

- The subsidy of the Ministry of Economic Affairs ('EZ contribution') amounts to twice the smallest contribution of either the KIS or Industry (in 2005 this was slightly adapted to 50% with a minimum participation of 20% of KIS and Industry each).
  These financial arrangements have enabled the commitment from both Industry and the KIS. In practice, the rule means that private sector input is 25%, which is justifiable if this concerns pre-competitive or fundamental-strategic research, but should be reconsidered if LTIs shift to more applied research positions.
  Furthermore, the strict interpretation of this rule requires complex planning and reporting procedures. This increases the administrative load and financial uncertainties. The adaptation of this regulation has decreased the effect of, sometimes inevitable, changes in planning – e.g. when not being able to hire a

PhD student on time – but still requires very detailed planning procedures. Further simplification may be obtained by determining the KIS/Industry ratio not yearly, but on a two or three yearly average.

- Additional subsidies, either national or international/EU, are to be subtracted from the EZ contribution. (From 2003 onwards accumulation of certain subsidies (e.g. EU) is allowed up to 60%). This limited accumulation hampers internationalisation and is dealt with in Chapter 7.

- LTIs are allowed to view the contribution of public research institutes (like TNO, DLO) as industrial contribution or as KIS contribution, or as a combination of both. This has led to strategic behaviour of some LTIs where they have assigned the contribution of TNO as belonging either on the industry side or the KIS side as seemed fit (or maximised subsidy). It also has led to dissatisfaction with the institutes and suboptimal participation. This is dealt with in section 5.5.

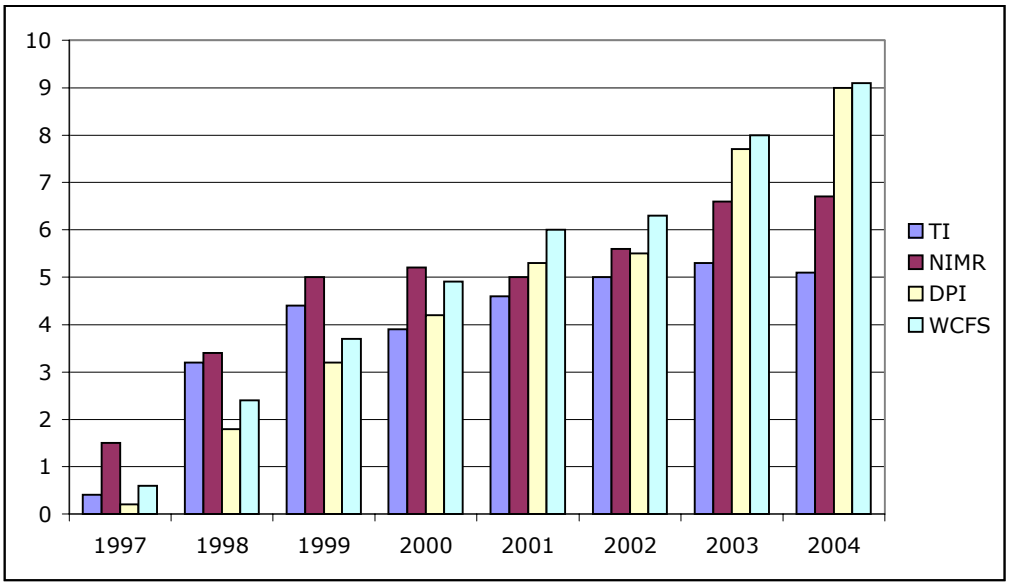
- LTIs are allowed to perform contract research.

- Subsidy is paid on the basis of the financial realisation.

3.2 Budget of the LTI instrument, additionality

The accumulated funding from the Ministry of Economic Affairs (EZ) in the period 1997-2004 has been close to €150 mln. Of these €150 mln, circa €41 mln went to WCFS, €37 mln to DPI, €39 mln to NIMR and €32 mln to TI. Exhibit 6 shows the development of this funding over the years[12].

Exhibit 6 EZ funding to LTIs in the period 1997-2004 (mln €)



[12] sources: Financial Reports LTI's, LTI interviews

The €150 mln EZ subsidy has led to investments of companies and KIS to approximately the same extent, but what would have happened if there had been no government subsidy? It is hard to measure such additionality of a government intervention (since comparison is made to the virtual situation of no government intervention), but there are indications that the LTI programme has additionality at programme level. The LTI proposals that did not receive government funding were never launched or started on a much lower ambition level compared to the LTIs (see Appendix B). Furthermore, respondents in interviews indicate that the extra funding has led to additional research and that they would stop their contributions when government contribution stops as well[13].

3.3 Monitoring and evaluation of the programme

LTIs report to the Ministry of Economic Affairs (EZ) on an annual basis (both a financial statement as a statement of activities). STW and external experts evaluated the programme in 2001. As a result of this evaluation, indicators were developed to report output and impact on an annual basis.

The reporting and monitoring of LTIs on these parameters have not been very consistent. Not all LTIs have reported on all the agreed performance indicators. Not all performance indicators were defined in sufficient detail to allow comparison between LTIs. Furthermore, the financial reporting is not sufficiently transparent and detailed to answer questions about efficiency. The central data collection at EZ leaves room for improvement.

[13] These are however weak indicators since the respondents have an interest in a positive outcome of the evaluation.

4 The individual LTIs: surroundings, facts and figures

4.1 The sectoral context of the LTIs[14]

In order to understand how LTIs have operated it is important to have at least some understanding of the sectors in/for which they operate. Differences between sectors include:

- The size and number of private sector stakeholders with an active involvement in R&D – and therefore possible commitment to the LTI;
- The outreach in terms of share of innovative firms in the Dutch economy that the LTI has involved;
- The degree of internationalisation of the sector; and
- The positioning of the research agenda on the scales of fundamental to applied research.

Exhibit 7 presents some background information on the sectors for which the LTIs operate: food industry for WCFS (SBI[15] code 15, 16), chemical industry and polymers for DPI (SBI 24, 25 – broader than polymers alone) and metals/machines/-transportation for NIMR (SBI 27-29, 34 – broader than metals alone). The Telematics Institute is working in the field of an enabling technology for various industrial sectors, so the absorption of the technology cannot be attributed to a single sector. For illustration purposes the figures for the computer service business (SBI 72) are presented. Furthermore, an estimate (based on CBS statistics, interviews and some preliminary desk research) is given for the number of R&D personnel in the private research infrastructure in the LTI areas in 1996 and in 2003 (2003 for companies). Reliable figures for the public research infrastructure could not be found.

Exhibit 7 LTI relevant sector data (for the Netherlands)

		Polymers related sectors	Metal related sectors	Telematics related sectors	Food related sectors
Added value *(mln euro)*		6300	14153	7612	14523
Added value *(% Dutch total industry)*		9.6	21.6	-	22.1
Added value *(% Dutch GDP)*		1.42	3.18	1.71	3.26
R&D expenditure *(mln euro)*		323	753	297	283
R&D intensity *(%)*		5.13	5.32	3.90	1.95
Innovation expenditure *(mln €)*		545	1192	439	518
Companies with own R&D personnel (#)		205	1033	538	224
Company size (# companies)	10-50 empl.	56	538	443	57
	50-250 empl.	111	400	77	92
	>250 empl.	39	94	18	75
# Participating companies in LTI (2004)		30	18	20	6[16]
R&D personnel in companies 1995 (fte)[17]		ca. 4500	ca. 6000	ca. 900	ca. 2750
R&D personnel in companies 2003 (fte)[18]		ca. 3000	ca. 8100	ca. 3800	ca. 2700

[14] See Appendix C for more detailed information (in Dutch).
[15] SBI = *Standaard Bedrijfsindeling*, as used by Statistics Netherlands (CBS).
[16] Including NZO, representing seven companies.
[17] Average of 1995/1996 CBS statistics because of large fluctuations

DPI serves two sectors: the polymer producing industry and the polymer using industry. The polymer producing industry sector is dominated by large multinational (chemical) firms with a high level of R&D and a high absorptive capacity for external research. These firms have a long-term time horizon of 10 to 15 years. The Netherlands plays a significant role in this sector internationally. The polymer producing industry sector is participating well in DPI. The polymer using industry sector, on the other hand, consists of approximately 1500, mostly smaller, companies. High-tech users in this sector (in general larger companies, like Océ, Philips, AKZO Nobel) are participating in DPI, especially in the area of functional polymers[19].
An important development in the last decade is the growing focus on added value. This means that producers of high-volume low-margin products have become separate companies, while the remaining parts of the 'old' integrated chemical companies focus on high-performance materials and functional polymers. In these areas new companies have been set up.
At the start of DPI, the number of polymer researchers in public KIS was rather low (ca. 150-200) and scattered, although possibilities for growth did exist, especially at the Eindhoven University of Technology.

NIMR focuses on metals, which play an important role in a wide range of industry sectors, in particular the basic metals industry, the metal products industry, the machine industry and the transportation industry. In general, there are many SMEs with low to zero R&D capacity. The absorptive capacity of such SMEs is limited and the gap with the public KIS is large. In addition, there is a limited number of innovation oriented SMEs and a small number of larger players (both with international markets). The overall competitive position of the Netherlands in the metals sector is limited. Important developments in the sector are internationalisation (e.g. merger of Hoogovens and British Steel to Corus) and supply chain changes where suppliers are increasingly taking over tasks of OEMs. Corus and Stork are dominant participants in NIMR.
While the quality of specialised metals research in the Netherlands is high, it represents only a small segment of the public KIS (a few hundred researchers). Related research areas (e.g. maritime technology, aerospace) are considerably larger.

Telematics involves the combination of informatics and telecommunication. Important research areas are both the development of new services as well as the development of new information and communication technologies (ICT) for these services. TI focused on four types of stakeholders: telecom companies, software designers and system houses and users of telematics applications (banks, manufacturing companies).
The telematics sector has been hit hard by the dot.com crisis. R&D activities in the Netherlands diminished sharply after 2001: Ericsson closed its research department in Enschede, KPN sold its research department to TNO Telecom, and Lucent decreased its Dutch based R&D activities drastically. However, there still remain telecom companies with substantial R&D activities in the Netherlands. In the first years, TI's

[18] These figures are based on CBS statistics for 2002 and 2003. An average of these two years is taken because figures tend to vary a lot per year.
[19] Functional polymers are in the polymers market only a marginal trend but are growing rapidly. They have been the largest technology area of activity within DPI since 2001.

focus on the telecom industry had to be adapted drastically to compensate for the loss of its telecom stakeholders. (On a positive note, TI's relations with the telecom industry have changed form national to European (EU) level).
The number of software designers and developers active in the Netherlands is limited. IBM and Microsoft have presence in the Netherlands with some R&D activities. Large service providers in ICT with partly Dutch origin (CMG, Cap Gemini, Ordina, etc.) are not R&D oriented.
Since ICT is an enabling technology, users of telematics can be found in many different sectors, as is shown by the members of TI. The Banking and Insurance sector is an important sector with a strong Dutch position internationally. These companies are increasingly global and want to have their information structure serviced globally. Figures on the number of public researchers in the telematics area around 1995 are not available. It is estimated (by TI) that at present there are some 1000-1200 ICT researchers in the Dutch public KIS.

The food sector is one of the largest industrial sectors in the Netherlands (the largest in number of employees), and it is internationally among the leaders. There are almost 5000 companies in this sector, many of which perform little or no R&D activities. The overall R&D intensity of the sector is low, and R&D expenditures are concentrated in the larger companies, which are responsible for 73% of research expenditures. The role of co-operative companies in the sector is large – especially in carbohydrates and dairy. The larger, internationally operating, companies are participating in WCFS. Its most important participants are the combined dairy industry, Unilever and DSM. That said, breweries, the meat sector and the retail sector do not participate. They often have limited fundamental R&D activities. Operating margins in the food industry are under pressure, especially in the secondary industry (carbohydrates, dairy), and innovation is oriented towards products with higher added values. 'Healthy products' may provide this added value. Food safety and biotechnology are other important research areas worldwide.
The number of researchers in public KIS is above 500.

The main conclusion from this analysis of the surroundings is that each of the LTIs operates in a very different industrial and technological environment, particularly in terms of the R&D intensity of their industrial target groups and the number of private actors with substantial R&D activities. In order to be effective, each LTI has adapted its strategy and governance to this environment. The flexibility of the instrument has had a positive effect on the development and adaptation of the institutes. In this regard, the fact that the LTI instrument did not prescribe in detail how the governance and membership models had to be organised was a good decision and has been important in maximising LTI effects.

4.2 Key characteristics of the four LTIs

Some key characteristics of the four LTIs are presented in Exhibit 8. Data for 2004 are used[20].

[20] Sources are LTI Annual reports, LTI financial reports, LTI interviews

Exhibit 8 Characteristics of the four LTIs (2004)

	DPI	NIMR	TI[21]	WCFS
Organisation type	Virtual	Virtual	partly virtual	Virtual
Research related personnel in central organisation	3	0	67	0
Research related personnel with KIS partners[22]	267 (150 fte)	±140	57	176 (150 fte)
Non-research / support / administrative personnel in central organisation	8	11	26	9 (7.5 fte)
# partner companies	30	18	20	6[23]
# new partner companies[24]	21	6	11	1
# former partner companies[25]	0	5	10	1
# KIS partners	14	5	23	5
# new KIS partners	9	1	14	1
# former KIS partners	0	0	0	0
Contribution EZ (mln €)	8.95	6.73	5.08	9.08
Contribution industry (as stated by LTI) (mln €)	4.49	3.71	3.77	5.40
Contribution KIS (mln €)	4.48	5.86	2.65	4.60
Other income (contract research, subsidies, etc. mln €)	0.05	0.06	3.97	1.37
Total income (mln €)	17.96	16.74	15.47	22.56
Contribution 3 largest industry partners (% of total industry contribution))	29[26]	77[27]	32[28]	83[29]
Contribution largest research partner (% of total research partner contribution))	47[30]	54[31]	47[32]	25[33]
Contribution research institutes as KIS (mln €)	1.09[34]	0.00	0.3	2.30[35]
Contribution research institutes as industry	0.58[36]	0.79[37]	0.3	0.00
Average project size	1,5-2 fte	1-1.5 fte	10-15 fte	8-12 fte
Time horizon of projects (years)	±4	±3-4	±2-4	±4-5

21 The figures relate to consortium members. TI also has project partners, companies and university professors that participate on a project basis

22 Within the projects there is sometimes also participation of researchers from business partners. This is very well developed in the case of TI where in addition to the TI and other KIS researchers some 55 fte research personnel in companies is organised

23 One of the partner companies is NZO (Netherlands dairy organisation). By way of NZO, 7 companies are participating in WCFS, represented by Campina and Friesland Foods

24 Number of new industrial partners since 1998 (WCFS), 1999 (TI), 2000 (DPI), 2001 (NIMR).

25 Number of industrial partners that have left consortium since 1998 (WCFS), 1999 (TI), 2000 (DPI), 2001 (NIMR).

26 Basell (12% of total industrial contribution), DSM (10%) and Shell (7%). Total contribution of TNO was €1.15 mln euro, but partly as KIS contribution.

27 Corus (54% of total industrial contribution), TNO (20%) and Boal Profielen (3.5%).

28 IBM, Lucent and Basell

29 NZO (52% of total industrial contribution), Unilever (21%) and DSM (10%).

30 TU/e

31 TUD

32 UT

33 All four research partners (WU, DLO, TNO and UM) have an equal contribution of 25%.

34 From the combined contribution of €1.67 mln for TNO, A&F and ECN, €1.09 mln is seen as contribution as KIS partners.

35 DLO and TNO both contribute €1.15 mln as KIS partners.

36 The contribution of TNO, ECN and A&F as "industrial partners" amounts to €326.890 in cash and €761.017 in kind. However from this in-kind contribution €503.591 is added to the contribution of knowledge institutes. The contribution of research institutes as industry is therefore €0.58 mln (source: DPI 2004 Annual accounts)

37 TNO and NLR contribute as industrial partners.

This shows that:

- Most LTIs have a completely virtual organisation, with a small central organisation and research conducted by the partner organisations. TI is partly virtual, and has a central research organisation of 67 fte;
- The number of research staff financed by means of the LTI instrument was 567 in 2004, meaning that on average the EZ contribution per researcher is ca. k€50;
- All LTIs involve around 150 fte R&D personnel (130-170);
- In addition to the LTI funding, additional contract research funding is acquired particularly by WCFS (income from other national and international programmes) and TI (both programme participation and direct contract research for industry and other organisations, e.g. governments);
- The stability of the partnerships varies considerably: while, for instance, WCFS has had almost the same – small – set of partners from the start, DPI's partnership network grew to over 50 members with many new companies and research centres joining in later years, and TI has lost a large number of partners (after the dot.com dip), but gained even more new ones;
- NIMR receives a dominant contribution of its three largest industrial partners. (The same is, in financial terms, valid for WCFS, but WCFS only has 6 partners);
- Within WCFS and TI, the budget is spent on large projects (ca. 10 researchers), while in DPI and NIMR smaller projects (individual researchers or teams of max. 3 researchers) are favoured;
- Time horizons are different: DPI and WCFS, and part of NIMR and TI funding is spent on projects with time horizons of ca. 4 years (the time generally needed to do a PhD). The time horizon of the other TI projects is much shorter, around 2 years. NIMR has application projects with even shorter time horizons.

The benchmark institutes, most of whom started in the 1980s, range from 40 to 300 staff and the turnover is between €4 mln and €20 mln – with the exception of IMEC: its staff exceeds 1300 and turnover is €159 mln. Turnover per head is comparable with LTI turnover (ca. k€75-125). Public funding varies between 22% (IMEC) and 100%, but is usually in the same range as the LTIs.

4.3 LTI programming mechanisms

One of the main aims of the LTI programme was to increase the industrial relevance of research in the Dutch public KIS. An important mechanism to ensure this is the involvement of industry in the programming of the LTI research programme. LTIs were free to choose their programming mechanism. All LTIs have experimented with their programming cycle but have now more or less chosen their way of programming. In the sections below the different mechanisms are described from two perspectives: Industry role and KIS-choice.

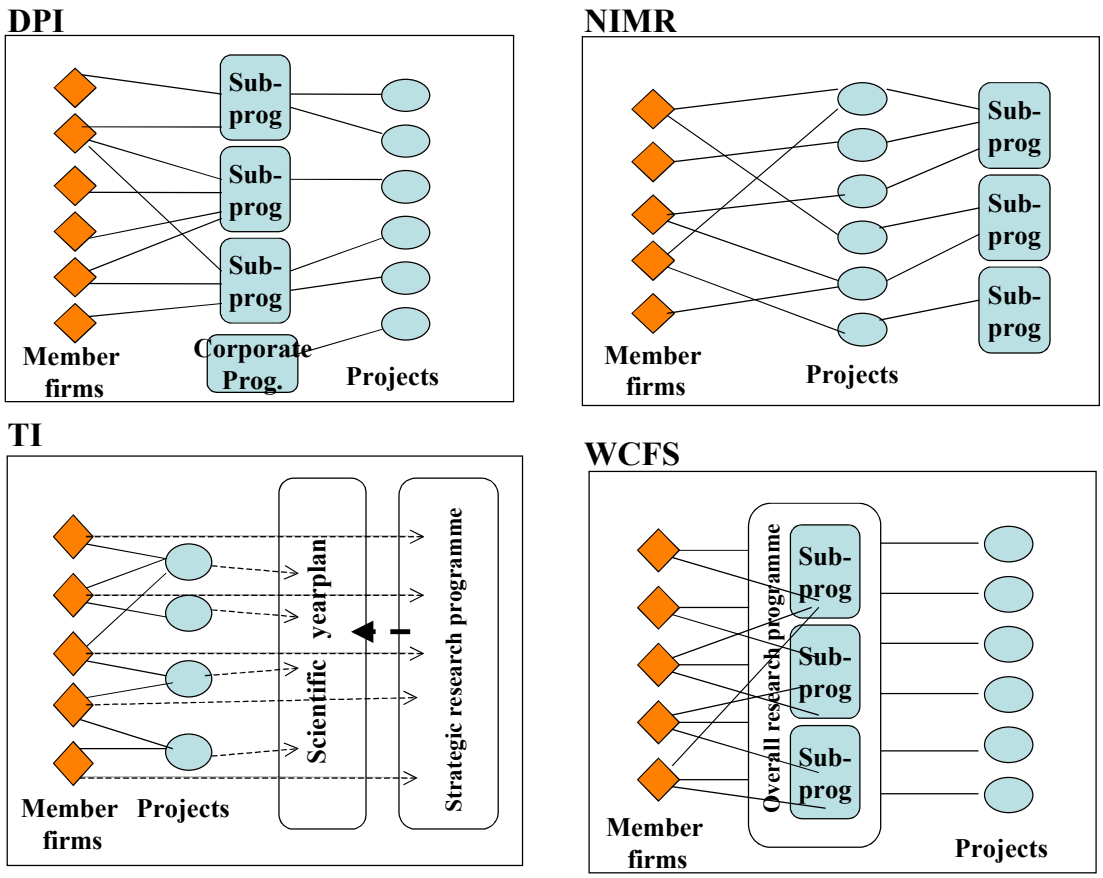
4.3.1 Industry role in programming process

Because of the inherent differences between the industries involved in the four LTIs, they have taken different approaches to their programming models. The differences concern:

- The influence of stakeholders on programmes and/or individual projects. This is relevant for the time horizon of the research activities. If industrial stakeholders decide on the level of research programmes (or sub-programmes) it can be expected that the time horizon is longer. If stakeholder decisions focus on the project level, the time horizon appears to be shorter.
- The degree to which independent scientific peer review is used to assess quality of proposals.
- The manner in which project ideas are developed and put forward.

We can distinguish the following models in terms of stakeholder involvement in the research programming:

Exhibit 9 Programming models of four LTIs[38]



Within DPI, industrial participants buy "tickets" of €50.000/year each, in one of six Technology Areas (TA). In return for one ticket they receive a seat and one vote in

[38] Source: Technopolis, based on LTI interviews and LTI Annual reports

the TA's Programme Board (more tickets means more votes). The Programme Board decides on the scientific programme for the TA, and on the projects that are carried out within the programme.
80% of the financial resources are used for research in the TAs, 10% is used for DPI overheads, and 10% is used by the scientific director of DPI to fund promising (breakthrough or enabling) research outside the TAs in the so-called Corporate Research programme. The final decision on projects is by the Executive Board of DPI (the scientific quality is explicitly evaluated by the Scientific Director at this moment). Afterwards, the Supervisory Board of DPI endorses the whole programme. Both KIS and Industry are having seats in the Supervisory Board.

