Chapter 11

Public-Private Partnerships — an Example from the Netherlands: The Industrial Partnership Programme

Pieter de Witte
Foundation for Fundamental Research on Matter (FOM),
P.O. Box 3021, 3502 GA, Utrecht, the Netherlands
pieter.de.witte@fom.nl

11.1 Introduction

11.1.1 *General Introduction*

The development of nanotechnology applications from fundamental nanoscience can be a luring perspective for innovative companies and entrepreneurs. Some examples of applications are nanofilters, spintronic devices, and nanobatteries, while new applications in fields like drug delivery, quantum computing, and optoelectronics are being developed or hold a future promise.* One way for companies to enhance their technological innovation capabilities

*This chapter is not intended to provide a review on nanotech applications. There are many books available on nanotech applications, mostly focusing on an application area. A flavour of applications can also be found in Chapter 1.

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and develop these new applications is to collaborate with universities and public knowledge institutes.

A specific example of public private collaboration in basic research is the Industrial Partnership Programme (IPP) in the Netherlands. An IPP is intended for longer-term basic research by academics in close contact with industrial researchers in areas with a good potential for innovation and challenging scientific questions. The industrial partner and FOM together finance an IPP.

This chapter is devoted to a practical description of the IPP. In describing the setup of the programme, and explaining crucial factors that make it a successful programme, I intend to provide an insight into how fundamental science can add to innovation, and, ultimately, commercialization in firms.

In this section the IPP is introduced and is described in a context of other public private initiatives and of open innovation. In Section 11.2 the organization of an IPP is described from the embryonic stage to the execution phase. In Section 11.3 I will qualitatively discuss the results obtained so far and elaborate on the role of knowledge transfer, and the network. I will also share some experiences from partners. The last section draws conclusions and provides an outlook for future developments.

The IPP is developed, managed, and executed by the Dutch science foundation in physics, FOM, and could provide a tool to help shape the (open) innovation process from a basic science perspective.

11.1.2 *Public-Private Partnerships in Research*

In their effort to move the frontiers of knowledge, universities are important contributors to technological innovation, either through basic or applied research. Generic links between universities and industry like graduate recruitment, the use of scientific publications or university patents add to the innovation capacity of companies. However, organized university–industry relationships such as research partnerships, contract research, and consulting may also play an important role in driving these innovation processes [1]. Public-private partnerships (PPPs) are an example of such relationships.

Commonly, companies develop one-to-one relationships with universities or specific research groups through dedicated funding of research activities based on the needs of the company. An example of this kind of partnerships is contract research, for example, funding of a PhD position. In this way, firms have access to specific knowledge, with the partner research group preferably near, but often further away from, the company.

PPPs are also realized by establishing a physical research lab at or near the academic premises. These are generally more collaborative and based on longer-term relationships. Examples, among many others, are IBM Zurich, Microsoft Station Q at UCSB, and Nokia at Cambridge. These are examples where a company reaches out to one or several universities that are globally distributed, for their particular expertise or excellence. In this way the firms are able to tap locally from the large body of specific knowledge and human capital and talent present in the university.

Every IPP is a research programme, consisting of multiple projects. The IPP is different from the examples given above, in that within an IPP a company can be connected to several universities distributed in a regional network (in contrast to global distribution).

With the Netherlands being a compact area the universities are all in close proximity, hence it can be considered as a "regional" programme. The participating university groups form a research network, viz., a connected group of laboratories that carry out the IPP projects. FOM serves as a link between the universities and the companies.

11.1.3 *Foundation FOM*

In order for you to appreciate the background and basic ideas of the IPP, it may be helpful to understand the organization FOM. FOM is the Foundation for Fundamental Research on Matter, which was founded in 1946, and which mission has since been to advance the fundamental research in physics in the Netherlands. FOM's activities benefit the common interest, specifically higher education and businesses.