The most direct project level involvement is within NIMR. Every company that participates for €50,000 obtains the right to determine the research of 2 fte research personnel conducting a research project. Projects are clustered in seven clusters. In order to ensure scientific quality, the proposed research projects must be approved by Programme Council, consisting of professors affiliated with the research groups that participate in the NIMR. In order to ensure the broader application potential, the research must fit with the general research strategy of NIMR (with six broad research themes that have been chosen by all partners at the beginning of NIMR) and the research must be approved by the Industrial Advisory Board (with representatives from the industrial partners). The NIMR Director takes the formal decisions. Part of the NIMR programme (ca. 20 fte) consists of 'fundamental' work in co-operation with FOM (Fundamental Research of Matter).
The overall scientific quality is furthermore safeguarded by a standing committee of international scientific experts.

In the case of TI, as with NIMR, projects are the central programming focus. However, the programming process starts with a four-yearly strategic programming process, involving Industry and KIS in workshops etc. This process results in a 'vision and focus' document stating the strategic research programme. Based on this document, projects are initiated by TI with industry partners. The combination of these projects is the annual scientific work plan. Terms of participation in the projects are negotiated between TI and the industry partners. The other partners do not know the terms of participation for the individual partner. The contributions of industry partners are, however, roughly correlated with the amount of influence they have on the project. This way of programming allows for large flexibility. There is no specific external evaluation of the scientific quality in the process. Such quality evaluation is performed internally (by research as well as industrial partners), as part of each planning step.

In WCFS the industrial partners give longer-term financial commitments to a predefined multiyear research programme. The size of the commitments is informally related to turnover and R&D expenditures. Individual research projects are initialised by the Focal Points of both companies and KIS. The WCFS Programme Council decides which projects are carried out within the research programme. In this Council all participants (including the KIS partners) are represented. All partners have one vote (NZO is represented by two partners). All project plans are reviewed by international scientific peers.

The evaluation suggests that the more direct the influence of industry on the programming (i.e. at project level), the more direct the use of the results by industry (participants of NIMR and TI tend to be better able to quantify the impact of the LTI on their turnover, see below), but also the stronger the tendency towards a short-term orientation, and the more often comments from universities are heard regarding loss of academic freedom.
The more transparent the programming process, the more partners know from each other, and the deeper the relation between partners. A higher degree of transparency, on the other hand, also contributes to a more difficult (and inflexible) planning process.
Smaller companies tend to have more difficulties in influencing the programming process. Not only do they have less time available to participate in this process, but also their ability to articulate their needs, particularly in the medium to long term, is less developed.

The structures developed reflect the sectors in which the LTIs operate. Flexibility is important for sectors with short business cycles (ICT) and for sectors with companies with limited strategic capabilities and absorptive capacity (NIMR). The LTIs in these sectors favour programming mechanisms where projects, rather than programmes, are the starting point. For other sectors, with longer business cycles and more strategic capabilities, it is more fitting to have a central programme (or programmes, when the technology is very diversified like in DPI).
There is no single best method for industry involvement in programming as there are different programming mechanisms that fit different situations. However, programming models that emphasize programmes rather than single projects, promote synergy and multidisciplinarity between/of projects, and allow for a longer-term focus of the research activities.

These findings are confirmed by the benchmark of the LTIs with foreign institutes (see Appendix F). The benchmark institutes are, apart from CAST, all physical institutes. In CAST, SICS, SIT, SIK and IMEC, industry participates in the organisation through membership in the governing or advisory board or through shareholdership (up to 70% in SIK). All institutes affirm that industry has a role in the research planning. However, the significance of this role is not easily measurable, and should therefore be considered with care. SIT and IFR are the only institutes that state that the role of industry in programme planning is insignificant. In SIT industry participates in the joint development of products, but does not take part in the programme planning. IFR's planning mainly relates to BBSRC strategies and their driver to accelerate in their core sciences.

Industry participation seems to become most tangible when it is part of a policy or strategy mechanism of the institute (like LKR's Kplus programme and IMEC's IIAPs and open research platforms). Most of the benchmark institutes conduct pre-competitive, basic research. However, almost all of them perform some contract research, or market oriented applied research. MPI-I, IFR and IMEC say to stay preferably focused on long-term basic research, although this research is often conducted under contract of third parties (industry, governmental bodies). SIT and IMEC explicitly desire a role as a bridge between science and industry, and MPI-P, LKR and IFR explicitly mention the multi- and interdisciplinarity of their research.

Most of the research is nationally focused, with the exception of a regular participation in EU research projects.

4.3.2 Allocating LTI research

The four LTIs have developed different allocation mechanisms to decide where the research is performed.

At DPI, since two years, university groups are asked (in regular calls) to submit research proposals that fit within the scientific programme once this has been drafted. The calls are sent to all polymer research groups in the Netherlands and to (in general) four top-research groups abroad. Calls can be in two rounds (depending on time available): in the first round short pre-proposals are evaluated, in the second round only a limited number of full proposals. Condition for carrying out a project is participation in DPI for 25% of the research costs (against fixed tariffs, based on VSNU tariff). The best proposals of each call are funded.

TI also has a rather open system. For every project the best available knowledge is sought (in the Netherlands – there is no foreign KIS participating in TI). There is no tendering, TI (in co-operation with the partners at project level) decides who will be approached as partners. In the last two years the number of KIS partners of TI has risen sharply. Apart from IT oriented groups also other groups are participating. When KIS partners participate in TI, their own contributions are 50% of the work they are performing.

At WCFS projects are distributed among the KIS partners. The best partner will be selected to do the research. It is agreed that KIS partners of WCFS at least 80% of WCFS research is performed. If no adequate expertise is available with the partners, outside parties can be approached (which gives flexibility). WCFS is now working on making a competence map of the partners in order to better align WCFS and KIS research.
There is a special clause that at least half of the financial contribution of NZO is spent at NIZO. KIS contributions have been agreed to in advance; KIS are paid for their efforts at full cost price (including all overheads).

NIMR divides work among its partners. In case the expertise needed is not available among NIMR partners, external expertise may be used. This external expertise is sought firstly among so-called affiliate KIS organisations. Currently, NIMR has five such affiliates, all outside the Netherlands. KIS partners get a fee based on VSNU tariffs. Running costs are €15,000/AiO/year.

From the evaluation is appears that the advantage of open procedures (either open call or choosing specific parties) is the possibility to choose the best knowledge institute to do the job. This also gives a stimulus for parties (selected and not selected) to improve their competences in order to be able to more competitive next time.
The advantage of closed procedures (i.e. only with preferred partners) is that strong, long term relations can be build with KIS partners, which may affect their strategic processes.
The advantages of calls are the transparency of the process and the need for KIS to specify specific expertise for the job asked. Picking the best knowledge for each

project (without calls) has the advantages of administrative simplicity and short decision periods.

As was the case with programming mechanisms, there is no single best allocation mechanism. What is the most adequate allocation mechanism is (at least partly) determined by the circumstances. Open systems prevail in situations with many groups to choose from (DPI, TI). In situations with long business cycles, calls are preferred because of the possibility to choose the best in a competition (DPI, WCFS). Where speed is needed 'picking the best partner' is in operation (TI).

The LTIs use different tariffs for the research performed at the research partners. There is no system that is both cost efficient and which is satisfactory to all research partners. The use of integral cost based systems (WCFS) makes participation by public research institutes such as TNO possible, but is also expensive (partly because of high overheads within the research institutes). The use of VSNU tariffs makes participation rather unattractive because costs are only partially covered. It is recommended to leave this matter to the negotiation of the individual LTIs as it depends on the role of research partners what price/quality relation is acceptable. The experiences of the present LTIs should be shared with the new LTIs.

5 Effects of LTI on the public knowledge infrastructure

This Chapter addresses the evaluation questions about the effect of the LTI instrument on the **research infrastructure** and the **focus and mass** of public research in the specific LTI areas.

In the original goals of the LTI programme, the effect on the KIS was present in all sub-goals. There should be:

- increase of concentration in the knowledge 'landscape'
- increase of the relevance of public research for Dutch industry
- excellence at Dutch universities
- international visibility and attractiveness

Given the size of the instrument (on average nearly €5 mln per LTI per year) a significant restructuring effect on the (whole) public KIS could not be expected, but the input in specific areas was significant.

At present, focus and mass are still very relevant but the international dimension is stronger, and more interaction between KIS and Industry is needed in order to improve valorisation of results.

5.1 Degree of participation (Dutch) knowledge infrastructure

With respect to participation of KIS in the LTIs, it can be said that the number of participants is steadily growing. 'First day' participants continue participating, and new partners are added. The largest growth can be found in DPI and TI. NIMR has grown with one foreign partner and five foreign affiliates. WCFS has added one new strategic KIS partner.[39]

Based on the Dutch research Database (NOD) overview it can be concluded that the most relevant Dutch university partners are included in the networks of DPI, NIMR and WCFS. Based on NOD it was impossible to assess whether the network of TI is complete in the Netherlands as the classification 'telematics' does not exist. However, all research institutes mentioning telematics in their description in the NOD are involved in TI. Moreover, respondents do not suggest they are missing participation of certain institutes. TI research is focussed on applications (not 'applied research') and a growing number of KIS partners is participating, not because of their telematics expertise – that is available within TI – but because of their technological (application) knowledge from a certain sector or problem.

An overview of the contribution of the most important KIS partners to the LTIs is given in Exhibit 10. There is no overview of the actual financial value of the work the KIS parties have performed. (A rough estimate can be obtained by multiplying TI contributions by 2 and others by 4).

[39] see Appendix E

Exhibit 10 Contribution of KIS parties to the LTIs (mln €, figures for 2004)[40]

	TUD	UT	TU/e	TNO	RuG	WU	UM	DLO	UvA	CWI	RWTH	DKI	A&F	ECN	KUN	UvT	UU	RUL
DPI	0.20	0.40	2.08	0.87	0.20	0.06	0.02		0.10			0.12	0.11	0.11	0.01		0.01	
NIMR	2.91	1.25	0.52		1.02						0.17							
TI	0.49	1.17	0.06	0.15	0.01		0.02		0.12	0.17					0.07	0.08	0.02	0.01
WCFS				1.15		1.15	1.15	1.15										
Total	3.60	2.82	2.66	2.17	1.23	1.21	1.19	1.15	0.22	0.17	0.17	0.12	0.11	0.11	0.08	0.08	0.03	0.01

Overall, the 3 TUs are the largest contributors, followed by TNO and DLO. The large role of RuG, which is not hosting a LTI itself, is striking.

5.2 KIS drivers for participation

There are several drivers reported why KIS parties participate in an LTI. Additional funding for research (with little red tape involved) and interesting research programmes are mentioned. The interdisciplinary approach of the LTIs is also mentioned as interesting. Furthermore, reputation and visibility are mentioned often, especially by KIS partners who joined in later. Apparently, participation in an LTI adds to the reputation of a research group or university (DPI, WCFS and, to a lesser extent, NIMR). NIMR participants mentioned the LTI as a possibility to create more continuity in their work with/for industry. Also the opportunity to work on interesting problems was mentioned.
Networking effects (e.g. contacts with new partners or new consortia of partners) are not mentioned by KIS respondents, but these were perhaps seen as obvious.

5.3 KIS output

The direct outputs of LTI funded research (apart from generated knowledge) are reported by the LTIs to the Ministry of Economic Affairs annually: the number of publications, the number of PhD's and the number of educated students (Exhibit 11).

The first indicator is the number of scientific publications. No conclusions can be drawn based on these figures as the reliability of the figures is considered low (with e.g. possible double-counting of co-authored articles). Comparison between LTIs is impossible because publication patterns are quite different depending on the research area. Publications in high-impact journals (*Science*, *Nature*, etc.) are reported from DPI, WCFS and NIMR.

We do not have bibliographic data on all benchmark institutes, but IMEC publishes 1.05 articles per year per staff member; SICS 0.75; and IFR 1.63 (which corresponds to its rather scientific focus).

[40] LTI Financial reports 2004

Exhibit 11 KIS related output parameters LTIs[41]

	DPI	NIMR	TI	WCFS
# papers in scientific journals/in conference proceedings (2004)	219	209	107	92
# papers/researcher (2004)	1.43	1.49	0.86	0.61
# PhD theses (1997–2004)	48	22	14[42]	26
# PhD theses (2004)	15	7	3	8
# educated researchers (cumulative until 2004), in brackets number of researchers departed with known fate and not retired)	200 (139)	71 (49)	n.a. [43]	110 (97)[44]
researchers ➙ university (1997–2004; #)	78	17	10[45].	62 (to KIS)
researchers ➙ university (1997–2004; % of known destination)	64	36	±25	64[46]

The table shows that the number of PhD theses (compared to budget) is relatively high in DPI. This is related to DPI's strategy, in which PhD researchers play a large role.
The education of talented students is seen as an important effect of all LTIs, both by Industry as well as by KIS. Students (also from abroad) seem to be attracted by the (international) reputation of the LTIs and the participating groups.
The statistics on where researchers go after working for an LTI are far from complete – even though this was a performance indicator for the LTIs.
DPI has so far educated the largest number of researchers: it has (together with WCFS) the largest budget, and primarily hires temporary personnel (PhD students and postdocs) that, by definition, leave the institute after finishing their research. NIMR and WCFS also use permanent staff in university on a secondment basis. TI employs a large part of personnel in their own central organisation, and partly uses lifetime contracts for its personnel in order to keep a stable organisation. Therefore, the number of researchers that leave TI is smaller.

5.4 Impact on the KIS

5.4.1 Effects on mass

As was mentioned before, there are no detailed and reliable figures available on the number of researchers in the public KIS. Observations below are based on the interviews and incomplete data, but do present an overall picture.

Public research in the polymers area has significantly (and steadily) grown since the start of DPI (estimated number of public researchers in 1995: 150-200; now: ca. 500). The growth is larger than the number of DPI researchers (150-200). This suggests that DPI has been an impulse in structurally increasing the mass of public polymer

41 LTI reports on performance indicators, LTI interviews
42 PhD students who are being or were employed by TICO. Another 30 PhD students per year are employed by KIS in the TI consortium.
43 Some 150 researchers from industry annually participate in TI-projects.
44 Although no statistics are available on the fate of personnel that left WCFS, the *Effectmeting WCFS 2005* (Hussarts and De Vos, Capelle a/d IJssel, March 2005) states that 7% of 85 respondents (from all WCFS partners) has employed former WCFS personnel.
45 Educated guess by the TI management; most researchers leave for a position in industry.
46 A WCFS respondent indicates that 50% of researchers that have left WCFS is now employed in industry.

research in the Netherlands. Overall, DPI is considered to have lifted polymer research in the Netherlands above critical mass (i.e. created adequate research and teaching capacity to provide in an institutionalised way (i.e. independent from one or a very few individuals) knowledge of high scientific quality and researchers for industry). The research programme, with its seven programme areas is, however, rather broad, and has the risk of becoming sub-critical at some points.

Although some university professors report a growth of their groups because of NIMR, the overall number of metal researchers in the Netherlands seems not to have increased since 1995. In terms of mass, NIMR has prevented the decay of public metals research in the Netherlands rather than given it a new impulse for growth. NIMR is also (partly) financing some metals research chairs in the Netherlands that would otherwise have disappeared. Metals research in the Netherlands is still very thin, and as a whole just above critical level. It is also rather broad, and at some points certainly below critical mass (as is also stated by the Scientific Advisory Board of NIMR).

It is very difficult to determine the number of telematics researchers in the Netherlands. Statistics are all based on ICT researchers, and there have been heavy fluctuations in the period 1995-2005 (partly because of economic developments (dot.com crisis), partly because of inaccurate statistics). Currently, there are estimated to be some 600 ICT researchers within NIRICT (the combined research activities on ICT research in the 3 TUs), and there may be some 400 to 600 researchers elsewhere in the public KIS (TNO ICT, TI, CWI and others). On a total of 1200 researchers, the 125 public KIS researchers at TI (both TICO and TI financed) constitute no more than 10% – the percentages for the other LTIs are 25 to 50%. Concentration of 70 telematics researchers in one organisation seems, at least for a large part, additional to the research capacity before in TRC. TI itself reports also a qualitative impact (because of the average seniority of TI researchers). This assumption could not be verified.

Food research has traditionally been concentrated in Wageningen. Changes in 'Wageningen' have been very significant in the last 10 years. WCFS seems to have contributed more to sustaining the mass of food research rather than to increasing it. WCFS research is now considered to be an important part of WUR food research. In Maastricht, WCFS participation has led to an increase in food research with 10 to 15 PhD students. Food research is above critical levels (with a rough estimation of above 500 (WUR, DLO, TNO, NIZO, Maastricht), but attention is necessary to prevent erosion of the knowledge base. In international perspective, the mass of WCFS may be too low to maintain the international competitive position on the long term, because of the national orientation of WCFS industrial partners (and therefore limited financial means).

In conclusion, the LTI programme has played an important role in increasing the amount of polymer research, and in keeping metals research and food research above critical mass.

5.4.2 Effects on focus

According to respondents focus effects of the LTIs have been more important than mass effects. Participation in LTI research has increased the industry focus, not only of those researchers taking part in specific LTI projects, but also wider in the departments and units involved. Thus, it has had an influence on the culture within the universities, although this is difficult to attribute to LTIs alone, because it is part of the more general trend of orienting public (university) research towards society needs. As is stated in section 4.3.1, industry plays a large role in programming the LTI research. After a first learning period the industry is now really taking the lead in this process. All LTIs have seen an increase in industry influence at the cost of KIS influence. Both KIS respondents and industry respondents report the effect on the industry orientation and focus of KIS and stress the importance of it. It is also exemplary that all LTI directors have an industry background by now.

A second focussing effect is on the scientific and technological focus of research in the KIS, e.g. the reduction of overlapping research and the increase in complementarities between research groups. Since knowledge institutes and universities must also invest 25% (to 50% at TI) of the total LTI budget as their participation in the LTI, the effect on KIS is wider than the LTI programme alone: it should affect their allocation of strategic means.
This effect, however, has been modest and remained limited to the LTI funded projects. In the case of WCFS, the effect on a division of labour with the development of clearer competences in each of the institutes can be identified most clearly. (By way of example: since UM is participating in WCFS it has shifted the focus of its research programme from toxicology to nutrition).
The appointment of professors is also influenced by the LTIs (DPI and NIMR finance some chairs directly), which has a lasting effect. Although remarkable transfers of internationally renowned scientists from abroad have not occurred, some good foreign professors have been appointed because of LTI opportunities and some Dutch professors stayed in the Netherlands.
The facilitation of multidisciplinarity is appreciated in all LTIs.

An exception is the field of telematics. Although the TI Central Organisation is characterised by respondents as very industry oriented, and although 50% of the TI basic programme research is done by researchers from the public KIS, TI has not been able to bridge the gap between the rather theory oriented KIS and the short-term industry (with horizons of less than 2 years). Although the way of working by TI (as a professional project organisation) may have had some follow-up within the universities, TI has had little or no influence on the programming of the public KIS in the Netherlands in the area of telematics in general. (TI may have had more influence outside the LTI basic programme in the BSIK programmes they have co-ordinated, e.g. GigaPort, but these projects were outside this evaluation).

5.4.3 Scientific quality and international reputation

In the goals of the LTI programme ‘scientific excellence’ and ‘industrial relevance’ are both mentioned. Although these two goals do not have to be opposed, they are hardly ever completely in line with each other. The scientific standing of application-oriented research is also very different in various scientific areas.

Within all four LTIs there has been (and still is) a clear area of tension between the (university) research community and the participating industries. In general terms: Industry finds university research too long term oriented, too fundamental and not easily applicable, while academics see industry orientation as too short term, risk avoiding and not scientifically interesting.
As the main goal of LTIs is the improvement of the competitiveness of industry, the industry is in most LTIs the dominant partner in the programming process (section 4.3.1). This leads to an increased industry orientation. In order to safeguard scientific quality (and at least in the case of DPI increase longer term orientation and breakthrough potential), some interesting mechanisms are in place. WCFS sends all research proposals to several foreign top-level experts for an independent evaluation of scientific quality. The Programme Board of NIMR assesses scientific quality of all research programmes before the Industrial Advisory Board assesses industry relevance. The Scientific Advisory Board of NIMR also advises regularly on scientific quality at portfolio level. DPI has recently (re-)installed a similar Board. DPI has created a Corporate Research Programme, funded with 10% of research budget which is at the disposition of the Scientific Director to spend on projects outside the current Technological Areas, i.e. projects of an enabling or emerging character, or too risky to perform inside the present areas.

When scientific quality is assessed, the different backgrounds of the LTIs need to be taken into account as well.

An independent assessment of the scientific quality of the LTI research was, however, not part of the Technopolis assignment to evaluate the LTI programme.
For this evaluation respondents from both industry and KIS have been asked to rate the scientific excellence and the international reputation[47] of the LTI in which they are participating. In general, the qualifications were rather consistent, which suggests they may be reliable.

- DPI has achieved international reputation, as is exemplified by the participation of international industrial companies and international top research groups. According to respondents, the scientific quality of the research is generally good, with some world-class researchers involved in DPI. The quality insurance system, however, may be improved and some measures have been taken recently (e.g. the creation of an international scientific board). Also, there might be more attention for higher risk/high reward projects.
- WCFS has also achieved an international reputation, which was not built from scratch, but could be based on the solid international reputation of 'Wageningen'. The orientation is long term, although the growing industrial influence is making the focus shorter term, and some KIS participants fear that this may affect the scientific standing of the research.
- NIMR is considered by its scientific board to be an internationally unique institute in the area of metals research. According to respondents, NIMR has no real international reputation yet, but the European reputation is growing rapidly. The

[47] These two items are strongly related. On the one hand, the reputation of an LTI is based on the scientific quality and reputation of the participating groups. A strong (international) reputation of the LTI, on the other hand, also influences the reputation of participating groups, and makes it attractive for (strong) groups to participate.

scientific quality of research is generally considered to be good to excellent (by the same Scientific Board), although open for improvement in some areas. The focus of the research is short to medium term because the strong possibilities of industry to direct the research. This is partly in conflict with achieving a high scientific profile.

- TI is very different from the other LTIs. The research has partly a scope of 1.5 to 2 years (which is considered very long term by parts of relevant industrial sectors), partly a scope of 4 years (for KIS participation – but with its orientation on application in a scientific area where a theoretical approach gives scientific standing, TI's scientific reputation within academia is not very high). The quality of research by TI is considered to be good, however, there is a large 'mental gap' between the researchers of participating universities and TI's researchers.

A specific remark that is often made, is that all LTIs have chosen a multidisciplinary approach. This is considered a strong point.

5.4.4 Other effects

Other effects of LTIs on KIS are the increased availability of state-of-the-art equipment (NIMR, DPI and to a lesser extent WCFS) and follow-up research contracts with industrial partners.[48] TI serves KIS partners with a substantial group of software engineers that partake in every project consortium, in building mock-ups, testbeds and prototypes.

Internationalisation aspects and network effects are dealt with chapters 7 and 8.

5.4.5 Conclusion regarding impact on KIS

Overall, the LTI programme has played a positive role in directing public research more towards industry needs, creating focus in the research and adding to the mass of research performed in their areas. The bearing of this role differs substantially between the four LTIs.

The impact on the KIS of WCFS, NIMR and DPI was according to expectations. The overall impact of TI on the KIS was too low.

LTIs are not primarily aiming at scientific excellence. This is only a secondary goal. However, there are many examples of scientific excellent research within the LTIs, of good researchers with international reputations, and of research leading to publications in high impact journals. As this was not a subject for this evaluation we only have anecdotal evidence.

5.5 Role of (semi-)public research institutes

Non-university research institutes of a (semi-)public nature form a special type of partners for the LTIs. They show aspects of research partners (they want to perform

[48] The 'Effectmeting WCFS 2005' (Hussarts en de Vos, Capelle a/d IJssel, maart 2005) states that KIS participants in WCFS have realised an additional income of k€360, and expect another k€5000 in additional turnover (with a 10% profit margin).

research themselves) as well as aspects of industrial partners (they want to exploit results of the LTI research). The different LTIs are treating these ambivalent institutes very differently.

On one side of the spectrum are WCFS and TI. Within WCFS, three research institutes (DLO, NIZO and TNO) participate. Their contributions are considered as KIS contributions, and they are performing research on the same footing as universities ('closed' calls for proposals). They can use their own integral research fee structure based on total cost price including all overheads.
Within TI there is participation of TNO (and CWI, whose position as fully public NWO Institute is different). TNO contribution was originally considered as KIS contribution, and TNO was treated the same as universities. However, with the transfer of KPN's research facility to TNO, TNO inherited the industry relation with TI from KPN Research. While TI preferred TNO to continue the industry relation (and stopped the KIS relation), TNO preferred to continue the KIS relation (and announced to stop the industry relation which was effected in 2005).

Within DPI four institutes participate (TNO, A&F, ECN and the German Max Planck Institute). The contribution of the Dutch research institutes is partly seen as KIS contribution, partly as industry contribution (including their cash ticket contribution). For each ticket they receive a seat and a vote in a programme board for a Technology Area. Furthermore, they compete with the universities in calls for research projects. Their research efforts are valued conform DPI tariff, which is covering approximately 50% of their real costs including overheads.

On the other side of the spectrum is NIMR with participation of TNO. The TNO contribution is entirely considered as an industry contribution. TNO may decide on the projects university researchers are working on but does not do that.

TNO is (very) dissatisfied with the way it is participating in the LTIs at present. They can get a higher return on investment in other places than with the LTIs. Participation of A&F in DPI is not completely up to expectations, although some knowledge has been obtained as well as a stronger role in the network. However, the IPR regulations make it hard to exploit research results and tariff structure makes larger participation in DPI impossible. (ECN has not been interviewed).

It was expected by many players that TNO – and similar organisations – could take up a role as an intermediary, although this is not stated in any policy document. However, the – financial – position given to TNO in the LTI programme remains unclear. For some of the LTIs, TNO had a role mostly as a 'receiver of knowledge' with the assumption that the LTI knowledge was used for commercial purposes by TNO (industrial party). In other LTIs, TNO was considered as one of the actors from the KIS performing LTI type research. It seems that the reasons for allocating TNO one or the other role were pragmatic rather than strategic. This should be clarified in a new LTI instrument. TNO should be given a role within an LTI that fits the strategic goals of the LTIs as well as their own strategy. Financial arrangements should be made to make this possible.

6 Effects of LTI on the business sector

The first evaluation question was:

What are the effects of the LTI activities on the **innovativeness** and (indirect) **competitiveness** of (Dutch) companies? (relevance and effectiveness of LTI-instrument)

This question is dealt with in this chapter. The first section deals with the degree of participation by Dutch industry. (Which part of industry is actually involved in the LTIs?) In section 6.2 the drivers of the participants are discussed. (What do they expect from their participation?) Section 6.3 discusses the valorisation activities of the LTIs. (How do they try to transfer knowledge and to whom?) These valorisation activities have become more central to the LTI goals over the years. In section 6.4 the level of industry satisfaction is given. Finally, section 6.5 addresses the final question, the effects of LTI on the business sector.

6.1 Degree of participation of (Dutch) industry

Various indicators are used to show the level of commitment and the degree of participation of Dutch industry (Exhibit 12). The coverage of LTIs of the relevant players in their sectors depends on the demarcation lines used to define the sector (e.g. polymers vs. chemical industry). In the case of TI it is difficult to make a clear demarcation as the institute has shifted focus from the 'ICT sector' to a much broader group of ICT users from a broad set of sectors.

Exhibit 12 Degree of participation of (Dutch) industry in LTIs (2004)[49]

	DPI	NIMR	TI	WCFS
# participating companies	30	18	20	6 (incl. NZO)
Industry contribution (mln €)	4.5	3.7	3.8	5.4
Turnover partners as % of turnover in sector	Medium-High	Low	Medium[50]	Low-Medium
# (Dutch) partners as % of R&D performing companies in the sector	High	High	Enabling technology	High

DPI has a very high degree of participation in polymer production and in advanced polymer users, but low in plastics conversion. For TI there are no figures available as the sectors it targets with its enabling technology are too divers. In NIMR and WCFS the largest R&D oriented companies do participate. Their sectors, however, consist of very many parties (including R&D performers).

6.2 Drivers for participation

In the interviews, the respondents were asked for their initial drivers of participation in the LTI. The most important driver by far was the need for complementary knowledge: especially the need for more fundamental knowledge, of high quality and

[49] LTI reports, LTI financial reports, Technopolis assessment

[50] TI covers a range of sectors. In each of these sectors, key-players are member of the TI-consortium or participate in projects as project partner.

with improved industry orientation, in order to obtain ideas for (longer term) innovation. Other drivers were the possibilities for improved networking, both with other companies and with KIS to improve the view on new scientific developments. Another more often mentioned reason, especially by larger companies, is the possibility to recruit new personnel from the LTIs.
Founding fathers of NIMR and DPI mention their fear for erosion of the Dutch public knowledge base and the need for a strong, industry oriented, public KIS.

The knowledge institutes (ATO, ECN, TNO, etc.) try to obtain more research work, but also want to be part of new developments they can use for further exploitation (i.e. in general contract research).

6.3 Valorisation of research results

Making the research programme of public KIS more industry oriented alone does not effect the competitive position of industry. The results of the research must be transferred to industry and 'absorbed' – and finally translated in (profitable) new products, services and processes. At the start of the LTI programme, there was, at policy level, little attention for this process of 'valorisation of research results'. The main objective of the LTIs was to conduct strategic-fundamental research, of international excellence and with industry relevance. From the start of the programme, little attention was given to how this knowledge should be taken up by industry. 'Normal' communication channels and career moves from researchers from university to industry were (implicitly) thought to be adequate. In addition, the work conducted by LTIs was of a pre-competitive nature, often shared by competitors. It was assumed that by putting industry in the programming boards and involving them in project advisory roles, the participating companies would be able to translate this knowledge in their own business strategies. Over the years the understanding increased that in order to solve the 'knowledge paradox'[51] specific activities might be needed. This became visible also in the LTI activities.

Valorisation has various meanings. We include in this term:

- Translation of research results that stem from LTI research activities by the industrial participants within their own business;
- Commercialisation of LTI results through licensing of patents by both participants and non-participants to the LTI programme;
- Launching of a spin-off company on the basis of knowledge generated by LTI research;
- Dissemination of research results or products and services to non-participants through various technology transfer mechanisms.

The activities of the four LTIs on these four types of valorisation are discussed in this section. The effects are dealt with in the following sections.

[51] With the knowledge paradox is meant the situation that excellent scientific quality does not lead to a large economic impact.

Exhibit 13 Characterisation of valorisation activities[52]

	Valorisation aimed at partners	Valorisation aimed at non-partners
Valorisation as part of research projects/programme	DPI, NIMR, TI and WCFS	
Specific valorisation activities outside research projects	NIMR, TI	NIMR, TI

Both NIMR and TI have an integral valorisation approach. From the start, TI has been very application oriented. Knowledge transfer is promoted by engaging both supplying industry and end-users in the projects. This approach was strengthened after 2001/2002 when a real problem driven approach was taken and 'science push' was more or less abandoned. Apart from knowledge transfer to participating partners there also is knowledge transfer to 'outsiders' in the projects (e.g. within Gigaport). Valorisation occurs via intermediary organisation like the 'Stichting Innovatie Alliantie' and Syntens, and through training programmes organised by TI.

As soon as the first scientific results of the research programme became available, NIMR detected a lack of absorptive capacity with its smaller members. Direct contacts between researchers and industry, the appointment of application engineers at NIMR and the development of training programmes (e.g. to understand the basic software NIMR developed models were based on) then started. The last 1.5 to 2 years, this has resulted in a three-level approach. The first level is the NIMR partners. They are stimulated to start 'mirror projects': internal research projects outside NIMR, but in the same area as the NIMR project, aiming at building absorptive capacity. Once the absorptive capacity is there, so-called 'knowledge application projects' are started within the NIMR programme, where direct transfer of knowledge is realised. At the second level there are 'knowledge demonstration projects'. These projects – in principle executed by the participating research institutes in NIMR – are aiming at demonstrating results of NIMR research to (non-participating) SMEs. The third level is that of 'knowledge transfer projects', carried out with (or by) the Dutch industry federations in the metals area that are associated members of NIMR. Knowledge transfer activities at this level include NIMR college training, brochures on (new) technologies, etc. Not only results of NIMR research are transferred, but developments in metals science and technology in general.

Valorisation activities within DPI and WCFS are primarily aimed at the participating (industrial) partners. The developed communication structures (at project level, (sub) programme level and institute level) should also have knowledge transfer effect. DPI's Technology Area Programme Committees and WCFS's Focal Point System seem to be effective when the participating companies themselves provide adequate effort ('if you don't put effort in the system, you don't get anything out of it'). All DPI companies and the larger, more R&D intensive WCFS companies have sufficient absorptive capacity. Some of the less R&D oriented companies within WCFS feel they miss the absorptive capacity to provide adequate effort for knowledge transfer. Knowledge transfer activities to non-participating SMEs in the polymers and food area do not exist.

[52] LTI interviews

It can be concluded that (in general) the valorisation process does not occur automatically within the LTI structures. Specific valorisation activities are important to increase the effectiveness of the instrument. It has been up to the LTIs to take up these activities and find financial modalities to support them. TI (that provides enabling technology to companies that do not see telematics as core business) and NIMR (that operates in a sector with limited R&D intensity) have integrated valorisation in their daily activities, both for participating large R&D intensive firms as well as for participating SMEs. Both LTIs also have developed specific technology transfer activities for non-participants.
Activities of WCFS and DPI are focussed on their participants. WCFS has a specific system (focal points). DPI has only modest activities. The large R&D intensive firms taking part should be able to absorb this type of knowledge. Nevertheless, there is still a lot to gain by organising this process within the companies better.

The funding model of LTIs, which is based on research activities and company membership fees, provides little room for developing activities to disseminate research results to non-members, or to attract SMEs to take part in dissemination activities such as workshops, demonstration projects, training courses and so on.

6.4 Industry satisfaction

In the interview round with industrial participants, respondents were asked to rate the LTI they were participating in on various items on rate from 1 to 5 (1= very unsatisfied; 5=very satisfied). In general, the respondents were rather satisfied with the performance of the LTIs: the scores on influence on programming, quality of research and role in network formation are around 4 (satisfied). These scores are in line with the customer satisfaction scores that are reported in the WCFS and NIMR stakeholder surveys.[53]
There is only one group of LTI users we interviewed that is really unsatisfied. This is the group of software applicators that is participating (or has participated) in TI. They think the TI research is (far) too fundamental, and it takes too much time to implement results (two years). This dissatisfaction is caused by the short time horizon of these companies (caused by the short business cycle in this sector), and by their lack of absorptive capacity (because they hardly perform any R&D themselves).[54]

The first, and most widespread, effect on industry has been an increase of knowledge and their knowledge base. In the context of this evaluation, the significance of this increased knowledge is difficult to measure. It has been stated by several respondents that the type of knowledge developed in the LTIs should move from 'nice to know' to 'need to have', meaning that the strategic character of LTI research and the integration with industries' own R&D strategies should improve further. This is the prime responsibility of industry. Nevertheless, continued commitment to fund LTI research is an indication of industry satisfaction.

[53] Tevredenheidsaudit WCFS Programmaraad, Totaalrapport 2005, Hussaarts en de Vos, Capelle a/d IJssel, Juni 2005 en Summary NIMR Stakeholdersurvey 2003, Erik van Westing, NIM, 2003

[54] Reasons for few R&D activities are that the profitability of their present core activity seems to be adequate, and R&D is perceived to be not necessary or too risky.

Striking is the contribution to competitiveness that NIMR respondents report. This is in line with the large attention NIMR has for valorisation of research results, and with the reported contribution of NIMR to the development of new products and processes.

6.5 Effects on participating industry

The effects on industry can be grouped in three categories:

- Effects before industrial exploitation: researchers, knowledge, patents and licences, spin offs;
- Intermediary effects on industry: additional investments in R&D, additional competences, knowledge position, entrance to new markets, network effects (inter-company, with KIS, EU projects, etc.) and strategic insight;
- Company outputs: new products, new processes, additional turnover, cost savings, and profits.

Four sources of information were used to determine the effects of the LTIs on Dutch industry: the annual output parameter reporting of the LTIs to EZ (Exhibit 14), Effect measurement[55] and stakeholder surveys by WCFS and NIMR, industry interviews and an analysis of patenting activities of the LTIs and of LTI partners.[56]

6.5.1 Effects on companies before exploitation

Exhibit 14 Output parameters with industry relevance[57]

	DPI	NIMR	TI	WCFS
# researchers ➙ industrial partner (cumulative, 2004)	30	9	±20	20
# researchers ➙ industrial partner (cumulative, 2004, %)	25	19	±50	11
# researchers ➙ other industry (cumulative, 2004)	13	21	±10	n.a.
# researchers ➙ other industry (cumulative, 2004, %)	11	45	±25	n.a.
# patents (granted)	2	3	4	4
# patent applications (pending)	27	4	0	16
# patents/m€ (total applications filed / total accumulated budget)[58]	0.49	0.08	0.06	0.23
# licenses granted or patents transferred	6	0	1	4
# spin-off companies	0	0	2	0

Almost every respondent mentions new, useful, knowledge as important output. This is used either as input for follow-up research (including process or product development, see below) or as background knowledge.

Another important output of LTIs is well-trained (research) personnel. Although, as stated above, the figures are incomplete, according to the LTI output parameters, an important part of researchers leaving an LTI, is employed by industrial partners in the LTI. Other industrial parties employ a similar amount of ex-LTI researchers. This is confirmed in the interviews. Especially in the case of DPI (where the use of PhD students is most prominent), the output of educated researchers is seen as an

[55] Hussaarts en de Vos, *Effectmeting WCFS, Totaalrapport 2005*, Capelle a/d IJssel, March 2005.
[56] J.H. Knecht, R.A.J. van Loen, *Technologische Topinstituten, Ocrooieeractiviteiten*, Rijswijk: Octrooicentrum Nederland, August 2005.
[57] LTI reports on performance indicators, LTI interviews
[58] Total accumulated budget for LTIs (1997-2004): DPI: ca. €75 mln; NIMR ca. 90 mln; TI: ca. 70 mln (excl. additional funding); WCFS: ca. €100 mln.

important result of the programme – the interviews confirm output parameter statistics. Because of the industrial orientation and interaction of LTI research these researchers are also more directly employable in industrial research which leads to considerable costs savings.

Approximately 40% of industrial respondents consider patents to be an important outcome of LTI research, especially DPI respondents. DPI also has most patent applications, followed by WCFS. NIMR and TI do not generate many patents. The areas of research of these institutes are not well suited for patenting (software applications and (computer)models.
Overall, the number of patents is rapidly growing, as might be expected when the research portfolio matures. Further maturing of the research portfolio, the (rather recently) started stronger directing of the research by industrial partners and the stronger interaction with companies at project level might lead to a stronger rise in patent activity, especially at DPI and WCFS. TI research is not in an area where patenting is very important as business cycles are very short. NIMR work consists mainly of modelling work and in that area patents are not very important.

The patenting behaviour of LTIs and the original LTI partner companies was also analysed based on open patent literature for the period 1990-2002 (by 'Octrooicentrum Nederland'). In this way, changes in patenting behaviour can be identified. After 1997 the patenting activities of the LTI institutes start. LTI partners remain active in the LTI technology areas and do apply for patents outside the LTI. Since the start of the LTIs, the number of patent applications of the LTI partners in the LTI areas is increasing. (It should be noted that the overall trend in the world in these areas is also an increase in patent application).

Benchmark institutes can be used to compare the patenting activities of the LTIs. SICS obtained 1.28 patents per million euro, while IMEC obtained 0.32 patents per million euro. There is no information available on the other institutes. It is, however, hard to compare because patenting behaviour varies considerably from sector to sector. A general target for all LTIs is not appropriate.
In line with their technology sectors, DPI and WCFS are most active in patent application – of which, so far, a limited number has been licensed to members. As can be seen from the number of patents transferred, patents have played a limited role in valorisation, so far.

The LTI programme has resulted in two spin-off companies, both from TI. The international benchmark shows that it can hardly be expected in a relatively short time span that the LTIs create many spin-offs – and certainly not in every sector. In addition, the lean structure of the (mostly) virtual institutes implies that there is hardly any support infrastructure to manage and coach this process.

6.5.2 Intermediary effects on industry

The knowledge that is developed in the LTIs is considered of additional value by 90% of respondents. Just over 60% report that it is of positive value for their innovative position. WCFS's effect measurement (see above) states that 60% of their respondents report follow-up R&D.

Only a limited amount of our respondents (25%) report LTI knowledge as important for their strategic decision-making. However, this should not be seen as low because for most companies, LTI research is only one source of strategic information out of many (traditional scientific sources being the most important). Moreover, LTI research is just a limited part of the research of most companies involved. They often have large R&D laboratories with highly qualified R&D personnel who are able to view technical developments in their surroundings. What matters is that LTI research becomes an integrated part of the industrial companies' research portfolio.

Entrance to new markets is hardly ever mentioned as an effect.

A specific effect reported by Dutch subsidiaries of foreign multinationals (in all LTIs except WCFS that does not have participations of such companies) is the strengthening of their position within their group because of LTI participation. In this way, the research activities in the Netherlands are better anchored in the KIS, and therefore less likely to be off-shored (moved out of the Netherlands).

The respondents also consider the network effects very important. These are considered in a separate section.

6.5.3 Output effects

40% of respondents report they have applied LTI knowledge in new products, and 25% that they have applied it in new processes. TI and NIMR respondents have the highest application rate of LTI knowledge. The more application-oriented approaches in their research portfolios seem indeed to be translated in innovations. The WCFS survey reports lower percentages: 27% has used WCFS knowledge for product innovation and 5% for process innovation.

During the course of this evaluation, it has not been possible to obtain a complete overview of the economic effects of the LTI research. Companies themselves are not always able to attribute these effects to earlier research, and if they can, they are, because of competition effects, hesitant to discuss them with outsiders.
The economic effects may, however, be considerable. One (large) company reports that at present 5% of its product portfolio turnover (and a higher percentage of profits) is based on LTI knowledge, and that this percentage is expected to rise to 30-40% within a few years. Another company reports multimillion turnover as a consequence of an LTI project (with a sister-company abroad because there was no market in the Netherlands), while a third reports savings of more than €5-10 mln per year for a period of five years.

The NIMR 2004 annual report showed many examples of product and process innovations realised with NIMR knowledge. Glare is by far the best known. Although this aluminium/polymer sandwich material was invented far before there was an NIMR, the producers say it would not have been on the market when there had not been the NIMR.

6.6 Conclusions with regard to industry impact

The main effect of LTIs on industry has been on improving the firm's knowledge base and networking abilities. Direct effects on competitiveness could be found for those LTIs that perform applied research projects close to market development. Indirect, more long-term effects cannot be established at this point in time.

Because of incomplete datasets and confidentiality requirements of interviewed companies, as well as the classical attribution problems, it has been impossible to quantify the direct economic effects of the LTIs. That said, industry satisfaction is in general large and many examples have been found of significant positive effects on turnover (and profit).

The timing of the expected impact of LTIs largely depends on their positioning in terms of fundamental-strategic versus applied research. If the LTIs are considered to maintain their position as 'centres of excellence', able to attract international top researchers and foreign industrial partners, their research activities will have impact on the medium to long term mostly. This impact could be large if LTI research succeeds in offering industry new roads for competitiveness. However, it will take a longer time than the current eight years to manifest itself on the market and quantifying the exact contribution of LTI activities will become more difficult. Those LTIs working in sectors with short product life cycles and limited R&D intensity will be able to show direct impacts more easily – as is the case with TI – but the spill-over effects to other players than those directly involved is likely to be much smaller.

7 Network effects

The LTI instrument was one of the first public-private-partnership instruments introduced in the innovation policy in the Netherlands. As a consequence, relationships between academia / research organisations and industry have been increased and intensified in the LTI areas. The widening of these public-private networks varies between LTIs. One LTI has seen a very stable but narrow network (WCFS), others a stable and growing network (DPI and NIMR) and a changing but growing network (TI).

In terms of the quality and relevance of the industrial partners, all LTIs have captured the appropriate players in the Dutch economy. With regard to KIS, the relevant research groups are involved as partners.

The intensity of the collaboration varies considerably and not all research partners intend to continue their participation after the LTI period.