Besides being a funding agency, FOM is a research organization and employs ca. 1000 people. It performs research of internationally high quality at three institutes (FOM Institute for Atomic and Molecular Physics AMOLF, National Institute for Subatomic Physics Nikhef in Amsterdam, and the FOM Institute for Plasma Physics Rijnhuizen in Nieuwegein, which is currently being transformed into the Dutch institute for Fundamental Energy Research) and in research groups at almost all Dutch Universities. International experts assess the research that takes place within FOM against stringent criteria. FOM thematic counsels are scientific committees that give advice to the FOM executive board about scientific proposals for new research programmes. Each year FOM turns out about 100 young doctoral researchers. Most of these remain in the research world at Dutch and foreign universities and in industrial R&D. FOM receives most of its funding from the Netherlands Organisation for Scientific Research (NWO), besides receiving incomes from partnerships with companies and from funds from the national government and European funds. Its total turnover is approximately 90 million euros per year. With scientific quality always being the prominent factor in allocating the research funds, FOM aims to contribute to innovation in firms, and, consequently, the Dutch economy, by conducting basic research.

In 2004, the FOM executive board decided to establish the IPP to increase its contribution to society by also carrying out fundamental research that is directed toward the needs of society, and companies in particular. Part of this trajectory is aimed at creating a change in culture: generated knowledge should find its way more efficiently and effectively to existing industries and entrepreneurs. FOM has other activities, complementary to IPP, to support commercialization and entrepreneurship.

11.1.4 *The Industrial Partnership Programme (IPP)*

An Industrial Partnership Programme [2] is intended for longer-term basic research by FOM staff in close contact with industrial researchers in areas with a good potential for innovation and challenging scientific questions. In other words, joint research that might yield groundbreaking innovations.

Born from the wish to contribute more visibly to the Dutch knowledge based economy without compromising the high scientific standards, the Industrial Partnership Programme started in 2004 with a long-term commitment of 3 M€ per year. It is particularly directed toward multinational firms who have their own R&D laboratories.

An IPP is financed jointly by FOM and the industrial partner(s), the latter contributing at least 50% in cash of the costs. This leads to a leverage on the research funds for IPP. The minimum budget amounts to 1.0 M€ (corresponding to about four PhD projects of 4 years each), which makes the IPP a genuine research programme. This provides for a broad embedding of knowledge also in the academic system. The scientific quality is the ultimate determinant for project funding. The firms "buy" their access to knowledge generated from the programme and also get access to the physics network. Conducting excellent research and the possibility to publish in scientific peer reviewed journals are a point of departure of every IPP.

Since 2004, the accumulated budget has increased from 3 M€ in 2004 to 50 M€ in 2009 (see Fig. 11.1). From this amount, FOM has contributed 18 M€ in cash, the companies have contributed 22 M€ in cash and 10 M€ in kind.

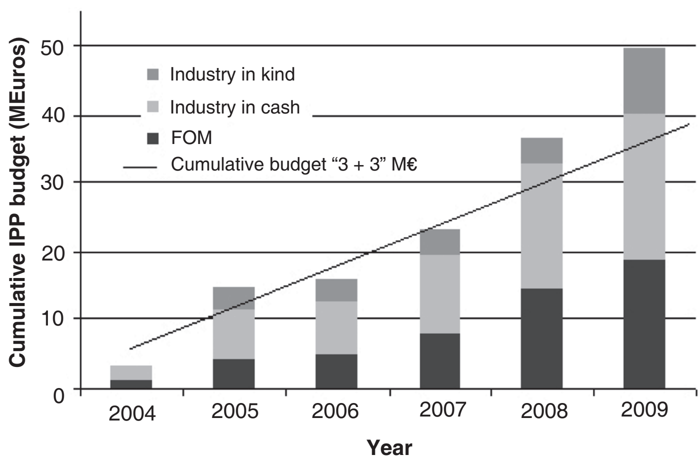

Figure 11.1. IPP total budget in time. Black line is the cumulative budget if the available 3 M€ per year for IPP was used and matched by 3 M€ from industry.

An IPP can be "open" or "closed." In a closed programme, all of the projects are already defined and the research consortium is established when the application is submitted. In the case of an open programme, a programme proposal is written after which a call for research project proposals is organized. More about the different forms of IPP can be found in the next section.

This chapter provides a qualitative description of the IPP. A quantitative study about the results of the IPP in light of its goals (excellent science and innovations) will be conducted at a later stage [3].