Network quality is hard to capture in hard facts. Network effects could not (yet) be identified from the patenting behaviour – there were few joint applications from more than one LTI partner. Follow-up research contracts with industrial partners are present[59], but are not systematically monitored. Therefore, the evaluation of the network quality is based on activity analysis and interview response.

Formal governance structures (on institute, programme and project level) have proved to be important forums for networking. The mechanisms to organise networking are embedded in the LTI structure. Although there are some general networking activities ('network events'), the most effective activities are the various boards and councils and the project exchange mechanisms.

In food and polymers areas, where (the R&D intensive part of) industry is rather uniform, joint programming exercises within the LTIs forced the industry to discuss their R&D strategies with each other and with KIS.
The sectors of NIMR and TI are more diverse. As a result, programming is less strategically oriented and network formation is more difficult. Both NIMR and TI have organised the development of Roadmaps for certain areas, which has had a strong network effect.
TI has had strong network effects at project level, in building (sometimes large and diverse) consortia for projects. Eight business developers have development and maintenance of networks as core activity. TI has also played a (sometimes leading) role in international standardisation forums (MPEG, IT architecture).

The effect of LTIs on business-to-business networks was not an explicit goal of the LTI instrument. Close to half of the company respondents have indicated that LTIs had a positive effect on their collaboration attitudes and on their openness in sharing

[59] The 'Effectmeting WCFS 2005' (Hussarts en de Vos, Capelle a/d IJssel, maart 2005) states that KIS participants KIS in WCFS have realised an additional income of k€360, and expect another k€5000 in additional turnover (with a 10% profit margin).

R&D intentions with other firms. Trust building has taken time to develop for each of the firms. In the modern economy depending on open innovation, this is an important learning effect. The existence of the LTI instrument in itself offers firms a platform for business-to-business collaboration, which would be very difficult to achieve without such a mechanism.

The sustainability of the networking effect is, therefore, very dependent on the LTI instrument and the existence of the institutes. Without the LTI instrument collaborations would most likely become more focused on bilateral relations. The business (and personal) relations developed within the LTIs make it easier to start such relations than before.

8 Internationalisation

LTIs operate in more or less open and international innovation systems. Apart from the fact that scientists and innovating companies must participate in the international scientific arena in order to stay in line with international developments (and therefore, within the boundaries of confidentiality and IPR arrangements, must publicise and go to conferences etc.), there are various internationalisation aspects. In the following Exhibit 15 the situation regarding internationalisation is presented for the four individual LTIs.

Exhibit 15 Various indicators for internationalisation of the LTIs[60]

	DPI	NIMR	TI[61]	WCFS
Share of researchers from non-Dutch origin (%)	75	68	±50	15
Share of researchers from non-EU origin (%)	25[62]	49	±20	2
Share of researchers leaving for a foreign position (cumulative, % of researchers with known fate) (%)	5[63]	44	<10	14
Share of researchers working in an institute not located in the Netherlands (%)	n.a.	10[64]	0	1
Number of foreign institutes were research is performed	12	6	0	2
Share of budget spent on research in institutes/universities outside the Netherlands (%)	6	4	0	1
Number of participating companies without Dutch subsidiaries	9	1	0[65]	0
Number of participating companies with Dutch subsidiaries but no production in the Netherlands (only marketing)	1	0	0	0
Number of participating foreign companies with production in the Netherlands, but no R&D	2	0	0	0
Number of participating foreign companies with R&D facilities in the Netherlands	7	0	0	0
Number of Dutch companies with international R&D organisations	8	7	7	4-5
Number of Dutch companies with production facilities abroad (that may use the results of R&D)	7	3	4	7
Number of other Dutch companies	3	4	8	0
Number of EU-projects (or other international research projects) of LTI	0	2	5	3
Use of foreign scientific evaluators in programming	Since 2005	yes	no	yes

The importance of internationalisation has increased during the lifetime of the LTI instrument, while there was no explicit strategy or vision regarding the implications for the LTIs.

All LTIs are part of the international scientific and business community. Most participants are multinationals that operate on global markets (and have global R&D budgets), researchers come from all over the world and they all publicise their results

60 Data for 2004; LTI Annual reports, LTI interviews

61 These figures relate to consortium members, but TI has project-based relations with foreign companies and KIS. Most of the major telecom consortium members of TI are 'internationals'; in legal terms they are 'Dutch'.

62 DPI estimates.

63 Excluding those employed by (foreign) partners.

64 RWTH Aachen is a member of the NIMR consortium.

65 Beyond TI's international project partnerships, structural co-operation has been established with parties as VTT, Fraunhofer, Vodaphone and NTT Docomo.

in international scientific papers. This international view is necessary in order to offer the companies the best international knowledge available and in order to offer researchers (and research institutes) international recognition.

Some LTIs have sought the internationalisation by finding complementary knowledge in foreign public research institutes (DPI and NIMR). DPI is the only LTI with an active strategy of involving foreign industrial partners. A limited, but rapidly growing, part of the research is performed in non-Dutch research institutes.

All LTIs, except WCFS, have involvement of large multinationals with foreign headquarters as participants.

TI participates in the largest number of EU projects. WCFS internationalisation strategy seems to be build on EU participation alone. A further increase in EU participation is limited by financial restrictions (i.e. the accumulation rule), not by international reputation of the institute.

Advantages and disadvantages of the various modes of internationalisation are given in Exhibit 16.

Exhibit 16 Advantages and disadvantages of internalisation of a LTI

	Advantages	Disadvantages
Foreign researchers	• Recruitment advantages: availability of researchers is larger, therefore opportunities to get researchers and to choose the best researchers • Network advantages: (research) relations improve with foreign groups from which researchers originate, or go to (e.g. this is mentioned as a way to obtain better involvement in Chinese developments)	• Valorisation disadvantages: likelihood for the researchers to stay in the Netherlands after their training period is smaller (than with Dutch researchers), and therefore the knowledge transfer to Dutch companies or institutes by means of employment
Foreign (public) knowledge infrastructure	• Knowledge advantage: opening up to foreign institutes enlarges the knowledge base and offers more opportunities to choose the best knowledge available, or to obtain knowledge not available in the Netherlands • Network advantages: participation of foreign knowledge institutes opens up foreign networks (at a low price) • Competition advantages: by choosing the best institute regardless location the Dutch KIS is stimulated to deliver quality • Financial advantage: when the financial position of Dutch KIS is weak additional finance can be obtained from foreign KIS • Price advantages: foreign research institutes are often cheaper than Dutch institutes	• Ideological disadvantage: Dutch tax-payers money is spent abroad (without foreign governments spending money with Dutch KIS) • Knowledge leak disadvantage: developed knowledge may more easily flow to foreign, non-participating companies and therefore effect the Dutch competitive position negatively • Competition disadvantage: opening up for foreign KIS combined with the possible inability of Dutch KIS to compete on quality may lead to erosion of Dutch knowledge base

	Advantages	Disadvantages
Participation of foreign companies	• Financial advantage: more financial means • Network advantage: participation of foreign companies opens up foreign networks • Knowledge advantage: participation of foreign companies makes the knowledge of these companies available to the LTI and therefore broadens the knowledge base • Reputation advantage: being a leading international institute	• Knowledge leak disadvantage: developed knowledge may more easily flow to foreign, non-participating companies and therefore effect the Dutch competitive position negatively • Programming disadvantage; research themes relevant for Dutch companies may be out of the focus of the LTI and the gap between Dutch KIS and Dutch company needs may widen • Ideological disadvantage: knowledge (partly generated with Dutch tax-payers money) is flowing to foreign companies without restriction
International projects/other	• Financial advantage: more financial means • Network advantage: participation in EU projects opens up foreign networks	• Organisational disadvantage: participation in foreign projects may be difficult to organise because of legal constraints (including max. government contribution) and amount of work

Many respondents argue that internationalisation is unavoidable and should be strengthened in the future.

The anti-accumulation condition in the EZ contribution (i.e. every additional government contribution that an individual LTI receives, is deducted from the EZ contribution) made participation in EU-projects virtually impossible for LTIs. Since participation is a way to improve the international reputation of the LTIs and since industry is asking (some of the) LTIs to play a role in setting up European projects, the anti-accumulation condition was partly lifted in 2003 (i.e. accumulation is possible, max. 60%). This has increased EU participation in recent years, but the rule is still hampering EU participation.

9 Efficiency and management aspects of the LTIs

This chapter deals with the efficiency of the LTI programme and with some management aspects of individual LTIs that are important for their performance.

9.1 Financial efficiency

In Exhibit 17 three indicators for efficiency are given for each LTI.

Exhibit 17 Efficiency indicators for the four LTIs [66]

	Total income / EZ contribution (A)	Total income / EZ contribution	Research related FTE / total income (B)	Research related FTE / EZ contribution (A*B)	Research related expenditure / total income
	2004	**1997-2004**	**2004**	**2004**	**2004**
DPI	2,0	2,0	8,5	17	0,93
NIMR	2,5	2,3	8,4	21	n/a
TI	3,0	3,2	8,0	24	n/a
WCFS	2,5	2,4	6,6	17	0,95

The first indicator (given for 2004 and for 1997-2004) indicates whether the LTIs have been able to obtain additional income, apart from the EZ subsidy and the minimal KIS and industry contributions. TI has been most successful in doing this, while DPI has not done this. Every EZ euro spent at TI has generated 50% more research income than the EZ euro spent at DPI.

The second indicator is a real output indicator. It indicates how many FTE of research has been created per million euro of income. In this sense, DPI is most efficient, closely followed by NIMR. This is caused primarily by the fact that these institutes primarily use (relatively inexpensive) PhD students to perform the work. Average integral costs are between €115.000 and €150.000/FTE (which is relatively high for PhD students[67], but relatively low for professors). A difference in productivity (and perhaps quality) of research is expected between PhD students and more senior researchers. Study of this effect, however, is outside the context of this evaluation.

The third indicator is the product of the first two indicators and states the number of FTE of research created with every EZ euro invested.

Finally, the last indicator is the amount of the available budget that is actually spent on the goal of the programme, i.e. the performance of (top-class) research. This type of efficiency indicator is often used by (innovation) agencies like SenterNovem. Figures for DPI and WCFS indicate that 93-95% of the available funds made available to them, are actually spent on research. Therefore, 5-7% is spent on

[66] Based on LTI financial reports
[67] DPI-costs for PhD students are €68.000/fte

programme management. There are no indications that these figures are very different for TI and NIMR.[68]

It can be concluded that the efficiency of the LTI institutes is high, as most LTIs have relatively small management units, which mobilise large networks of people and organisations to take part in the main research activities.

As a consequence of the high efficiency at institute level, it is expected that the overall efficiency of the instrument is high as well. However, data on the management costs of the instrument by the Ministry are not recorded.

9.2 Human Resource Management

Four factors determine the HRM system of an LTI (Exhibit 18). Important considerations in designing a HRM structure are flexibility in personnel, directive power over personnel, social costs ('wachtgeld'), whether or not university overheads have to be paid by the LTI and administrative costs of personnel administration. Each LTI has chosen a model that fits its own way of working.

Exhibit 18 HRM system of the LTIs[69]

	Recruitment	Employment	Location	Other HRM activities of LTI
DPI	KIS	KIS	KIS	Some
NIMR	PhD students; KIS Postdocs: KIS+LTI	LTI, seconded by KIS	KIS	Many
TI	TICO: LTI KIS: KIS	TICO: LTI KIS: KIS	TICO: LTI KIS: KIS	TICO: yes KIS: no
WCFS	LTI (from among KIS employees)	Seconded by KIS to LTI	KIS	Many

Another HRM issue is the educational level of the personnel that is hired. Exhibit 8 states the number of PhD students that is employed by the LTIs. DPI is employing predominantly PhD students (70-30 division), NIMR has a 60-40 division, WCFS 20-80 and TI 40-60.
The ratio PhD student/other researcher appears to be context determined. DPI chooses PhD students because the projects are multi-annual and rather mono-disciplinary, and because PhD students are less expensive and recruitment is an important goal of the participating industries. NIMR chooses also postdocs, because transfer of results to industry is also very important (and absorptive capacity in industry is low). TI hires mainly researchers who already have done their PhD because they want experienced researchers with an interest in other disciplines, business and societal problems and easy communication to the KIS, as well as high project management skills.

[68] NIMR and TI do not separate personnel costs for researchers and supporting staff in their financial reports to EZ. For TI this is a fundamental difficulty because as a separate research organisation they also have overheads that are calculated in the university and institute rates normally.

[69] LTI interviews

9.3 IPR policy

9.3.1 IPR-output

Currently. all IPR developed within DPI is owned and maintained by DPI. KIS partners receive a fee for the transfer of IPR to DPI.[70] KIS partners may use the research results freely for education and further research. All industrial partners may obtain a licence. The costs for application and maintenance are, however, becoming too high, and the system will be changed so that industry partners have to decide earlier whether they want to obtain the patent. They then have to pay the application fee and patent maintenance costs, but have more exclusivity than in the present system.

At NIMR, IPR is also owned and maintained by NIMR. Industrial partners can get a permanent, royalty free, non-exclusive license to use the IP. The total amount of licenses obtained may not be higher than the total NIMR contribution of that partner or they must pay the difference to NIMR).[71] A patent may be transferred to a partner by NIMR when this is necessary for economic exploitation. NIMR will determine a suitable price for this transfer.

At WCFS, tangible commercial results will be patented (when the Focal Points and Programme Council decide patenting is useful). Patent applications are filed and paid for by WCFS. The costs are settled with the financial contributions of interested partners. Soon after that, all interested parties for a license form a consortium. All further costs are divided among the consortium members. If one party wants to obtain legal ownership of the patent he can get it, but he must give WCFS and the other consortium members a worldwide, royalty free, non-exclusive license. Partners who want to join in later may get a license against a reasonable fee.

At TI, IPR (and copyrights) on research results within the basic funding of TI are owned by the employer of the researcher (or shared by the employers when more researchers are involved in the invention). If TI is not the employer of the researcher, then TI may get a licence free of charge. TI will provide all participants or associated members who so desire with a (sub)licence free of charge (participants) or for a reasonable fee (associates). KIS may obtain a (sub)license for their own educational or scientific goals only. Licenses cannot be claimed to rights that have been acquired by TI before the party who wants the license was participant or associate of TI. In general, licenses end when participants or associates leave TI. In case of joint financing of projects by TI and other partners specific agreements will be developed.

All IPR arrangements seem to evolve in the same direction: in principle the knowledge is for all partners. Since IPR maintenance is very expensive, rights are transferred early in the patenting process (only initial filing done by LTI). A partner may claim specific rights against a fee: the fee may be settled with the partner contribution (i.e. the higher his contribution to the LTI, the more claims he can make).

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[70] € 5581 after application, € 5581 five years after application when patent still exists and € 5581 ten years after application. An extra fee is possible at exceptional high patent returns.

[71] The value of a patent is the aggregate costs of research and administration for the patent. The value of a license is the value of the patent multiplied by the proportion of the total industrial contribution of the partner to NIMR

9.3.2 IPR input

A partner's contribution in an LTI is either a cash input or a translation in monetary terms of an input in people or equipment. The knowledge that companies bring into projects is generally not valued. This may prevent partners from bringing in their knowledge in projects, which may slow down progress and diminish chances of success.

At TI there is currently an obligation for partners to provide relevant technologies to TI, by way of a licence for relevant background knowledge against reasonable conditions. This obligation is part of a tendency towards more open innovation processes that is especially visible already in the ICT area. Uncertainties or disputes with regard to the value of background knowledge may hamper these open innovation processes.

Some participating companies respond that their participation in an LTI would increase when a system is in place to have their background knowledge valued. It is recommended to study this possible barrier in more detail.

9.4 Other management aspects

Respondents noted that most LTIs had a learning period of organising their 'back office' support functions, such as offering appropriate financial and project management systems. In recent years this has been stabilised.

Many respondents have noted the benefits of having an LTI director who speaks the language of both industry and research.

10 Findings, conclusions and recommendations

10.1 Main conclusion

The LTI programme has enabled the launch and development of four successful LTI institutes, providing industry with relevant research. Each has performed well in terms of its own goals and business plans[72]*. However, none of the four LTI institutes has yet fully developed into 'international centres of excellence', which conduct fundamental-strategic research and harbour researchers and equipment of international excellence. It has been the assumption of the LTI programme that this type of research activity of international excellence is required to have a significant and lasting impact on the innovative capacity and competitiveness of participating sectors. After eight years the LTI instrument has not (yet) fully reached its goal, although some of the LTI institutes have shown potential in this direction.*

All four LTI-institutes needed time to find the appropriate balance between 'research excellence' and pure applied research. An important reason for this was a lack of guidance from the industrial partners, concerning their strategic research needs, in the early LTI years. In the latter years of the LTI institutes the balance shifted towards more industry oriented research but in some cases this has shifted the balance towards more short term applied research. Complementary to other existing policy instruments such as the direct funding of industrial research, or applied research through the TNO and GTI institutes, the LTI instrument aims at more medium to long term fundamental-strategic research which is able to open new technological opportunities and breakthroughs.

In order for a research institute to perform research of excellent quality, which is at the same time relevant for industry, the LTI needs to programme, jointly with the active involvement of industry. It is necessary to establish the medium to long-term technological opportunities and challenges, which can provide the industry with strategic knowledge, altering their competitive position ('need to know knowledge'). This requires both a strategic R&D vision (to anticipate market/technology options and needs) and an absorptive capacity (to translate LTI knowledge into innovations within the firm) on the side of the participating firms. It also requires a research staff and LTI management, who understand this process from two sides: (public) research and industry.

It appeared that:

- In some of the sectors in which the LTIs operate this strategic vision was hardly present (e.g. telematics users) or it took member firms quite some time to be able and willing to articulate these visions and needs. As many LTIs operated in times where industrial R&D staff and activity decreased and shifted towards more applied research, their industrial counter parts were less able to formulate how LTI research could contribute to their capabilities and challenges.

[72] A short summary of the performance of each LTI is given in Appendix F

- The 'absorptive capacity' (e.g. the ability to understand and apply research results and translate this into marketable innovations) on the industry side was either limited to a small number of industrial partners (e.g. food, metals, telecoms) or hardly present (e.g. software houses, ICT users);
- The evaluation showed that LTIs have interpreted their positioning in terms of short - long term and strategic - applied research in very different ways. This was partly determined by the type of industrial partners they involved (with varying R&D capabilities and time horizons) but also due to the programming modalities they chose to implement for their research activities;
- Across all LTIs the ability to attract top level international researchers have been limited;
- International experience shows that developing 'centres of excellence' needs time. The time frame of eight years is not sufficient.

10.2 Effects of LTI activities on the innovativeness and competitiveness of Dutch companies

The main effect of LTIs on industry has been on improving the firm's knowledge base and networking abilities. Direct effects on competitiveness could be found for those LTIs that perform applied research projects close to market development. Indirect, more long-term effects cannot be established at this point in time.

- The first, and most widespread, effect on industry has been an increase of knowledge and their knowledge base. In the context of this evaluation the significance of this increased knowledge is difficult to measure. It has been stated by several respondents that the type of knowledge developed in the LTIs should move from 'nice to know' to 'need to have', meaning that the strategic character of LTI research and the integration with industries' own R&D strategies should improve further. This is the prime responsibility of industry. Nevertheless, continued commitment to fund LTI research is an indication of industry satisfaction;
- Because of incomplete datasets and confidentiality requirements of interviewed companies, as well as the classical attribution problems, it has been impossible to quantify the direct economic effects of the LTIs. Industry satisfaction, however, is in general, large and many examples have been found of significant positive effects on turnover (and profit);
- Another important outcome of the LTIs has been the training of well-educated researchers who could be recruited by industry. The cost of training researchers to acquire a company focus in their work has decreased for those firms who have recruited LTI researchers. The pool of researchers has also increased, which has been a bottleneck for industry in many areas;
- The timing of the expected impact of LTIs depends very much on their positioning in terms of fundamental-strategic versus applied research. If the LTIs are considered to maintain their position as 'centres of excellence', able to attract international top researchers and foreign industrial partners, their research activities will have impact on the medium to long term mostly. This impact could be large if LTI research succeeds in offering industry new roads for

competitiveness. However, it will take a longer time than the current eight years to manifest itself on the market and quantifying the exact contribution of LTI activities will become more difficult. Those LTIs working in sectors with short product life cycles and limited R&D intensity will be able to show direct impacts more easily – as is the case with TI – but the spill-over effects to other players than those directly involved is likely to be much smaller.

The LTI programme did not take account of 'valorisation' activities that should take place within or alongside the core LTI research activities. The evaluation shows that –in general- the valorisation process does not occur automatically within the LTI structures. Specific valorisation activities are important to increase the effectiveness of the instrument. It has been up to the LTIs to take up these activities and find financial modalities to support them. TI and NIMR have integrated these activities in their daily activities, also for non-participating companies. WCFS is focussed on participating companies, and DPI has spent only modest efforts to this process.

- The main objective of the LTIs was to conduct strategic-fundamental research, of international excellence and with industry relevance. From the start of the programme little attention was given to how this knowledge should be taken up by industry (at programme level). In addition, the work conducted by LTIs was of a pre-competitive nature, often shared by competitors. It was assumed that by putting industry in the programming boards and involving them in project advisory roles the participating companies would be able to translate this knowledge in their own business strategies. The large R&D intensive firms taking part should be able to absorb this type of knowledge. Nevertheless, there is still a lot to gain by organising this process within the companies better. Those LTIs that operated in sectors with limited R&D intensity (TI, and later NIMR) have shifted their activities towards more applied research projects and developed specific technology transfer activities;
- The LTI programme has resulted in two spin-off companies both from TI. The international benchmark shows that it can hardly be expected in such a short time span that the LTIs create many spin-offs. In addition, the lean structure of the mostly virtual institutes implies that there is hardly any support infrastructure to manage and coach this process;
- The funding model of LTIs, which is based on research activities and company membership fees, gives little room for developing activities to disseminate research results to non-members, or to attract SMEs to take part in dissemination activities such as workshops, demonstration projects, training courses and so on;
- Patenting behaviour varies considerably from sector to sector. A general target for all LTIs is not appropriate. In line with their technology sectors DPI and WCFS are most active in applying patents of which a limited number so far has been licensed to members. So far, patents have played a limited role in valorisation;

10.3 The effect of the LTI instrument on the research infrastructure

The LTI programme has played a positive role in directing public research more towards industry needs, creating focus in the research and adding to the mass of

research performed in their areas. The bearing of this role differs substantially between the four LTIs.