11.1.5 *The Advent of Open Innovation and the Rise of the IPP*

The process of deconcentration in "corporate research" is accompanied by a decline in in-house fundamental research. Instead of keeping all the knowledge internal and secret, firms now link to external sources of knowledge, which is also partly brought about by the increasing complexity of technological developments. Industrial innovation is more and more dependent on R&D outsourcing and the ability to participate in strategic alliances, especially for the larger companies in the high tech industry [4] — a process that has intensified with the rise of open innovation [5]. The open innovation paradigm states that firms should use external ideas as well as internal ideas, and both internal and external paths to market, when realizing innovations. The use of deliberate input and output of knowledge in combination with the expansion of markets for external use of innovations should enable firms to achieve high-risk discontinuous innovations more easily. Firms are, therefore, more susceptible to external knowledge and ideas. In short, R&D is treated as an open system [6].

Due to this development, the role of FOM in the R&D ecosystem has changed and the IPP is a response to the need of firms for fundamental knowledge and new ideas. Corporate R&D labs appear to act more like science parks and incubators and seek strategic alliances. An example is the High Tech Campus of Philips in Eindhoven, that underwent a transformation from a hermetically sealed campus to an open terrain where other firms are established and clean rooms can be rented. Philips was one of the early proponents of open innovation in the Netherlands, and, not accidentally, was our first IPP partner. We established a FOM research group on their campus.

11.1.6 *Summary*

An IPP is intended for longer-term basic research by academics in close contact with industrial researchers in areas with a good potential for innovation and challenging scientific questions.

The IPP is an example of a public-private partnership programme in basic science. The form is somewhat different from most existing examples of PPPs in that a company has access to a network of research groups through one point of contact. The rise of the IPP coincides with the appearance of the open innovation paradigm.

11.2 Description of the Industrial Partnership Programme

11.2.1 *Introduction*

Besides the "fundamental" character of the research and the potential for technological innovations that I mentioned in the previous section, other principles of an IPP are the in-cash contribution from the company that amounts to at least 50% of the total research costs, and the minimum size of an IPP being 1 M€. New programmes are awarded on the basis of peer review assessment; there is no guarantee *a priori* that a programme will start, even with the in-cash contribution of the company.

This section describes the structure of the Industrial Partnership Programme in more detail. I will discuss the characteristics of an IPP, the practical aspects related to the development of a new IPP, the collaboration agreement, and the management.

FOM created an IPP office that is the contact desk for industry. Besides the programme management, it is instrumental in setting up new programmes, in the brokerage of research partners, in network events, and in the communication between all partners. These are key elements in the IPP, as will become clear in the next section.

11.2.2 *Characteristics of the Programme*

Below is a set of basic conditions that apply when starting a new IPP, followed by some practical aspects of an IPP, from the embryonic phase to the execution of a programme.

FOM and the industrial partner(s) together determine the precise design of the programme, however, there are six basic conditions that all programmes must meet:

- It concerns fundamental research by personnel employed by FOM in close cooperation with researchers from one or more companies.
- The partners jointly formulate the research objectives.
- Companies finance at least half of the programme budget in cash.
- Each programme budget amounts to at least 1 million euros.
- Every programme proposal is to be assessed for its scientific quality by international independent referees.
- Agreements are made about the intellectual property rights and disclosure of information.

The IPP is organized according to the form-follows-function principle; it can be a multidisciplinary programme, other industries can be sought to enter a broader application field, or funding agencies from other disciplines can be approached for joint funding of the programme.

An important aspect of the IPP is the training of young researchers both through regular PhD courses offered by FOM, and through courses provided by the partner companies.

11.2.3 *Forms of IPP: Open, Closed, or FOM Group at Company Laboratory*

Industrial Partnership Programmes can be open or closed. In a closed programme, all of the projects are already defined when the application is submitted. The consortium is therefore already established. In the case of an open programme, the programme outline is written by a scientific project leader together with the industrial partner. Subsequently, a call for proposals is issued.

Closed IPPs generally address issues related to problems associated with products or processes in a company. These programmes tend to be more focused and have more defined research questions. Generally, they result in filing of more patents than open programmes and are closer to commercialization.

Open programmes are generally aimed at building up a broader knowledge base. They have a more generic reference to existing products or processes and their focus is generally on creating completely novel ideas, hence they tend to be somewhat further from the market than closed IPPs.