- Given the size of the instrument (on average nearly €5 million annually per LTI) a significant restructuring effect on the public research infrastructure cannot be expected. The impact on the KIS of WCFS, NIMR and DPI was according to expectations. The overall impact of TI on the KIS was too low.
- Participation in LTI research has increased the industry focus, not only of those researchers taking part in specific LTI projects, but also wider in the departments and units involved. Thus, it has had an influence on the culture within the universities, although this is difficult to attribute to LTI alone;
- Overall the influence on the scientific and technological focus of research in the KIS has been modest and limited to the LTI funded projects. In the case of WCFS the effect on a division of labour with the development of clearer competences in each of the institutes can be identified most clearly. The facilitation of multi-disciplinarity is appreciated in all LTIs;
- Furthermore, LTI has played an important role in increasing the amount of polymer research, and in keeping metals research and food research above critical mass;
- Only two institutes (WCFS and NIMR) have external scientific quality assurance mechanisms in place. However, there are many examples of scientific excellent research within the LTIs, of good researchers with international reputations, and leading to publications in high impact journals. As this was not a subject for this evaluation we only have anecdotal evidence;
- It was expected by many players that TNO – and similar organisations – could take up a role as an intermediary, although this is not stated in any policy document. However, the – financial – position given to TNO in the LTI programme remains unclear. For some of the LTIs, TNO had a role mostly as a 'receiver of knowledge' with the assumption that the LTI knowledge was used for commercial purposes by TNO. In other LTIs, TNO was considered as one of the actors from the KIS performing LTI type research. It seems that the reasons for allocating TNO one or the other role were pragmatic rather than strategic.

10.4 The efficiency of the LTI instrument and the separate institutes

The efficiency of the LTI institutes is high as most LTIs have relatively small management units, which mobilise large networks of people and organisations to take part in the main research activities.

- Although data cannot be attributed to management versus research activities for each individual institute, overall it can be said that the LTI institutes have a relatively lean organisation spending less than 10% of their overall budget on operational management. However, the current financial reporting does not allow an accurate assessment of this indicator for every LTI;
- Respondents noted that most LTIs had a learning period of organising their 'back office' support functions such as offering appropriate financial and project management systems. In recent years this has been stabilised;

- Many respondents have noted the benefits of having an LTI director who speaks the language of both industry and research.

As a consequence of the high efficiency at institute level, it is expected that the overall efficiency of the instrument is high as well. However, data on the management costs of the instrument by the Ministry are not recorded.

There are a number of characteristics of the LTI instrument, which have had an influence on its impact and efficiency.

Flexibility
Each of the LTIs operates in a very different industrial and technological environment. In order to be effective each LTI has adapted its strategy and governance to this environment. In this regard, the fact that the LTI instrument did not prescribe in detail how the governance and membership models had to be organised was a good decision and has been important in maximising LTI effects.

Time horizon
The LTI programme horizon of eventually 8+2 years was absolutely crucial in the success of the programme. If the commitment of the government had been for a shorter period, industry and KIS would not have taken a similar risk by investing time and resources in the LTIs. For the success of a public-private partnership it is necessary that the commitments (both formal and informal) of public and private parties have the same time horizon, which fits with the aims of the PPS.

The 25-25-50 rule
The financial arrangements within the LTI instrument (25-25-50 rule: government finances twice the amount of the lowest contributor (either industry or knowledge institutes, on a yearly basis) have enabled the commitment from both industry and the knowledge infrastructure. In practice, the rule means that private sector input is 25%, which is justifiable if this concerns pre-competitive or fundamental-strategic research, but should be reconsidered if LTIs shift to more applied research positions.
The strict interpretation of this rule, requires complex planning and reporting procedures, and therefore increases administrative load and the financial uncertainty. The widening of this regulation in 2005 (when the EZ finance became maximal 2,5 times the minimum contribution of either industry or KIS) has decreased the effect of, sometimes inevitable, changes in planning but still requires very detailed planning procedures.

Subsidy accumulation
The anti-accumulation condition in the EZ-contribution (every additional government contribution an individual LTI is receiving is deducted from the EZ contribution) makes participation in EU-projects virtually impossible for LTIs. Participation is a way to improve the international reputation of the LTI and industry is asking (some of the) LTIs to play a role in setting up European projects. Therefore, the anti-accumulation condition was lifted partly in 2003 (accumulation possible until 60%). This has increased EU participation in recent years, but is still hampering EU participation.

Evaluation and monitoring of the instrument
As the objectives of the LTI instruments have not been clearly codified and defined in rather broad terms, the evaluation of whether the instrument has fulfilled its goals is difficult to establish. The interpretation of what constitutes a 'good' LTI institute is ambiguous. Therefore, there is no clear yardstick whether an LTI institute complies with the instrument's intentions.

The reporting and monitoring of LTIs have not been very consistent. Not all LTIs have reported on all the agreed performance indicators. Not all performance indicators were defined in sufficient detail to allow comparison between LTIs. The financial reporting is not sufficiently transparent and detailed to answer questions about efficiency. The central data collection at EZ leaves room for improvement.

10.5 The network effects of the LTI instrument

The LTI was one of the first public-private-partnership instruments introduced in the Netherlands. The networking effects of the LTI were as follows:

- Relationships between academia/ research organisations and industry have been increased and intensified. The widening of these networks varies between LTIs where some have seen a very stable but narrow network (WCFS), others a stable and growing network (DPI and NIMR) and a changing but growing network (TI);
- In terms of the quality and relevance of the industrial partners, all LTIs have captured the appropriate players in the Dutch economy;
- In terms of knowledge institutes the relevant research groups are involved as partners. The intensity of the collaboration varies considerably and not all research partners intend to continue their participation after the LTI period;
- Formal governance structures (on institute, programme and project level) have proved to be important forums for networking, as are the informal relationships which have been created;
- The effect of LTIs on business-to-business networks was not an explicit goal of the LTI instrument. Close to half of the company respondents have indicated that LTIs had a positive effect on their collaboration attitudes and an increased openness in sharing R&D intentions with other firms. Trust building has taken each of the firm's time to develop. In the modern economy depending on open innovation this is an important learning effect. The existence of the instrument in itself offers firms a platform for business-to-business collaboration, which would be very difficult to achieve without such a mechanism;
- The sustainability of the networking effect is therefore very dependent on the LTI instrument: without the instrument collaborations would most likely become more focused on bilateral relations.

10.6 The internationalisation of LTIs

Internationalisation has increased in importance during the lifetime of the LTI instrument, although there was no explicit strategy or vision what this implies for the LTIs.

The evaluation found that:

- Some LTIs have sought the internationalisation by finding complementary knowledge in foreign public research institutes (DPI and NIMR);
- DPI is the only LTI with an active strategy of involving foreign industrial partners;
- All but WCFS have involvement of large multinationals with foreign headquarters as participants;
- Many respondents claim that internationalisation is unavoidable and should be strengthened in the future.

10.7 Recommendations and lessons learnt for future LTIs

The evaluation leads to a number of lessons for the LTI programme and four key recommendations.

These are the following:

1 EZ should continue financing each LTI until December 2007;
2 A new LTI-programme should maintain the strong points of the present programme: long term commitment and contributions from KIS, companies and government, flexibility in the implementation and low management costs;
3 In the future a strategy for internationalisation – for industrial and KIS members - should be addressed more explicitly and play a more prominent role, by all partners (government, industry and KIS);
4 The focus of LTI activities from the start was to provide excellent science relevant for industry, with insufficient attention to modes for translating this science into innovations. The position, financing and modalities of valorisation and dissemination activities should be addressed in the business plans of each LTI and discussed with EZ.

In the remainder of the final paragraph the arguments for these key recommendations are elaborated and a number of more specific recommendations listed. Some of the lessons learnt that could be useful for future LTIs are described in the last paragraph.

10.7.1 The continuation of financing the existing LTIs

EZ should continue financing each LTI until December 2007.
The performance of the individual LTIs is satisfactory to good. Each LTI has a contribution to (Dutch) industry. Their performance is in **line with their business plans**, and it is therefore justified for EZ to continue financing each LTI until December 2007.

Continuation of subsidy should be evaluated according to the business plans of the LTIs. This evaluation brought forward that TI lacks a number of LTI characteristics, as was anticipated by the Ministry of Economic Affairs (EZ). Nevertheless they have performed according to their business plan, which has been negotiated with EZ on a yearly basis. In addition the direct economic effect of some of their research projects on their partner companies is significant. The subsidy should therefore be continued.

10.7.2 Recommendations with respect to a new LTI programme

A new LTI-programme should maintain the strong points of the present programme: long term commitment and contributions from KIS, companies and government, flexibility in the implementation and low management costs.

- The long-term view of 10+ years for the programme should be maintained. The long term commitment of government should be made more explicit: a commitment for at least five years (at any moment) is necessary, with a possibility for termination if a mid-term evaluation shows that the initiative is seriously underperforming;
- The financial arrangements within the LTI instrument (25-25-50 rule: government finances twice the amount of the lowest contributor (either industry or knowledge institutes, on a yearly basis) have enabled the commitment from both industry and the knowledge infrastructure. In order to decrease administrative loads and increase flexibility (in end-of-year situations) it is recommended to determine the KIS/industry ratio not yearly, but on a two or three yearly average;
- The flexibility of the instrument has had a positive effect on the development and adaptation of the institutes to the needs of their environment. The flexibility in the present LTI-programme should therefore be maintained, and no 'blueprint' for an LTI should be made in advance. However, possible new LTIs should take into account the experiences of the present LTIs in order to shorten learning curves;
- The high efficiency of the small central units of the LTIs should be maintained.

In order to further improve the LTI programme and its subsequent evaluation improvements can be made with regard to internationalisation (including subsidy accumulation), valorisation, the role of TNO, IPR input, more explicit goal setting and monitoring.

- Many respondents claim that internationalisation is unavoidable and should be strengthened in the future. It is recommended to demand an explicit strategy in this respect of any future LTI;
- Larger involvement of foreign companies in the LTIs, on the same basis as Dutch companies is recommended because it strengthens the international position of the Netherlands based KIS and opens up international networks;
- Participation of top foreign (EU) research institutes (at the same conditions of Dutch participation) is also recommended because it improves the quality of the research, stimulates national R&D groups to compete and opens international R&D networks. It is however proposed to limit the maximum participation (to 10-25% of budget), in order to keep a relation between Dutch investments and effects in the Netherlands (unless funding from international sources can be found (e.g. EU, extra contribution from foreign institutes or agencies);

- The anti-accumulation condition in the EZ-contribution (every additional government contribution an individual LTI is receiving is deducted from the EZ contribution) makes participation in EU-projects virtually impossible for LTIs. Since participation is a way to improve the international reputation of the LTI and industry asks (some of the) LTIs to play a role in setting up European projects, it is recommended to allow accumulation to a higher percentage, e.g. 75%;
- In a new LTI programme or similar initiative more attention should be focused on mechanisms to ensure dissemination and valorisation of research results. It should be considered whether these types of activities should be funded through different mechanisms and maybe with the involvement of other players such as TNO and Syntens. As each technology area and sector is different the amount of effort that needs to be invested in this activity varies considerably, partly depending on the absorptive capacity of the target groups involved. Thus this function should not be 'standardised' for each separate LTI initiative;
- It was expected by many players that TNO – and similar organisations – could take up a role as an intermediary, although this is not stated in any policy document. However, the – financial – position given to TNO in the LTI programme remains unclear. This should be clarified in a new LTI instrument. TNO should be given a role within an LTI that fits the strategic goals of the LTIs as well as their own strategy. Financial arrangements should be made to make this possible;
- Some participating companies respond that their participation in an LTI would increase when a system is in place to have their background knowledge valued. It is recommended to research this possible barrier in more detail;
- In order to evaluate a new LTI-programme in due time, and be able to assess whether this programme has reached its targets, it is necessary to specify programme goals more explicitly in advance. Since a flexible programme is proposed, with numerous specific actions, it is also necessary to specify, in advance, specific targets per specific action;
- The reporting and monitoring of LTIs have not been very consistent. Not all LTIs have reported on all the agreed performance indicators. Not all performance indicators were defined in sufficient detail to allow comparison between LTIs. The financial reporting is not sufficiently transparent and detailed to answer questions about efficiency. Performance indicators need to be better defined, and the completeness, quality and consistency of the reporting needs to checked by EZ each year;
- The central data collection at EZ including archiving should be improved;

It is recommended, for a possible next LTI evaluation, to perform a publication analysis as well as a citation analysis in advance of the evaluation and organise a peer review as part of such an evaluation.

10.7.3 Learning points for new LTIs

*The four present LTIs provide many **learning points** for new LTI initiatives.*

- When setting up a new LTI initiative it is crucial to ensure the existence of sufficient **'absorptive capacity' on the side of industry**. Industrial members should be able to play an active role in the research programming and thus set the medium to long-term goals for the research activities of the LTI. The number and

scale of industrial partners with 'absorptive capacity' should also be large enough to translate this pre-competitive knowledge into marketable innovations, within the present business models of the companies, or permit the entry into new business models. In the selection and start up phase it should be ensured that industrial partners regard LTI research as a strategic part of their own R&D portfolio;

- The programming mechanisms and membership financing models of the LTI should be organised in such a way that the LTI does not focus too strongly on short term 'problem solving' types of applied research or development projects. In relation to existing players (e.g. TNO) in the Dutch landscape such an LTI would not have sufficient added value. In addition this would not justify a level of only 25% private funding. This implies that industry should be involved and committed in setting the agenda on the level of programmes and sub-programmes, and not solely on the level of single projects. The latter model has little effect on creating coherence and critical mass in public research or on shifting the competitiveness of the firms involved significantly;
- The creation of a separate physical institute (instead of a virtual institute) implies that the budget available for influencing the (other) KIS will be very limited. This may limit the effect the LTI has on changing the culture and the creation of focus and mass in the existing research centres. The virtual model of LTIs has shown to work well and mobilised the existing KIS players;
- The balance between PhD students and postdocs (or other senior researchers) is different in each of the existing LTIs and adapted to the LTI surroundings. It is recommended for new LTI initiatives to have explicit attention for this balance when setting up their business plan.
- The LTIs use different tariffs for the research performed at the research partners. There is no system that is both cost efficient and which is satisfactory to all research partners. The use of integral cost based systems (WCFS) makes participation by public research institutes such as TNO possible, but is also expensive (partly because of high overheads within the research institutes). The use of VSNU tariffs makes participation rather unattractive because costs are only partially covered. It is recommended to leave this matter to the negotiation of the individual LTIs as it depends on the role of research partners what price/quality relation is acceptable. The experiences of the present LTIs should be shared with the new LTIs.
- Many respondents have noted the benefits of having an LTI director who speaks the language of both industry and research. The new LTIs should seek for a director who has such a dual background.

In order to safeguard scientific quality we recommend to involve international top scientists in evaluating the scientific value and relevance of proposals (e.g. as is done at WCFS) and in evaluating scientific progress of ongoing projects (e.g. with a Scientific Board as in NIMR). This stronger scientific quality assurance should however not diminish the steering role of industrial participants.

List of appendices

Appendix A List of interviewees

Name	Organisation
R.F. van Tuil	A&F
P. Penders	ABN-AMRO
B.P. Genemans MBA	Avantium
J.J. Elmendorp	Avery Dennison Materials Nederland BV
K.E. Nilsen	BOAL BV
H. Broeders	Cap Gemini
P. Jongenburger	Corus
A.A.M. de Laat	Cosun
J.K Lenstra	CWI
P. Klint	CWI
M. Dröscher	Degussa
M. Steijns	Dow Benelux
S. De Vries	DPI
M.C.A. van Egmond	DPI
J.G.H. Joosten	DPI / DSM
M.A.J. Michels	DPI / TU Eindhoven
R.P.A. van den Hof	DSM/DPI
C. Laane	DSM
J. van der Meer	Ericsson
C.P. Buijink	EZ
Tj. R. Gorter	Friesland Coberco Dairy Food
F. de Jong	FEI
H. Mulders	FEI
A. Kraaijeveld	FME-CWM
Ph. den Ouden	Fed. Ned. Levensmiddelenindustrie (FNLI)
F.J. Weggen	Fontijne Grotnes BV
T. Krug	Hauzer Techno Coating BV
O.L. Warren	Hysitron
A.A.P. Reuver	IBM
M. Van Duuren	ING
U. Bethke	INPRO
P. Reinold	Lucent
K. Müllen	Max Planck Institute für Polymerforschung
L.Hviid	NIMR
A.W.A. Konter	NIMR
N. Broekhart	NIMR
O.J.L. Ruigrok	NIMR
T.M. Plantenga	NIMR
S. Hoekstra	NIMR
A.C. Juriaanse	NIZO food research
E. Huizer	NOB/UU
Th. Ockhuizen	NZO

R. Hamberg	Oce
E.A.A.M. Broesterhuizen	OCW (nu KNAW)
T. Rodrigues	Ordina
F. Boekhorst	Philips
Spierings	Polynorm
B. Van de Graaf	Schelde Groep
H. Kuipers	Shell
H. Van Wechem	Shell
A. Broek	Sigma Coatings
H.E.H. Bouland	Stork
K. Neggers	SURFNET
E.J. Sol	TNO Industrie
G. Van Oortmerssen	TNO-ICT
C.E. Koning	TU Eindhoven
J.T. Fokkema	TU Delft
J.C.K. Consemulder	TU Delft
W.H.M. Saris	UM
J. Maat	Unilever
J.Th.M. de Hosson	University of Groningen
P.M.G. Apers	University of Twente
H. Tijdeman	University of Twente
J. Seidell	VU
J. Castenmiller	WCFS
D. Vergouwen	WCFS
W.M. de Vos	WU / WCFS
F. Voragen	WU

Appendix B The fate of not-subsidised LTI proposals

B.1 Afgewezen TTI-voorstellen

In 2001 heeft EZ laten onderzoeken wat er is gebeurd met de vijftien TTI-voorstellen die in 1996 zijn ingediend maar die niet zijn gehonoreerd[73]. Op basis van dit onderzoek en drie interviews met de directeuren van Connekt, SDE, en ESI blijkt dat voor het merendeel van de vijftien afgewezen TTI voorstellen er geen sprake is van publiekprivate samenwerking waarbij sprake is van strategische kennis ontwikkeling. Het blijkt dat:

- Zeven ingediende samenwerkingsverbanden niet van de grond zijn gekomen.
- Twee samenwerkingsverbanden, FIGON (Federatie voor Innovatief Geneesmiddelenonderzoek) en Water-Front, zich hebben ontwikkeld tot een kennisplatform, maar programmeren of financieren geen onderzoek. Beide hebben als doelstelling om kennis en informatie uitwisseling te stimuleren tussen de leden; onderzoeksinstituten, universiteiten, bedrijfsleven, (semi)overheden, etc.
- Zes samenwerkingsverbanden, in verschillende vormen, zijn voortgezet. Dit zijn Biomade (RUG), Vakgroep Verbrandingstechnologie (RUG), Samenwerkingsverband Duurzame Energie, Connekt, Embedded Systems Institute, en ACTS. Deze worden hieronder verder uitgewerkt.

Het blijkt dat de zes samenwerkingsverbanden ieder een andere weg zijn gegaan in termen van publiekprivate samenwerking en het uitvoeren van onderzoek. Meer informatie over deze samenwerkingsverbanden is in B.2 te vinden.

Eind 1999 is SDE van start gegaan met een budget van ongeveer 20 miljoen euro voor vier jaar. Hiervan is 50% betaald door EZ, 25% door kennisinfrastructuur en 25% door de industrie (cash bijdrage). Een belangrijk probleem waar SDE mee te maken had was de liberalisering van de energiemarkt waardoor het onderzoeksbudget van elektriciteit bedrijven is geminimaliseerd waardoor de industriële bijdrage aan SDE beperkt was. Mede hierdoor, de grote versnippering van energie onderzoek in Nederland en de aanwezigheid van grote onderzoeksinstituten als ECN en TNO-MEP is de impact van SDE op het energie onderzoek in Nederland beperkt gebleven.

Het Embedded Systems Instituut bestaat sinds 2002 en is een publiekprivate samenwerking tussen de drie technische universiteiten, TNO, Philips, ASML en Océ. ESI is een stichting en heeft een eigen missie en een eigen onderzoeksagenda dat hieraan gekoppeld is. Het onderzoek is fundamenteel strategische en gericht op toepassing van industriële producten van de belangrijkste klanten. Het onderzoek wordt gezamenlijk uitgevoerd door wetenschappers en industrieel R&D personeel. ESI heeft een financiering van EZ (aardgasbaten) gekregen van 25 miljoen Euro voor een periode van 8 jaar. Daarnaast dragen industriële partijen bij (cash en in kind).

Connekt is een innovatie netwerk voor verkeer en vervoer en vormt een intermediair tussen overheid, bedrijfsleven en wetenschap. Connekt heeft met name een netwerk

[73] B&A Groep. 2001. Leren van niet gehonoreerde Technologische Top Instituten. Den Haag

functie en treedt op als programmabureau voor Transumo, maar heeft geen echte rol in onderzoeksprogrammering. Er worden alleen kleine verkennende onderzoeken uitgezet (budget ongeveer 10.000 euro). Financiering komt voor 20% direct van de overheid (EZ en V&W), 30% van private partijen en de overige 50% komt binnen via project werk van Connekt.

Biomade richt zich op de (commerciële) toepassing van wetenschappelijke kennis, maar het bedrijfsleven speelt geen rol bij de onderzoeksprogrammering. Het wordt geheel bepaald vanuit de universitaire gemeenschap en is heel erg gericht op het commercialiseren van reeds bestaande kennis. De vakgroep verbrandingstechnologie is weliswaar een publiekprivate samenwerking, maar de impact is zeer beperkt omdat er maar 2 partijen deelnemen (RUG en Gasunie). Er is geen directe bijdrage van de overheid.

ACTS is een goed voorbeeld van een samenwerkingsverband waarin overheid, industrie en kennisinstelling participeren en waar hoge wetenschappelijke kwaliteit en industriële relevantie hand in hand gaan. Echter hier speelt een attributie probleem aangezien veel meer factoren dat het TTI voorstel ten grondslag hebben gelegen aan dit samenwerkingsverband, waarvan de “katalyse technologie roadmap misschien wel de belangrijkste was.

Conclusie

SDE, ESI, ACTS zijn publiek private samenwerkingsverbanden waar het programmeren en financieren van onderzoek een gezamenlijke activiteit is van kennisinstellingen, bedrijfsleven en de overheid. Alhoewel deze initiatieven in het verleden zijn afgewezen voor TTI financiering ontvangen SDE, ESI, en ACTS substantiële bijdrage van de rijksoverheid via anderen subsidiegelden. Dit blijkt essentieel te zijn om excellent onderzoek uit te voeren.

De impact van Biomade en de Vakgroep Verbrandingstechnologie op onderzoek is laag mede omdat er geen directe financiële steun is vanuit de overheid. Hierdoor ook is de rol van bedrijfsleven bij het programmeren van het onderzoek beperkt. Alhoewel Connekt een belangrijke publiekprivate netwerk rol heeft is het niet in staat om een rol te spelen bij onderzoeksprogrammering omdat een substantiële overheidsbijdrage ontbreekt.

Uit de interviews met SDE, ESI, en Connekt blijkt dat er een interesse is van het bedrijfsleven in dit soort publiekprivate initiatieven. Een belangrijk punt hierbij is de 50% matching vanuit de overheid wat een belangrijke prikkel is voor bedrijven om ook te investeren in gezamenlijk onderzoek. Een constante cofinanciering van de overheid biedt tevens de mogelijkheid om gezamenlijk iets op te bouwen op een bepaald wetenschappelijk terrein.

Om samen te vatten, zonder significante contributie van de overheid (50% matching) lijkt het vrijwel onmogelijk om een top onderzoeksinstituut op te zetten dat fundamenteel strategisch onderzoek uitvoert wat relevant is voor het bedrijfsleven en tevens een hoge mate van wetenschappelijke excellentie heeft.

B.2 Afgewezen TTI-voorstellen

Embedded Systems Institute
Het Embedded Systems Instituut bestaat sinds 2002 en is een publiekprivate samenwerking tussen de drie technische universiteiten, TNO, Philips, ASML en Océ. Het is voortgekomen uit het Eindhoven Embedded Systems Instituut opgericht door de Universiteit Eindhoven in 1998 na het negatieve oordeel over de TTI.

Het instituut heeft en eigen missie en onderzoeksverantwoording en programmeert onderzoeksprojecten waarin ook andere bedrijven en instellingen dan bovengenoemde kunnen deelnemen (ook internationaal). Er is geen tender systeem, maar onderzoek moet passen binnen de doelstellingen van ESI en het moet relevant zijn voor de belangrijkste industriële klanten van ESI (Philips, ASML, Océ). Vervolgens zoekt ESI de beste onderzoekers (nationaal en internationaal; academische en industriële onderzoekers) bij elkaar die het onderzoek gaan uitvoeren.

De onderzoeksprojecten zijn multidisciplinair en combineren wetenschappelijke kennis met een praktische insteek. De onderzoekprojecten worden gezamenlijk uitgevoerd door academische en industriële onderzoekers. De projecten die ESI uitvoert zijn grootschalige projecten (dit is een noodzaak voor de industrie). Gemiddeld project kost 6-8 miljoen euro; 6-9 promovendi; 15-20 fte per jaar. Duur 4 jaar. Er lopen nu vier projecten en in 2005 komen er nog 2 bij. Wetenschappelijke en industriële onderzoekers zitten fysiek bij elkaar om voor een aantal maanden onderzoek te doen, vaak bij TU Eindhoven, maar soms ook bij een bedrijf. Een belangrijk doel is om resultaten van onderzoek snel toegankelijk te maken via publicaties, cursussen, kennis cirkels, internet site, etc.

De vaste staf van het instituut is beperkt tot 20 man. De overige onderzoekers participeren via onderzoeksprojecten. In totaal zijn er nu ongeveer 80 onderzoekers aan het werk op ESI projecten.
Financiering komt van de overheid (25 miljoen voor 2x4 jaar uit de aardgas baten) en private partijen. Daarnaast worden er op project niveau ook subsidies aangevraagd bij NWO en moeten industriële partijen betalen (niet commerciële basis) voor het onderzoek dat ESI doet.

Samenwerkingsverband Duurzame Energie
De opzet van SDE is na de afwijzing als TTI veranderd. In het najaar van 1999 is het met een eenmalige subsidie van EZ als nog van start gegaan voor een periode van 4 jaar. Het totale budget van SDE was ongeveer 10 miljoen Euro waarvan EZ 50% betaalde, kennisinstellingen 25% en industriële partijen ook 25%. Alle activiteiten van SDE zijn nu bijna afgerond. Er wordt alleen nog wat promotie werk gedaan en er wordt een internationale biomassa aio-dag georganiseerd

De deelnemende partijen aan SDE waren de universiteiten van Twente, Eindhoven, Delft, Utrecht, Essent, Electrabel (EPON), ENECO Delfland, NUON, ECN, TNO-MEP, KEMA, Shell, Stork, BTG. De industriële partijen zijn ook vertegenwoordigd in Raad van Bestuur.

In eerste instantie was de focus met name op de elektriciteit sector, maar participatie was problematisch. Door de liberalisering van de energie markt hebben de energiebedrijven hun onderzoeksinspanning geminimaliseerd. Dit had grote gevolgen voor SDE. De elektriciteit sector stapte in feite uit SDE en dus was een groot deel industrieel geld weg. Er werden wel nieuwe industriële partners aangetrokken (o.a. Shell) maar de bijdrage en committent van de industriële partijen is gedurende de looptijd relatief beperkt gebleven. Er is geen vervolg financiering gevonden voor SDE en het is nu nog maar gedeeltelijk actief.

Gedurende vier jaar zijn er ongeveer 50 onderzoeksvoorstellen ingediend door de kennis instituten binnen SDE, de bedrijven hebben geen voorstellen ingediend. De voorstellen werden over het algemeen goedgekeurd als er ten minste 2 bedrijven die het interessant vonden. Er was geen uitgebreid evaluatie systeem om de bureaukosten beperkt te houden. Bij elk onderzoeksproject van SDE was een stuurgroep met vertegenwoordigers van bedrijfsleven aangesteld. De voortgang onderzoek werd daar besproken. De onderzoekswerkzaamheden zijn in de regel uitgevoerd bij de partijen uit de kennisinfrastructuur. Bedrijven droegen bij door geld te geven aan SDE en soms door laboratoria of installaties beschikbaar te stellen. Een groot deel van het onderzoek is bij ECN gedaan.

Connekt (kenniscentrum voor verkeer en vervoer)
Het kennis centrum voor verkeer en vervoer Connekt is een intermediair tussen overheid, bedrijfsleven en wetenschap en biedt toegang tot de netwerken van deze partijen en is ook in staat de dialoog tussen de netwerken te starten en op gang te houden. Het doel van Connekt is om een plaats te zijn waar publiek en privaat partijen elkaar kunnen ontmoeten en gezamenlijk een visie opstellen over belangrijke verkeer en vervoer thema's zoals beprijzing, mainport functie van Nederland, etc.

De leden van Connekt zijn ministeries van V&W en EZ en bedrijfsleven (NS, Haven Rotterdam, etc). De leden participeren actief en dragen financieel bij. EZ en V&W financieren samen 20%, private leden: 30% en de overige 50% wordt verdiend met project werk, met name bureau functie voor programma's als Transumo.

Naast de netwerk functie speelt Connekt ook een rol als programmabureau voor onderzoeksprogramma's op het gebied van verkeer en vervoer, zoals het NWO/Connekt stimulering programma verkeer en vervoer en TRANSUMO. Connekt zelf heeft geen onderzoeksagenda en heeft ook niet de middelen om onderzoek te financieren. Wel worden er kleine onderzoeken uitgevoerd (budget ongeveer 10.000 Euro) naar onderwerpen die relevant zijn voor de leden. Dit vormt een soort eerste aanzet voor verder onderzoek dat de leden, als ze geïnteresseerd zijn, zelf verder kunnen oppakken alleen of in samenwerking met elkaar.

Advanced Catalytic Technology for Sustainability (ACTS)
Na afwijzing van het TTI voorstel Katalyse is de samenwerking voortgezet in het kader van IOP-katalyse. Na afronding van de tweede fase IOP is gezocht naar een andere samenwerkingsvorm. Dit is ACTS geworden. In dit platform is de gehele katalyse gemeenschap vertegenwoordigd en werken partners vanuit de industrie, kennisinstellingen en overheid samen. Financiering komst van de overheid (met name NWO, EZ) en industriële partners.

De belangrijkste functie van ACTS is het financieren van precompetitief, wetenschappelijk uitdagend katalyse onderzoek. ACTS voert het onderzoek niet zelf uit, maar speelt een coördinerende rol. De “katalyse technology roadmap” speelt een belangrijke rol bij het vaststellen van het onderzoeksprogramma. Tot nu toe zijn er vijf onderzoeksprogramma’s geïdentificeerd. Project financiering vindt plaats via “calls for proposals”. Elk programma heeft een programmaraad waar diverse ACTS partners in zitten. Daarnaast speelt ACTS ook een rol in universitair onderwijs.

Biomade
Biomade is een onafhankelijk, multidisciplinair onderzoekinstituut op het gebied van moleculaire bio-nanotechnologie. De onderzoeksprojecten van Biomade richten zich op de toepassing en commercialisatie van wetenschappelijke kennis. Er is een nauwe band met verschillende onderzoeksinstituten van de RUG. Fundamenteel onderzoek vanuit de universiteiten (met name RUG) biedt de basis voor de activiteiten van Biomade. Biomade heeft ongeveer 30 onderzoekers in dienst. Bescherming van IP is een belangrijk onderdeel. Patenten worden ondergebracht in een aparte BV. Op basis van de technologieën die zijn ontwikkeld binnen Biomade zijn er twee spin-off bedrijven ontstaan die deze technologieën op de markt gaan brengen. Voor zover bekend participeren bedrijven niet in Biomade. Ook is er geen direct overheidsfinanciering.

Vakgroep verbrandingstechnologie, RUG
Het samenwerkingsverband op het vlak van aardgasverbranding is voortgezet in een structurele samenwerking tussen RUG en de Gasunie. Beide partijen doen gezamenlijk onderzoek naar verbrandingstechnologie binnen de vakgroep verbrandingstechnologie van de faculteit Wiskunde en Natuurwetenschappen. Er zijn 6 onderzoekers in dienst waardoor de impact beperkt is. Financiering door RUG en Gasunie. Geen directe financiering overheid.

Appendix C Quick scans of LTI surroundings

Per TTI is, op basis van deskresearch, en aangevuld met informatie vanuit de interviewronde, een korte analyse gemaakt van de sectoren waarin de TTIs opereren. Hierbij zijn de sectoren (voeding, metalen, polymeren en ICT/telematica)) in kaart gebracht om het belang van het veld te achterhalen (voor de Nederlandse economie), om de belangrijkste spelers te identificeren en om te achterhalen hoe de TTI's op eventuele dynamiek in de omgeving gereageerd hebben.

C.1 WCFS

De belangrijkste sector voor het WCFS is de voedings- en genotmiddelenindustrie, een van de grotere industrietakken in Nederland.[74] De sector is bovendien sterk geïntegreerd met andere sectoren zoals de primaire sector (landbouw, veeteelt, visserij), de machinebouw, verpakkingen en (door non-food toepassingen van agrogrondstoffen) de chemische industrie. De grote Nederlandse voedingsmiddelenindustrie is daarnaast nauw verbonden met de rol van Nederland als distributieland in Europa. De banden met handel en transport zijn zichtbaar aanwezig.[75]
Volgens de European Trend Chart on Innovation's *Sector Scoreboard 2003* is de innovation performance van Food sector bovengemiddeld sterk in vergelijking met de EU15. Ook heeft de sector een bovengemiddeld economisch belang voor Nederland.[76]

In 2002 waren er ruim 4800 bedrijven actief in de branche – circa 10% van het aantal bedrijven in de gehele industrie.[77] De sector is relatief arbeidsintensief en qua werkgelegenheid is het de grootste branche binnen de industrie. De sector biedt werkgelegenheid aan circa 149 duizend mensen – circa 15% van de werknemers in de totale industrie. De voedings- en genotmiddelenindustrie realiseert ruim 25% van de totale omzet van de industrie (alleen de aardolie-, chemische, rubber- en kunststofindustrie en de metaal-, elektrotechnische en transportmiddelenindustrie realiseerden meer omzet). De toegevoegde waarde is 14,5 mln euro (3,3% van BBP; 22% van Industrie). De voedings- en genotmiddelenindustrie is verantwoordelijk voor 22% van de totale buitenlandse omzet van de Nederlandse industrie.

De R&D-uitgaven van de arbeidsintensieve sector zijn 283 mln euro (3,5% van de totale R&D-uitgaven in alle sectoren; 8,1% van Industrie). De R&D-intensiteit is met 1,95 relatief laag ten opzichte van sectoren als de chemische eindproductenindustrie

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74 De statistische informatie in deze paragraaf is gebaseerd op: CBS (2003) *Industriemonitor 2003/10* (Branche uitgebreid: de voedings- en genotmiddelenindustrie, door Margot de Bontridder)

75 TNO (1996) *De technologische kennisinfrastructuur van Nederland*, TNO-rapport STB/96/005, p. 8-2.

76 "In Food products, beverages and tobacco the Netherlands is only just behind Denmark, the leader in Europe. The Netherlands is also showing a very high market share in this sector. The strong Dutch performance can be partly explained by the presence of multinational Unilever and the research network around WCFS." (European Trend Chart on Innovation. Exploring Innovation Performances by Sectors, 2003, p. 66.)

77 De hierna volgende cijfers komen van CBS en zijn voor het jaar 2002.

(16,0%), de machine-industrie (9,9%), en met name de elektrotechnische industrie (28,2%).
De innovatie-uitgaven van de sector zijn 518 mln euro, oftewel 3,6% van de toegevoegde waarde. Met een aandeel van 9,4% van de totale innovatie-uitgaven door de Nederlandse industrie vormt de voedings- en genotmiddelenindustrie een belangrijke innovatiesector. Alleen de farmaceutische industrie, de machine-industrie en de elektrotechnische industrie gaven meer uit aan innovatie. Bijna driekwart van de innovatie-uitgaven (378 mln euro) worden gedaan door grote bedrijven (>250 werknemers).[78]
Van de in totaal ruim 4800 bedrijven zijn er 224 bedrijven met eigen R&D-personeel. Daarvan behoorden 75 tot de grote bedrijven (meer dan 250 werknemers), 92 tot de middelgrote bedrijven (50 tot 250 werknemers) en 57 tot kleine bedrijven (mindere dan 50 werknemers).

Tabel 1 Kengetallen voor sector gerelateerd aan WCFS

2002 *(mln euro)*	Toegevoegde waarde *(mln euro)*	R&D-uitgaven *(mln euro)*	R&D intensiteit *(%)*	Innovatie-uitgaven *(mln euro)*	Aantal bedrijven met eigen R&D-personeel	Bedrijfsgrootte *(werkzame personen)*		
						10-50	50-250	>250
Voedings- en genotmiddelenind.	14523	283	1,95	518	224	57	92	75
Industrie	65588	3454	5,27	5510	2315	1041	947	327
Totaal	445160	8019	1,80	8618	4169	2276	1393	500

Bron: CBS (2005) *Kennis en economie 2004: Onderzoek en innovatie in Nederland,* Voorburg/Heerlen: Centraal Bureau voor de Statistiek.

De markten worden gedomineerd door grote bedrijven, steeds meer ook multinationals zoals de Nederlandse bedrijven Unilever en Heineken. Ook de agrarische coöperaties zoals Friesland Coberco en Campina in zuivel, Cosun in ingrediënten en Best Meat in vlees spelen een belangrijke rol.[79] Door overnames zijn de coöperaties groter en internationaler geworden.

Ontwikkelingen in de sector worden gekenmerkt door het toenemen van de grootschaligheid van de productie en van de kapitaalintensiviteit. Ook de kennisintensiteit is toegenomen. Ambachtelijke productieprocessen zijn in toenemende vervangen door industriële productieprocessen. De laatste jaren is de kwaliteit van de voeding en het gezondheidsaspect steeds belangrijker geworden. Voeding en farma komen dichter bij elkaar.

In de SWOT-analyse zoals die door Berenschot is gemaakt t.b.v. de Industriebrief worden sterke en zwakke punten van de Nederlandse voedings- en genotmiddelenindustrie onderscheiden. Uit de analyse blijkt dat Nederland een goede uitgangspositie heeft op het gebied van voedingsmiddelen. De ‘greenports’- en ‘food valley’-concepten zijn gebouwd op een lange historie van kennisopbouw in agrarische productie en fabricage van voedingsmiddelen. Ook voedselveiligheid en certificering in allerlei vormen zijn state-of-the-art in Nederland. Mondiaal is hier een reputatie in

[78] 17% van de uitgaven wordt gedaan door middelgrote bedrijven (50-250 werknemers) en 10% door kleine bedrijven (<50 werknemers).
[79] SWOT analyse (Industriebrief 2004)

opgebouwd.[80] Als sterke punten worden o.a. genoemd de sterke rol in de ketenregie en goede export- en handelsrelaties. Bovendien is er sprake van hoge kennisdichtheid in met name de agro-food sector en is er een relatief sterk netwerk. Als zwakke punten worden aangemerkt: het geringe onderscheidend vermogen, de relatief hoge loonkosten t.o.v. de productiviteit en een beperkte marktoriëntatie. Ook is er een gebrek aan innovatiebereidheid. Kansen voor de sector zijn o.a. een toenemend besef van de relatie tussen voeding en gezondheid, een verdere ontwikkeling van marktgestuurde ketens, het gebruik van resultaten uit life sciences in innovaties en de ontwikkeling van Nederland Food Valley (meer focus en massa). Tegelijkertijd zijn er bedreigingen in de vorm van weinig ruimte voor de primaire sector, gebrek aan een level playing field (door regelgeving), een afnemende handelspositie door verzwakking van de primaire sector, een gebrek aan ondernemerschap in de sector en de grote macht van retailers en van multinationals.

Deelnemende industriële partners in WCFS zijn Avebe, Cosun, CSM, DSM, Unilever en NZO (als 1 partij met 2 vertegenwoordigers (Campina en Friesland Foods), die 7 bedrijven vertgenwoordigen). Grote spelers uit de voedings- en genotmiddelenindustrie zoals Heineken en Best Meat ontbreken.

C.2 NIMR

In haar jaarverslag 2004 definieert het NIMR haar belangrijkste klantengroepen als de machine-industrie (food, printing, semiconductors, medical), de transportmiddelenindustrie (automotive, aerospace, shipbuilding), de basismetaal- en metaalproductenindustrie (ferro & non-ferro production, asting, moulding), en de bouwwereld (rail, road, offshore, installations & utilities).[81] De bedrijfstakken die relevant zijn voor het NIMR zijn dus talrijk en gevarieerd. Bovendien zijn er binnen de bedrijfstakken vaak grote verschillen qua bedrijfsgrootte, afzetmarkt of productieproces.[82]

Onderstaande tabel geeft een aantal kengetallen voor de betreffende bedrijfstakken.

[80] SWOT analyse (Industriebrief 2004)

[81] In termen van CBS gaat het om SBI 27-29, SBI-34-35 en SBI-45. In deze sectoranalyse wordt met name gefocust op de basismetaalindustrie, de metaalproductenindustrie, de machine-industrie en de transportmiddelenindustrie.

[82] CBS (2003) *Industriemonitor 2003/12* (Branche uitgebreid: de metaal-, elektrotechnische en transportmiddelenindustrie, door Hen van der Bosch)

Tabel 2 Kengetallen voor sectoren gerelateerd aan NIMR

2002 *(mln euro)*	Toegevoegde waarde *(mln euro)*	R&D-uitgaven *(mln euro)*	R&D intensiteit *(%)*	Innovatie-uitgaven *(mln euro)*	Aantal bedrijven met eigen R&D-personeel	Bedrijfsgrootte *(werkzame personen)*		
						10-50	50-250	>205
Basismetaal-industrie	1571	83	5,28	133	33	5	18	10
Metaalproducten-industrie	4718	58	1,23	173	354	205	129	20
Machine-industrie	4837	480	9,92	700	525	285	202	38
Transportmiddelen-industrie	3027	132	4,36	186	121	43	51	26
Subtotaal	14153	753	5,32	1192	1033	538	400	94
Industrie	65588	3454	5,27	5510	2315	1041	947	327
Totaal	445160	8019	1,80	8618	4169	2276	1393	500

Bron: CBS (2005) *Kennis en economie 2004: Onderzoek en innovatie in Nederland,* Voorburg/Heerlen: Centraal Bureau voor de Statistiek.

De *basismetaalindustrie* (SBI 27) wordt gekenmerkt door aantal dominerende grootschalige producenten die delfstoffen zoals ijzererts en bauxiet verwerken tot staal, aluminium en halfproducten zoals platen en rollen. Corus is de belangrijkste producent in Nederland.[83] De helft van de afzet van de basismetaalindustrie komt voor rekening van de export. De sector biedt werkgelegenheid aan circa 26000 mensen.[84] De productiewaarde was ruim 5700 mln euro en de toegevoegde waarde was 1571 mln euro.[85]
De R&D-intensiteit van de sector is vergelijkbaar met die van de voedings- en genotmiddelenindustrie (5,3%). De R&D-uitgaven zijn 83 mln euro, slechts 2,4% van de Industrie. De innovatie-uitgaven bedragen 133 mln euro, waarvan 123 mln wordt uitgegeven door de grote bedrijven (>250 werknemers).
Een belangrijke trend van de afgelopen jaren was dat de eisen t.a.v. kwaliteit en prestaties van materialen steeds zwaarder worden, ook t.a.v. traditionele materialen in grote volumes. Proces- en productinnovaties zijn steeds belangrijker geworden, ook bedrijfstakken verderop in de waardeketen. Ook heeft de bedrijfstak te maken met grote concurrentie uit Oost-Europa, de VS en Zuidoost Azië met name op het gebied van low-cost, low-quality producten. Samenwerking met de klant om betere producten tegen lagere prijzen te kunnen leveren is steeds belangrijker geworden.

De *metaalproductenindustrie* (SBI 28) wordt gekenmerkt door een sterke vertegenwoordiging van het MKB. Het gaat vaak om toeleveranciers die met name produceren volgens de specificaties van de opdrachtgever en om bedrijven die voor opdrachtgevers halffabrikaten be- of verwerken (bijv. lasinrichtingen en oppervlaktebehandelingbedrijven). Ook zijn er bedrijven die ontwerpen o.b.v.