A special type of a closed IPP is the FOM research group at an industrial laboratory. FOM employs the research personnel that is stationed at the company, among the industrial researchers. These young FOM researchers remain real scientists, but they are embedded in an industrial environment and are fully involved in the life of the laboratory. The company provides lab and office space, research facilities and bench materials, and a part of the personnel costs. The FOM group takes part in relevant meetings of the company. This group is scientifically supervised by a FOM group leader at an institute or university. The FOM group consists of a group leader and several PhDs and possibly post-docs.

11.2.4 *The Start-Up Phase of an IPP*

11.2.4.1 The embryonic stage of a potential new IPP

We discern three ways in which an IPP can germinate:

1. Researchers already have good contacts with companies, or vice versa, and submit a proposal.
2. The IPP office acts as a matchmaker/broker for researchers with an idea or a company with a problem. The IPP office can organize a brokerage event, for example, a scientific workshop in which academic and industrial participants seek partners (scientific expertise or funding partners) and establish the scientific challenges. The network activities that the IPP office organizes facilitate this matchmaking process.

3. The IPP office acquires companies from outside the network. This latter activity is particularly relevant, since firms often need to find new partners and networks to acquire external knowledge.

If a consortium is formed, parties jointly draw up the research proposal in consultation with the IPP office. The latter supports items such as budget and form of collaboration. Every programme is custom made.

11.2.4.2 Application and review procedure

After the programme proposal is received by the IPP office, the FOM executive board decides whether the application is admissible or not. Criteria are the cash contribution of the private partner, the scientific value, the value of the collaboration, and the potential impact of the IPP on the research landscape.

The scientific assessment is performed according to standard FOM quality procedures.

For a closed IPP, the proposal is subsequently assessed by independent international referees. The applicants can give rebuttal. Based on the referee's comments and the rebuttal the FOM thematic counsels give a funding advice to the executive board.

In case of an open IPP, thematic counsels give advice to the executive board about the scope of the overarching programme proposal, viz. the research theme, fit in the research landscape, anchorage of the knowledge in the research infrastructure (both at the private partner and at FOM). On this programme proposal a call for (pre)proposals for research projects is based. Preproposals are screened by the Programme Committee, wherein also representatives from the company have a seat. Full proposals are assessed by a panel of international independent experts, who have interviews with the applicants.

The final granting decision is made by the FOM executive board.

11.2.4.3 Success rate of IPP applications

The success rate of a closed IPP application is 73%. This means that about a quarter of the applications do not pass the independent scientific assessment, even while the partnering company has already guaranteed its cash contribution.

The success rate for open IPPs is 100% for the overarching programme proposal. For project applications within an open IPP (call for proposals) this number is typically 40–50% for the preproposal stage and 50% for the full proposals, leading to an overall success rate of ca. 25% for the projects in an open IPP.

11.2.4.4 The collaboration agreement

The collaboration agreement is made up simultaneously with the review procedure. The agreement reflects both parties' interests. For a company this implies access to useful knowledge, inventions, and trained people, while for FOM publications, PhD defences and sharing revenues from exploitation are important. There is no guarantee that FOM delivers dedicated results; the programme is built up from the science case and the collaboration is an "effort-obligation."
Some typical agreements are as follows:

- There are no obstacles for researchers to obtain their PhD. A defence can never be delayed. If the company decides to quit its activities related to the IPP, it is obliged to support the completion of the thesis work of the researchers.
- All publications are screened by the company before publication.
- It contains standard conflict resolution procedures.

Usual intellectual property rights (IPRs) agreements are as under:

- The rights in the results are vested in FOM. The partner company gets the first right to apply for a patent in the particular area. FOM maintains the right to apply for a patent if the company decides not to make use of this right.
- If the company makes use of this first right of refusal the rights are transferred and FOM receives an incentive bonus, that is available for the research group that made the invention. All costs incurred by the patent applications are borne by the company.

- A market fee based on revenue sharing arrangements is agreed. This is based on the market value research of the patent and the chance for commercial exploitation. Based on the outcome of this research an agreement about extra allowance is made.
- Research results are always available for research and education purposes.
- In case more companies join in one IPP, rights are mostly established according to their application field, for example, food versus non-food applications.
- Specific agreements vary from sector to sector.

11.2.5 *The Execution Phase of an IPP*

11.2.5.1 Organization and management

Besides funding of the research projects, and the programme management, the IPP office takes an active role in the construction of an IPP, the partner selection, the knowledge transfer, and in maintaining networks. It has dedicated tasks in steering and supporting the application and in the process of agreement by the partners on the content of the proposal and the results and outcome. The IPP office manages IPR negotiations and contractual issues as well.