[83] Bij Corus in IJmuiden werken 9.500 mensen (2005). Zij produceren 6,5 miljoen ton hoogwaardig en bekleed staal in de vorm van rollen. Staal uit IJmuiden wordt met name verwerkt in de automobielindustrie, de bouw en de verpakkingsindustrie. Het wordt verder toegepast in buizen, industriële voertuigen en huishoudelijke toepassingen zoals witgoed. De jaaromzet bedraagt 2,2 miljard euro. (zie www.corus.nl)
[84] De hierna volgende cijfers komen van CBS en zijn voor het jaar 2002.
[85] Statistiche informatie in de paragraaf is gebaseerd op: CBS (2003) *Industriemonitor 2003/12* (Branche uitgebreid: de metaal-, elektrotechnische en transportmiddelenindustrie, door Hen van der Bosch)

klantenspecificaties en bedrijven die een eigen ontwerp maken. De variëteit in de bedrijfstak is groot: er is zowel enkelstuks als massafabricage, het gaat zowel om onderdelen, sub-assemblies als om eindproducten. De internationale concurrentiedruk is groot. Ruim een kwart van de afzet is bestemd voor export en 60 procent is voor intermediair gebruik in Nederland. De sector biedt werkgelegenheid aan 104000 mensen. De productiewaarde is 13800 mln euro en de toegevoegde waarde is ruim 4700 mln euro (ruim 7% van de toegevoegde waarde van de gehele Industrie).
De R&D-intensiteit is relatief laag met 1,23%. De R&D-uitgaven zijn 58 mln euro (1,7% van de R&D-uitgaven door de gehele Industrie).

De *machine- en apparatenindustrie* (SBI 29) kent veel MKB-bedrijven. Het gaat vaak om (gespecialiseerde) toeleveranciers van grote bedrijven die complexe productiesystemen leveren. Meer dan 40% van de afzet komt voor rekening van de export. In 2002 werkten er 96000 mensen in de bedrijfstak. De productiewaarde is ruim 15 miljard euro en de toegevoegde waarde is vergelijkbaar met die van de metaalproductenindustrie (ruim 4800 mln euro, oftewel 7,4% van de toegevoegde waarde door de gehele Industrie).
De R&D-intensiteit is relatief hoog met 9,92%. De R&D-uitgaven bedragen 480 mln euro, en dat is 13,9% van de R&D-uitgaven door de gehele Industrie.

De *transportmiddelenindustrie* (SBI 34, 35) kent enerzijds enkele grote autofabrikanten en scheepswerven en anderzijds veel kleine bedrijven. Ruim eenderde van de afzet komt uit de export. In de transportmiddelenindustrie werken 61000 personen. De productiewaarde is ruim 13,5 miljard euro en de toegevoegde waarde is circa 3000 mln euro. De R&D-intensiteit is 4,36 en de hoogte van de R&D-uitgaven is 132 mln euro.
De bedrijfstakken van machinebouw en transportmiddelen kennen diverse segmenten. Er zijn bedrijven die machines bouwen op klantspecificatie, bedrijven die ontwerpen en bouwen op klantspecificatie, bedrijven die daarnaast ook onderliggende producten/processen ontwikkelen, en bedrijven met massafabricage. Sommige delen van de Nederlandse machinebouwindustrie hebben een sterke thuismarkt. De belangrijke industriële clusters agro-food en chemie vormen bijv. een strategische thuismarkt voor de machines die in deze sectoren worden gebruik.[86] Afgezien van sommige specifieke niches is Nederland in internationaal opzicht een kleine speler, zeker waar het 'off-the-shelf' machines betreft. R&D en innovatie zijn voor machinefabrikanten van groot belang. Voorbeelden van nieuwe technologische ontwikkelingen zijn het gebruik van nieuwe materialen en nieuwe technieken voor oppervlaktebehandeling.

Een belangrijke trends in de metaalproducten- en machine-industrie is een nieuwe inrichting van de waardeketen waarbij toeleveranciers steeds meer taken overnemen van OEM'ers, zoals de productie van complete (sub)systemen, het productontwerp, de logistiek, etc. De eisen die gesteld worden aan toeleveranciers worden steeds hoger. Toenemende internationalisatie is bedreigend voor Nederlandse toeleveranciers die meer op prijs dan op specialisme concurreren (jobbers) maar biedt ook kansen voor kennisintensieve bedrijven. Schaalvergroting bij afnemers biedt kansen voor toeleveranciers om diensten uit te breiden. Toeleveranciers moeten goed

[86] Nederland is bijv. marktleider in machines voor de zuivel- en vleesverwerkende industrie. Bron: EZ (1998) *Technologieradar – sectorprofielen*.

inspelen op steeds korter worden productlevenscycli. R&D en (niet-)technologische innovatie zijn steeds belangrijker geworden om een goede concurrentiepositie te krijgen en te behouden.

C.3 DPI

Het Dutch Polymer Institute heeft als belangrijkste klantengroep de bedrijven die polymeren produceren, polymeren verwerken tot kunststoffen en toepassers van kunststofproducten.
De groep van polymeerproducenten bestaat in Nederland vooral uit multinationale chemische concerns, aangevuld met een vijfentwintigtal producenten van speciale kunststoffen. De groep van multinationale polymeerproducenten bestaat niet alleen uit Nederlandse (Shell, Akzo Nobel, DSM), maar ook uit buitenlandse ondernemingen (Dow, BASF, GE Plastics en DuPont) die in Nederland gevestigd zijn. De groep van kunststofverwerkers bestaat in Nederland vooral uit ca. 1500 MKB bedrijven, maar kent ook een aantal grote geavanceerde kunststofverwerkers (waar onder Wavin, Philips en Fokker Special Products).
Toepassers van kunststoffen zijn vooral te vinden binnen de kring van de automobielindustrie (NedCar, DAF, Vredestein en toeleveranciers aan buitenlandse auto-industrie zoals Polynorm), vliegtuigbouw (Fokker Special Products), bouw (zowel voor interieurs als exterieurs), elektronica (Philips en een grote groep toeleveranciers), onderdelen voor apparatuur (Océ), huishoudelijke artikelen (Curver), textiel en verpakkingsindustrie.[87]

De onderzoekscapaciteit in het bedrijfsleven is met name geconcentreerd bij de grondstofleveranciers, zoals Akzo Nobel, DSM, GE Plastics, Basell en Shell. Zij onderzoeken en ontwikkelen verbeterde polymeren voor bestaande toepassingen, maar ook nieuwe toepassingen voor bestaande polymeren.
Recente R&D resultaten van de polymeerproducenten in Nederland zijn hoge sterkte vezels zoals Twaron van Akzo Nobel en Dyneema van DSM, en polymeren voor professionele toepassingen zoals Carilon van Shell, Stanyl van DSM en Xenoy van GE Plastics. De polymeerproducenten zijn kapitaal- en kennisintensief en sterk internationaal gericht. Zij doen applicatieonderzoek voor klanten en voor de afnemers van hun klanten. Hooguit 10% van de kunststofverwerkers doet eigen onderzoek en ontwikkeling. Voor het overgrote deel zijn de kunststofverwerkers afhankelijk van hun toeleveranciers. Die toeleveranciers zijn zowel de polymeerproducenten als de machineleveranciers.
Grote toepassers van kunststof halffabrikaten hebben een innovatiebevorderende werking op de gehele keten van grondstofleverancier tot eindproduct. Vooral de auto- en vliegtuigindustrie is daarin bepalend (NedCar, DAF en Fokker Special Products), maar Nederland kent ook een heterogene groep van technologisch vooraanstaande bedrijven die in nichemarkten actief zijn en specifieke eisen stellen die leiden tot vernieuwingen in de gehele keten. Momenteel doen Philips, Akzo Nobel en Océ grote R&D inspanningen voor nieuwe elektrisch en optisch actieve polymeren.

De polymeerproducerende industrie (Akzo Nobel, Dow, DSM, GE Plastics, Montell/Basell, Shell, etc.) is een belangrijk onderdeel van de Nederlandse chemische industrie. In 1995 kwam circa 40% van de omzet van de chemische industrie voor

[87] Bron: EZ (1998) *Technologieradar – Technologieprofielen*.

rekening van de polymeerproducerende industrie (ca. 8,7 miljard euro in 1995). Daarbovenop komt de omzet van de polymeerverwerkende industrie (ca. 3,5 miljard euro in 1995), die bestaat uit zo'n 1500 kleine en middelgrote bedrijven en een paar grotere bedrijven zoals Philips, Wavin etc. De totale omzet van de polymeerindustrie komt daarmee op 12 miljard euro (1995), wat goed is voor 10% van de totale industriële productie in Nederland.[88]. De internationale concurrentiepositie is goed, de sector is exportgeöriënteerd en dekt de gehele waardeketen.

In termen van CBS zijn de volgende bedrijfstakken van belang voor DPI: de chemische basisproductenindustrie (SBI 24.1+7) en de rubber- en kunststofindustrie (SBI93 25). Onderstaande tabel geeft een aantal kengetallen voor de betreffende bedrijfstakken. De cijfers zijn echter van beperkte waarde, omdat de genoemde bedrijfstakken (veel) breder zijn dat polymeren.

Tabel 3 Kengetallen sectoren gerelateerd aan DPI

2002	Toegevoegde waarde *(mln euro)*	R&D-uitgaven *(mln euro)*	R&D intensiteit *(%)*	Innovatie-uitgaven *(mln euro)*	Aantal bedrijven met eigen R&D-personeel	Bedrijfsgrootte *(werkzame personen)*		
						10-50	50-250	>205
Chemische basisproducten-industrie	4358	284	6,52	441	77	18	34	25
Rubber- en kunststofindustrie	1942	39	2,01	104	128	38	77	14
Industrie	65588	3454	5,27	5510	2315	1041	947	327
Totaal	445160	8019	1,80	8618	4169	2276	1393	500

Bron: CBS (2005) *Kennis en economie 2004: Onderzoek en innovatie in Nederland,* Voorburg/Heerlen: Centraal Bureau voor de Statistiek.

DPI heeft een goede dekking van het veld van grotere bedrijven. De belangrijkste polymeerproducenten zijn vertegenwoordigd (DSM, Basell, Shell, GE Plastics, Dow) evenals belangrijke polymerenverwerkers en –gebruikers (Philips, Océ) (maar niet Wavin).

C.4 Telematica Instituut

Het begrip telematica is afgeleid van de combinatie van telecommunicatie en informatica. In de sector gaat het vooral om het ontwikkelen van nieuwe telematicadiensten en de ondersteunende ICT-technologie hiervoor. De telematicadiensten zijn gericht op het verbeteren/vernieuwen van producten, diensten, werkwijzen en processen van en in gebruikersomgevingen. Deze telematicadiensten worden gekarakteriseerd door informatica-applicaties die gebruik maken van gekoppelde (heterogene) telecommunicatienetwerken zoals internet, UMTS etc. Aan de technologiekant gaat het om netwerken en de gedistribueerde informatica-applicaties (software). Telematicaproducenten zijn IT providers, netwerkproviders en de telecomindustrie.
Het TI acquireert projecten in private en de publieke sector. In de private sector zijn dat de procesindustrie, telecom, IT-industrie, hightech maakindustrie en de financiële

[88] Deze informatie is gebaseerd op Business Plan van DPI

dienstverlening. In de publieke sector gaat het om overheidsinstellingen, zorg en sociale veiligheid.[89]

In termen van het CBS is met name de sector Computerservice en informatietechnologie (SBI 72) van belang. De volgende statistische gegevens worden voor de bedrijfstak gegeven.

2002	Toegevoegde waarde *(mln euro)*	R&D-uitgaven *(mln euro)*	R&D intensiteit *(%)*	Innovatie-uitgaven *(mln euro)*	Aantal bedrijven met eigen R&D-personeel	Bedrijfsgrootte *(werkzame personen)*		
						10-50	50-250	>205
Computerservicebureaus e.d.	7612	297	3,90	439	538	443	77	18

Belangrijke trends in de gehele ICT-branche zijn: (1) een afnemende dreiging van hypercompetitie en meer aandacht voor kwaliteit, afstemming met klanten en met samenwerkingspartijen; (2) een toenemende volwassenheid van de ICT-sector (consolidatie); en (3) een voortschrijdende globalisering.[90] Dat betekent dat er steeds meer aandacht wordt besteed aan.
De conjuncturele terugslag in de ICT-sector heeft geleid tot een sterke vermindering van R&D-activiteiten in deze sector. Zo sloot Ericsson in 2002 haar onderzoeksafdeling in Enschede. KPN heeft zijn R&D ondergebracht bij het publieke TNO Telecom. Toch zijn er nog steeds telecombedrijven met een substantieel R&D-budget (zoals Ericsson in Rijen, Vodafone, Draka, Twentsche Kabelmij, Lucent en JDS Uniphase). Dienstverlenende bedrijven geven weinig uit aan onderzoek. Er zijn geen gegevens beschikbaar over de hoeveelheid onderzoek die ICT-intensieve bedrijven besteden aan ICT-gerelateerd onderzoek.[91]

Nederland kent weinig grotere bedrijven die software ontwerpen en ontwikkelen. De internationale markten worden gedomineerd door buitenlandse spelers. Voor het ontwikkelen van software voor kleinere bedrijven zijn nog wel kansen.
Banken en verzekeringen investeren intensief in nieuwe ICT-toepassingen. Samen met de telecomsector zijn ze de motor in de groei van de zakelijke dienstverlening en de ICT-diensten. Nieuwe concepten en diensten die gebruikmaken van internet en PC's van de klanten, vinden ruime verspreiding en leiden zowel tot nieuwe omzet als tot verlaging van kosten.
Nederland heeft een sterke financiële sector en een sterke verzekeringssector. Banken en verzekeringen zijn goed gepositioneerd in de thuismarkten en expanderen op basis van de sterke thuismarkt in andere landen. De effecten van de conjuncturele teruggang zijn voor de banken en verzekeringen beperkt gebleven. Dat geldt niet voor de zakelijke dienstverlening en ICT-dienstverlening. Deze bedrijven lijden nog onder de bezuinigingen die door bedrijfsleven en overheid zijn ingezet.

89 Jaarbericht 2004, p. 19.
90 EZ (2004) *ICT innovatie in Nederland: Een strategische analyse van het Nederlandse ICT-innovatiesysteem*, Den Haag: Ministerie van Economische Zaken.
91 EZ (2004) *ICT innovatie in Nederland: Een strategische analyse van het Nederlandse ICT-innovatiesysteem*, Den Haag: Ministerie van Economische Zaken.

Tabel 4 Toegevoegde waarde, R&D-uitgaven en R&D-intensiteit per sector

2002	Toegevoegde waarde (mln euro)	R&D-uitgaven (mln euro)	R&D-intensiteit (%)
Industrie	65588	3454	5,27
Voedings- en genotmiddelenindustrie	14523	283	1,95
Textiel- en lederindustrie	1364	12	0,88
Papierindustrie	1801	11	0,61
Uitgeverijen en drukkerijen	5636	24	0,43
Aardolie-industrie	5142	9	0,18
Chemische basisproductenindustrie	4358	284	6,52
Chemische eindproductenindustrie	3543	568	16,03
Rubber- en kunststofindustrie	1942	39	2,01
Basismetaalindustrie	1571	83	5,28
Metaalproductenindustrie	4718	58	1,23
Machine-industrie	4837	480	9,92
Elektrotechnische industrie	5012	1414	28,21
Transportmiddelenindustrie	3027	132	4,36
Overige industrie	8114	56	0,69
Diensten	216732	2049*	0,95
Overig	53689	204	0,38
Totaal	445160**	8019	1,80

* Inclusief researchinstellingen, research-ondernemingen en Particuliere Non-Profit instellingen
**Bruto binnenlands product (marktprijzen).

Bron: CBS (2005) *Kennis en economie 2004: Onderzoek en innovatie in Nederland,* Voorburg/Heerlen: Centraal Bureau voor de Statistiek.

Tabel 5 Innovatie-uitgaven

2002 *(mln euro)*	Totaal	Eigen onderzoek	Uitbesteed onderzoek	Inkoop apparatuur	licenties/ advisering	Overige uitgaven
Totaal	8618	4571	1224	1503	370	949
Industrie	5510	3492	907	770	78	263
Voedings- en genotmiddelenindustrie	518	287	76	81	13	61
Textiel- en lederindustrie	48	14	2	29	1	2
Papierindustrie	152	13	18	115	1	4
Uitgeverijen en drukkerijen	205	26	8	104	22	46
Aardolie-industrie	44	9	6	28	0	0
Chemische basisproductenindustrie	441	285	129	24	2	2
Farmaceutische industrie	615	382	202	27	1	2
Overige chemische eindproductenindustrie	282	186	39	28	1	26
Rubber- en kunststofind.	104	43	4	52	1	4
Basismetaalindustrie	133	84	26	18	1	4
Metaalproductenindustrie	173	67	7	85	3	11
Machine-industrie	700	487	142	34	11	26
Elektrotechnische ind.	1758	1416	213	63	12	55
Transportmiddelenind.	186	132	28	19	4	4
Overige industrie	152	60	10	62	5	16
Diensten	2424	856	186	511	229	642
Overig	684	223	131	223	63	44

Bron: CBS (2005) *Kennis en economie 2004: Onderzoek en innovatie in Nederland,* Voorburg/Heerlen: Centraal Bureau voor de Statistiek.

Tabel 6 Aantal bedrijven met eigen R&D-personeel

	2001	2002			
	Totaal	Totaal	Bedrijfsgrootte (werkzame personen)		
			10 tot 50	50 tot 250	250 of meer
Totaal	3624	4169	2276	1393	500
Industrie	1987	2315	1041	947	327
Voedings- en genotmiddelenindustrie	186	224	57	92	75
Textiel- en lederindustrie81	60	14	x	x	
Papierindustrie	x	60	10	x	x
Uitgeverijen en drukkerijen	23	68	30	25	13
Aardolie-industrie	x	9	4	–	5
Chemische basisproductenindustrie	44	77	18	34	25
Farmaceutische industrie	21	27	10	8	9
Overige chemische eindproductenind.	117	145	77	54	14
Rubber- en kunststofindustrie	108	128	38	77	14
Basismetaalindustrie	35	33	5	18	10
Metaalproductenindustrie	280	354	205	129	20
Machine-industrie	457	525	285	202	38
Elektrotechnische industrie	267	301	179	92	31
Transportmiddelenindustrie	113	121	43	51	26
Overige industrie	197	182	67	84	32

Bron: CBS (2005) *Kennis en economie 2004*, Tabel A.3.1.2.1.

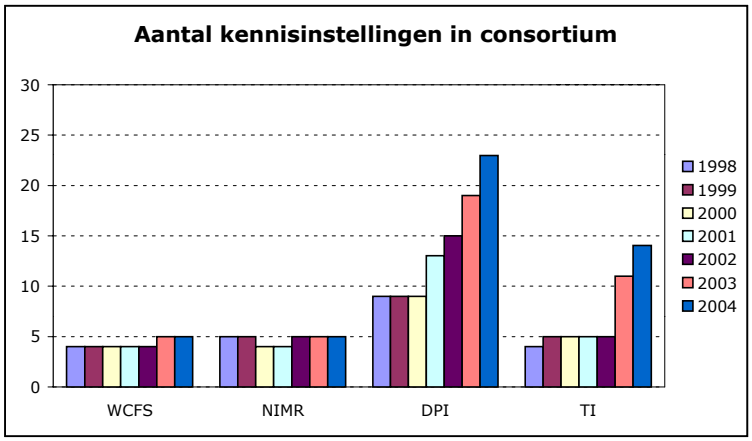
Tabel 7 Innovatie-enquête: onderzoekspopulatie en percentage innovatieve bedrijven naar bedrijfstak, 2000–2002

	Totaal[1)]	Inno-vatoren als % van (1)	Bedrijfsgrootte (aantal werkzame personen)					
			10 tot 50		50 tot 250		250 of meer	
			bedrij-ven	inno-vatoren als % van (3)	bedrij-ven	inno-vatoren als % van (5)	bedrij-ven	inno-vatoren als % van (7)
	1	2	3	4	5	6	7	8
	abs.	%	abs.	%	abs.	%	abs.	%
Totaal	59183	20	49002	16	8479	35	1702	52
Industrie	11775	40	8781	31	2434	61	560	77
Voedings- en genotmiddelenind.	1676	30	1239	19	337	54	100	89
Textiel- en lederindustrie	485	24	370	13	106	59	9	84
Papierindustrie	254	55	128	41	101	68	25	76
Uitgeverijen en drukkerijen	1306	26	1063	22	196	41	47	52
Aardolie-industrie	24	50	18	33	–	–	6	100
Chemische basisproductenind.	165	67	62	54	71	68	32	89
Farmaceutische ind.	63	66	32	63	21	54	10	100
Overige chemische eindproductenind.	215	79	118	75	79	81	18	88
Rubber- en kunststofindustrie	512	51	324	39	171	68	17	100
Basismetaalindustrie	115	53	61	27	37	78	17	92
Metaalproductenind.	2190	37	1795	32	361	56	34	89
Machine-industrie	1517	55	1117	46	352	77	48	100
Elektrotechnische industrie	809	48	602	40	171	66	36	97
Transportmiddelenind.	557	38	401	28	120	56	36	80
Overige industrie	1887	35	1451	30	311	56	125	47

[1)] Bedrijven met 10 of meer werkzame personen.
Bron: CBS (2005) *Kennis en economie 2004*, Tabel B5.2
Bron: CBS, Enquête R&D en innovatie bij bedrijven.

Appendix D Participation of KIS in LTIs

Figuur 1 Aantal deelnemende KIS in vier TTIs (1998-2004)



Tabel 8 KIS participants per TTI (2001-2004)

	2000	2001	2002	2003	2004
DPI	TU/e TNO UT RuG TU Delft KU Nijmegen WU U. Hamburg U. Napoli	TU/e TNO UT RuG TU Delft KU Nijmegen WU U. Hamburg U. Napoli UU UvA U Leiden U Stellenbosch	TU/e TNO UT RuG TU Delft KU Nijmegen WU U. Hamburg U. Napoli UU UvA U Leiden U Stellenbosch ATO Queen Mary	TU/e TNO UT RuG TU Delft RU Nijmegen WU U. Hamburg U. Napoli UU UvA U Leiden U Stellenbosch ATO Queen Mary U Maastricht NWO Dubble ECN TU Athens U. Leeds	TU/e TNO UT RuG TU Delft RU Nijmegen WUR U Hamburg U Napoli UU UvA U Leiden U Stellenbosch A&F Queen Mary U Maastricht NWO Dubble ECN TU Athens U. Leeds U. East Anglia ESPCI/CNRS DKI
DPI #	9	13	15	19	23
TI	CWI KUB (UvT) TNO-MET TU Delft UT	CWI KUB (UvT) TNO-MET TU Delft UT	CWI UvT TNO-MET TU Delft UT	CWI UvT TNO TU Delft UT KU Nijmegen LIACS Roessingh R&D TU/e UvA CeTIM	CWI UvT TNO TU Delft UT RU Nijmegen LIACS Roessingh R&D TU/e UvA CeTIM RuG UM UU
TI #	5	5	5	11	14
NIMR		TU Delft TU/e RuG UT	TU Delft TU/e RuG UT RWTH Aachen *"Academic contacts"* U Trondheim SINTEF U Gent KU Leuven U Sheffield	TU Delft TU/e RuG UT RWTH Aachen *"Academic contacts"* U Trondheim SINTEF U Gent KU Leuven U Sheffield U Cambridge	TU Delft TU/e RuG UT RWTH Aachen *"Academic contacts"* U Trondheim SINTEF U Gent U Oxford U Cambridge
NIMR#		4	5+5	5+6	5+5
WCFS	NIZO TNO DLO WU	NIZO TNO DLO WU	NIZO TNO DLO WU	NIZO TNO DLO WU UM	NIZO TNO DLO WU UM
WCFS #	4	4	4	5	5

DPI kent in 2005 nog 3 nieuwe KIS deelnemers: U Birmingham, U Köln en Max Planck Inst. Für Polymer Forschung.

Appendix E Some remarks on individual LTIs

E.1 DPI

DPI has achieved international reputation. The most important Dutch players participate, both from industry as well as from the KIS. There is also a large participation from foreign companies and a relatively large part of the research is performed by foreign KIS. The (large) contribution of Dutch research institutes is partly seen as industrial contribution. The industry contribution (without these institute contributions) is 21.8 % of total budget. The industry is very satisfied with their influence on DPI programming, which is based on a ticket system where companies can buy tickets for programme areas. Research groups are asked for their participation in regular calls for proposals. Non-Dutch groups are also asked to submit proposals. Final choice of the researcher is based on quality.
The scientific quality of the research is good (according to respondents), with some world-class researchers involved in DPI. The quality insurance system however may be improved and some measures have been taken recently (a.o. creation of international scientific board).
The focus of the research is middle to long term. Some KIS repondents state there is a tendency to become too short term (and scientifically less interesting). There is only limited attention for valorisation of research results. This is however not a problem since the 'absorptive capacity' for scientific knowledge of the industry involved is high.
The contribution of DPI to the competitive position of participating companies is limited but present, and may increase over time. Creating a strong public research infrastructure in the Netherlands on polymer research (approx. 500 researchers in 2005, compared to 150-200 in 1995) and the education of many good, industry-oriented researchers are considered the main results of DPI.

E.2 NIMR

NIMR is considered by their scientific board to be an internationally unique institute in the area of metals research. According to respondents NIMR has no real international reputation yet, but the European reputation is growing rapidly.
The industry sector is very diverse and consists largely of SMEs of which only a few participate. There are only a few larger players, most of these participate.
There is no significant participation from foreign companies (although some participations are from Dutch subsidiaries from multinational companies). The research is mainly performed in the Netherlands (exception: RWTH Aachen is an important partner). The (large) contribution of Dutch research institutes (mainly TNO) is entirely seen as industrial contribution. The industry contribution (without these institute contributions) is only 17,9% of total budget. The industry is satisfied with their influence on NIMR programming, which is a direct return system: every €50.000 participation gives a right on 2 fte research capacity: the programme is based on the resulting projects. Research groups are chosen for the specific expertise asked in the projects. This is a closed system: only when the expertise cannot be found with the NIMR research partners' external expertise is sought.

The scientific quality of research is generally considered to be good to excellent, (by the same Scientific Board) although open for improvement in some areas.
The focus of the research is short to term because the strong possibilities of industry to direct the research. There is extensive attention for valorisation of research results: both towards partners as well to the general metals sector in the Netherlands. This is necessary because of the low absorption capacity of most companies in the sector. NIMR has organised this very well, in cooperation with the sectoral organisations and the research institutes.
The contribution of NIMR to the competitive position of participating companies is evaluated as rather high: this is probably caused by the very high attention for knowledge transfer and therefore the presence of non-pre-competitive activities within NIMR.
NIMR has not lead to an increase in number of metals researchers in the public infrastructure in the Netherlands, it has however increased focus of the public research towards industry needs. It is very likely that, when NIMR would not have existed that metals research in the Netherlands would have slipped below critical mass. NIMR helps companies in shaping their technology strategy by performing roadmap studies.

E.3 TI

TI is very different from the other LTIs. It is partly non-virtual (50% of budget is spent in the own TI Central Organisation (TICO). This is considered necessary by TI management because the gap between public research infrastructure and business is enormous. KIS research is rather theory-oriented, is, because of the necessity to deliver PhD theses, thinking in time frames of 4 years and is almost entirely monodisciplinary oriented, while the TI related business sectors have in general short business cycles (2 years is very long) and are very risk aversive. The dot.com crisis had a very drastic impact on the TI surrounding: telecommunications hardware research where thousands were employed in the Netherlands reduced its personnel sharply, and other ICT research also slowed down. Many original TI partners diminished their participation and the gap between KIS and industry increased again. TI had to rebuild its member group, and focused more on building consortia with possible end-users of telematics. TI has done this succesfully.
The potential group of end-users is enormous. From the knowledge chain the software houses are missing within TI, they know TI but are very negative because they say the work of TI is far to fundamental. Participating end-users, hardware developers and systemintegrators however are rather positive about TI. They think TI has good project managers, and have a good quality on a national level.
TI however is not internationally (scientifically) outstanding, and has no international scientific reputation, according to most respondents. TI on the other hand does not strive for scientific excellence, but wants to provide directions for solutions for practical problems that directly improve the competitive position of partners.
There is no significant participation from foreign companies , but much participation is from Dutch subsidiaries from multinational companies that use the TI knowledge abroad as well. The research is for 50% performed within TICO, 50% is ‘outsourced’ to Dutch KIS.
The industry is satisfied with their influence on TI programming. There is a long-term scientific plan, but the real programming is done on project level where participants have a direct influence on the project set up. The programming process however is

not very transparent. Research partners are approached on the base of project needs. KIS partners are in general not satisfied with their role. The projects are considered not scientific excellent and they think TICO is performing too much work themselves. They feel they have to compete with TICO.
The focus of part of the research is, compared to the other LTIs, short term (0,5-2 year), but for part of the business far too long term. The projects are very much application oriented, and there is specific attention for valorisation of research results outside the (project)partners (e.g. with Syntens, not financed from LTI core budget).
The contribution of TI to the competitive position of participating companies is evaluated as low to non-existent, but respondents report a rather large satisfaction with the contribution of TI research towards new products of processes. Reported cost savings and turnover are in the range of tens of millions.
TI influence of TI on Dutch public KIS has been small, compared to the other LTIs. TI's way of working with end-users in a very professional project management manner may however have influenced KIS research positively. TI only play a limited role in setting research agendas, although many had hoped that TI would have been able to do that. The gap between KIS research and industry remains large.
The distinction between the role of TNO ICT and TI is not clear and needs clarification.
TI seems to perform a necessary role in the ICT research landscape. TI also has carried out it's own approved businessplan.

E.4 WCFS

WCFS also has an international reputation, this was however not build from scratch, but is based on the solid international reputation of 'Wageningen'. The number of participants (both companies and KIS) is limited, but the most important R&D players in the Netherlands are present. There is no participation of foreign partners. Mass may therefore become too low to maintain the international competitive position on the long term. The contribution of research institutes is seen as KIS contribution. The industry contribution is therefore 25 % of total budget.
The industry is satisfied with their influence on WCFS programming, but sees room for improvement. Programming is done centrally, all participants have equal votes (apart from the dairy industry who have two votes) but the programming process takes interests of the different parties in account in relation to their contribution.
Participating KIS has the guarantee that at least they perform 80% of the research. They are mobilised by means of (internal) calls. If no suitable KIS partner can be found within the WCFS consortium external partners are sought.
The scientific quality of the research is good in two programme areas, but may improve in the third (according to respondents). The focus of the research is long term. There is only attention for valorisation of research results within the consortium.
The smaller partners in the WCFS consortium feel they lack the absorptive capacity, and transfer to SMEs outside WCFS does not exist.
The contribution of WCFS to the competitive position of participating companies is limited but for some parties clear and expected to increase. Results of WCFS research start to appear in new products and concepts.
Maintaining the strong public research infrastructure in the Netherlands on food research is considered an important result of WCFS. Creating a common vision for fundamental strategic research, (beginning) new product concepts and good researchers are considered important as well.

Appendix F Benchmarking the LTIs with institutes abroad

F.1 Introduction

After 8 years the LTIs are expected to have built an international reputation and be comparable to other leading institutes worldwide. In this section the results of an international benchmark will be described. For this activity 8 benchmark institutes have been selected based on their scientific and their organizational characteristics.

The following institutes have been selected:

5 Swedish Institute of Computer Science (SICS), Sweden
6 Fraunhofer-Gesellschaft Institute for Security in Information Technology (SIT), Germany
7 Swedish Institute for Food and Biotechnology (SIK), Sweden
8 Institute for Food Research (IFR), UK
9 Cooperative Research Center for Cast Metals Manufacturing (CAST), Australia
10 ARC Light Metal Competence Center Ranshofen (LKR), Austria
11 Max Planck Institute for Polymer Research (MPI-P), Germany
12 Interuniversity Electronics Center (IMEC), Belgium

The purpose of the benchmark is to compare some critical performance indicators and best practice information from a number of leading institutes worldwide which are similar to the Dutch LTI's in scientific focus or organisation structure.

F.2 Facts and funding

Most institutes started in the 1980s, with the exception of SIT (1961 in its previous format) and the two metals-institutes (1990s). Staff numbers range from 40 (LKR) to more than 300 (IFR) except for IMEC: its staff exceeds 1300. The turnover of IMEC and is an isolated case as well: with its 159 m€ it leaves the other institutes far behind. Most of the institutes retain a yearly turnover between 4 m€ and 20 m€. Concerning the funding model, 3 institutes are comparable to the Dutch LTI's: industry funds +/- 25%, 50% is funded by the government and 25% by others, which is broader than university funding (also EU and other funds). These are CAST, SIC and SIT. Two others, SIK and IMEC, are quite profoundly funded by the industry, while IFR is mostly funded by government or research councils. For two institutes the findings are not sufficient. Almost all the institutes are founded as not-for-profit, independent organizations.

F.3 Organization and industry participation

Except for one, the organizational models of the institutes are distinct from the way the Dutch LTIs are organized. All organizations except for CAST's, are physical, unlike the virtual organization of (most of) the LTIs. CAST is -as an unincorporated

joint venture- exceptional, but still employs 65 researchers and 25 graduate students as permanent staff. The benchmark institutes do take place in networks in and outside their organizations, and some have strong links with university and industry.

In CAST, SICS, SIT, SIK and IMEC, industry participates in the organization by being member in the governing or advisory board or holding shares (up to 70% in SIK). Moreover, all the institutes affirm that industry has a role in the research planning. However, the significance of this role is not easily measurable, and therefore should be considered with care. Only SIT and IFR state that the role of industry in program planning is insignificant: In SIT the industry does participate in the joint development of products, but does not take part in the program planning. IFR's planning mainly relates to BBSRC strategies and their driver to accelerate in their core sciences. Industry participation seems to become most tangible when it is part of a policy or strategy mechanism (like LKR's Kplus programme and IMEC's IIAP's and open research platforms) of the institute.

F.4 Research position

Most of the benchmark institutes conduct pre-competitive, basic research. However, they also almost all do perform to a certain extent contract research, or market oriented applied research. Only MPI-I, IFR and IMEC say to stay preferably focused on long-term basic research, although this research is often conducted under contract of third parties (industry, governmental bodies). SIT and IMEC openly desire a role as bridge between science and industry, and MPI-P, LKR and IFR explicitly mention the multi and interdisciplinarity of their research. Most of the research is nationally focused, with the exception of a regular participation in EU research projects.

F.5 Scientific output

It is very difficult to collect data about scientific output of the institutes without carrying out a survey or conducting interviews. Based on website information and annual reports only four benchmark institutes gave insight in their output in terms of patents, publications or spin-offs. IMEC publishes 1,05 articles a year per staff member; SICS 0,75; and IFR 1,63, which corresponds to its rather scientific focus. SICS obtained 1,28 patents per year per million Euro, while IMEC only obtained 0,32 patents p.y.p.m. There is no information available about the other institutes. However, when focusing on spin-offs, IMEC takes the lead with 20 spin-offs since foundation, followed by SICS, accountable 11 spin-offs and SIT, with 2 spin-offs.

Info all based on annual reports 2003-2004 and websites	**General information** **-***Year of foundation* *-Turnover* *-Staff*	**Funding model** *-Legal entity* *-Government*[92] *-Industry* *-Other*	**(Research) organization model** **-***Virtual/ physical*	**Industry participation and influence** *-Participation in organization* *-Influence in program*	**Output** -Patents (p. year p. m€ turnover) *-Publications (% nrstaff)* *-Spin-offs*	**Research position** **-***Focus* *-Internationalization* *-Interdisciplinary*
Dutch Polymer Institute (DPI)	**-** **-18 m€** **-150**	**-Foundation** **-Gov. 50% (9 m€)** **-Industry 25% (4,5 m€)** **-Other 25% (4,5 m€)**	**-Virtual**	**-Participating in consortium (53 companies)**		**Exploratory, pre-competitive research**
Max Planck Institute for Polymer Research and Johannes Gutenberg-Universität Mainz (MP-IP)	-1983 *-No information available* -450 (163 scientists, 139 grad's and PhD students, 148 technicians, SA's and adm. staff, 57 visiting scientists)	- Non-profit under private law, registered association -No info about funding available	-Physical	-No participation in organization -Industry has influence in basic research and funds researchers	*No information available*	-Basic research, exploratory but in close collaboration with industry -Internationalization: only participation in EU projects -Interdisciplinary
Netherlands Institute of Metals Research (NIMR)	- **-16,7 m€** **-97**	**-Foundation** **-Gov. 40% (6,7 m€)** **-Industry 22% (3,7 m€)** **-Other 38% (6,3 m€)**		**-Participating in consortium (23 companies)**		
Cooperative Research Center for Cast Metals Manufacturing (CAST)	-1999 -10,5 m€ yearly 63 m€ (over 7 years to 2006) -65 researchers, 25 graduate students	- Part of government CRC program -no info on CAST alone -In the field manufacturing technology (CAST is part of this category) - Gov: (27%) 188,4 m€ -Industry: (23%) 165,5 m€ -Others: (50%) 355 m€	-Virtual: unincorporated joint venture of 19 partners (industry, universities, research organizations)	-Industry is member in Governing Board and shareholder -Industry participants are integrated in program planning	*-No information available*	-Research for industry -International focus: collaboration with LKR, Canada, etc
ARC Light Metal	-1994	-Independent	-Physical: 3 profit	-no information on industry	*-No*	-Application orientated (non-

[92] This comprises both basic (subsidies etc) as contract (program/project related) funding

Competence Center Ranshofen (LKR)	-4 m€ (2004) -40 (+20 temp)	-Gov. 100% with partnerships with industry and research organizations. *Further specifications not given.*	centres	participation in organization - Kplus combines partners from science and industry for a period of seven years for the purpose of research projects.	*information available*	Kplus) and on long-term cooperation between industry and research (Kplus) -Nationally focused
Telematics Institute (TI)	**-** **-15,5 m€** **-124**	**- Foundation** **-Gov. 33% (5,1 m€)** **-Industry 25% (3,8 m€)** **-Other 42% (6,6 m€)**		**-Participating in consortium (34 companies)**		**Fundamental research and the market-oriented application of developed systems. Strategic top-level research for business and industry.**
Swedish Institute of Computer Science (SICS)	-1985 -8,6 m€ -88 (77 researchers)	-Non-profit, owned by industry and government -Gov. 60% (5,2 m€) -Industry 26% (2,2 m€) -Other: 14% (1,2 m€) (technology transfer revenues).	-Physical	-The industry has influence in SICS research program since it owns 60% of its shares. It has a majority vote on the Board of Directors Next to this, the industry has certain rights to SICS owned IPR. - It is active in defining research programs.	-1,28 -0,75 -8 spin-offs (since 1998) + 3 prior to this date: but dissolved with no trace	-Contract and long-term research, think tank -Nationally focused
Fraunhofer-Gesellschaft Institute for Security in Information Technology (FhG-SIT)	-1961 as computer center, many changes and shifts: since 2001 in current model -3,08 m€ -140 (80 researchers)	-Non-profit, part of FhG but independent (decentralized management) -Gov. 44% (1,35m€) -Industry 38% (1,17m€) -Other 18% (0,56m€)	-Physical with membership in virtual networks: ICT group, E-security network, CAST forum et cetera	-Participation in organization in Advisory Board -Joint development of products in 'partners for innovation program'. No strong influence in program.	-*No information available on patents* -*No information available on publications* -2 spin-offs (since 2001)	-Bridge between science and industry in applied research, both pre-competitive as contract research -Internationally focused: representative in Japan
Wageningen Centre for Food Sciences (WCFS)	**-** **-22,6 m€** **-176**	**-Foundation** **-Gov. 40% (9,1 m€)** **-Industry 24% (5,4 m€)** **-Other 36% (8,1m€)**		**-Participating in consortium (11 companies)**		**Project based research with common interest of industrial and scientific partners**
Swedish Institute for	-No information	-Independent, merged	-Physical but	-Industry participates in	-*No*	-Both long-term and short-term

Food and Biotechnology (SIK)	available -10,7 m€ (2004) -100	with SP -Gov. 33%[93] (3,56 m€) -Industry 66% (7,1 m€) -Other 0%	member in virtual network of knowledge centers	member's association (70% of SIK's shares) -Industrial committee steers research policy, programs strongly directed to questions and needs of members	*information available*	(contract) research -Internationalization: international members in Members' Association, participation in int. networks and EU projects
Institute of Food Research (IFR)	-1986 -20,5 m€ (2004) -306 (235 researcher)	-Non-profit, charity -Gov. 68% (14 m€) -Industry 7% (1,4 m€) -Other 25% (5,2 m€) (EU, FSA, research councils)	-Physical, but participant in bioscience network	-Industry participation through food & health network/ expertise clusters -No strong influence in program: international quality is the primary driver of CORE science. -But participants of industry in Governing board assisting research policy -Industry is one of several stakeholders in fundamental research activities. Confidential research contracts and consultancy services. Interaction through DEFRA LINK and KT Partnerships, and through our EC funded projects	-*No information available* -1,63 -*No information available*	-Mostly basic and long-term research -Internationalization: participation in EU projects -Multidisciplinary
Interuniversity Micro Electronics Center (IMEC)	-1984 -159 m€ -1328 (430 industrial residents and guest researchers)	- Non-profit, independent -Gov. 22% (34,5 m€) -Industry 67% (107 m€) -Other % 11% (17,4 m€)	-Physical	-Delegates of industry in the Board -Influence in program in open research platforms; IIAP; sponsorship programs	-0,32 -1,05 -20 spin-offs (since foundation)	-Pre-competitive research (3-10 years ahead of industry demand); bridge between industry and research -Internationalization: international research focus, also international 'representatives' in US, China, Japan

[93] Inclusive VINNOVA, EU and research councils

Appendix G List of abbreviations

AiO	PhD student
ATO	Agrotechnological Research Institute
A&F	Agrotechnology & Food Innovations B.V. (formerly ATO)
BBSRC	Biotechnology and Biological Sciences Research Council (UK)
Bsik	Decree Regarding Subsidies for Investment in the Knowledge Infrastructure
CAST	CRC for Cast Metals Manufacturing (Australia)
CBS	Statistics Netherlands
CWI	Center for Mathematics and Computer Science
DKI	Deutsches Kunststoff-Institut
DLO	Agricultural Research Organisation
DPI	Dutch Polymer Institute
ECN	Dutch Energy Research Center
ERA-NET	European Research Area Network
EU	European Union
EZ	Dutch Ministry of Economic Affairs
FhG-SIT	Fraunhofer-Gesellschaft Institute for Security in Information Technology (Germany)
FOM	Foundation for Fundamental Research on Matter
GTI	Large Technological Institute
HRM	Human Resource Management
IFR	Institute for Food Research (UK)
IIAP	Industrial Affiliation Programme
IOP	Innovation Oriented Research Programmes
IMEC	Interuniversity Micro Electronics Centre (BE)
INRA	French National Institute for Agricultural Research
IPR	Intellectual Property Rights
IS	Programme Innovation Subsidy for Collaborative Projects
KIS	Knowledge Infrastructure
KUN	Nijmegen University (Radboud University)
LKR	ARC Light Metal Competence Centre Ranshofen (Austria)
LTI	Leading Technological Institute
MPI-P	Max Planck Institute for Polymer Research (Germany)
NIMR	Netherlands Institute for Metals Research
NIZO	Netherlands Institute of Dairy Research
NLR	National Aerospace Laboratory
NOD	Dutch Research Database
NWO	Netherlands Organization for Scientific Research
NZO	Netherlands Dairy Organization
R&D	Research & Development
RUG	Groningen University
RUL	Leiden University
RWTH	Aachen University of Technology (Germany)
SBI-code	Dutch Standard Company Classification
SIK	Swedish Institute for Food and Biotechnology
SICS	Swedish Institute of Computer Science

SKO	Knowledge Transfer Entrepreneurs SME
SKB	Knowledge Transfer Trade Associations
SME	Small and Medium size Entreprizes
STW	Technology and Science Foundation
Syntens	Innovation Network for Entrepreneurs
TA	Technology Area
TI	Telematics Institute
TNO	The Netherlands Organization for Applied Scientific Research
TRC	Telematics Research Centre
TU	Technical University
TUD	Technical University Delft
TU/e	Eindhoven University
UM	Maastricht University
UT	Twente University
UU	Utrecht University
UvA	University of Amsterdam
UvT	Tilburg University
VSNU	Association of Universities in the Netherlands
VTT	VTT Technical Research Center of Finland
WBSO	Research and Development (Promotion) Act
WCFS	Wageningen Centre for Food Sciences
WU	Wageningen University