To facilitate knowledge transfer, several schemes are in place:

- A formal reporting scheme consisting of regular progress meetings with all partners, progress reports, and exchange of researchers.
- Mirror projects and project leaders at the company; every project has a contact person at the company that is available for discussions, inventions, and access to infrastructure. This person also takes care of the in-company embedding of the knowledge.
- Education of IPP researchers through trainings.
- Informal meetings are a relevant aspect of knowledge transfer, see Section 11.3.3.

Before research personnel (PhD students and postdoctoral researchers) is hired by the project leaders, they are presented to the company for approval.

During the execution of the projects, tuning of research focus and picking up new chances can occur after deliberation between project leader and the company.

11.2.5.2 Governance

Every programme has a proper governance structure wherein both FOM and the company are represented. Usually an IPP has a steering committee and a programme committee. The former is a group of responsible representatives from all stakeholders. FOM is represented by its head of the research policy department as delegate from the executive board. The programme committee consists of the scientific managers within a programme. Every IPP has a programme leader who is responsible for the scientific execution and chairs the programme committee. The staff of the IPP office acts as secretaries to these committees.

11.2.5.3 Financial aspects

Companies pay at least 50% of the programme costs in cash, with a minimum of 500 k€. This in cash contribution includes 15% overhead costs. FOM executes the programme and invoices the companies annually. The programme includes budget for meetings, workshops, and knowledge transfer.

11.2.6 *Summary*

In an IPP the industrial partner contributes at least 50% in cash of the total research costs and the execution is done by FOM. The scientific assessment of an IPP application is performed by international independent referees.

IPPs can be open or closed, the choice of the company usually depends on whether it has specific problems associated with its products or processes or whether it wishes to explore completely novel ideas. A special closed form is a FOM group at an industrial research lab.

The collaboration agreement reflects both parties' interests. It balances the freedom to conduct and publish basic research and the confidential disclosure of information to the company and agreements for the valorization of IPR.

The IPP office has an active role in setting up a new IPP, in bringing together parties, and in knowledge transfer.

11.3 Experiences and Results

During the last FOM Strategy meeting in spring 2010 with participants from academia, industry, research agencies, and other stakeholders, it became clear that the IPP had gained in popularity among the researchers. Those same researchers were fairly sceptical during the preceding strategy meeting five years earlier when the IPP concept was introduced. It was agreed that the IPP will be reviewed in 2012 when enough data will be available from completed programmes. Since we have not yet conducted a review, I will provide you here with a qualitative insight into the obtained results, based on the experiences from the IPP office and from the participants. I will discuss in what way the IPP has been successful, and what aspects of the IPP seem to be critical factors in its success.

11.3.1 *Success Comes in Different Shapes and Sizes*

From Fig. 11.1 it is apparent that in the last few years, the IPP is generating more external budget than was put in by FOM. From the growth of the budget and the fact that the cash contribution from industry is higher than the cash contribution from FOM, it may be concluded that the IPP is a successful instrument. This is substantiated by the fact that some companies are involved in several partnerships, and that some companies have started a new IPP after their IPP had ended.

How to measure if your programme is successful? For FOM an IPP is successful if it results in scientific publications, in human capital (trained PhD students and Post-docs), and if the firms acquired relevant new knowledge that facilitated their innovations. Table 11.1

Table 11.1. IPP nanotechnology related programmes. Numbers are a snapshot of the status in 2010.

Name	Industrial partner	IPP form	Budget (M€)	No. of projects	No. of researchers[1]	No. of publications[2]	No. of patent applications	Duration
Microphotonic light sources	Philips	FOM group at Philips	1.8	3	6	33	8	2005–2010
Extreme multilayer optics	Carl Zeiss SMT	Closed	7.7	9	10	20	13	2005–2010
Microscopy and modification of nanostructures with focused electron and ion beams	FEI electron optics	Closed	2.7	5	10	10	1	2007–2012
Innovative physics for oil and gas — a deep dive into the nano domain	Shell International Exploration and Production	Open	2.2	6	10	0	0	2009–2014

Notes: (1) PhDs and post-docs; (2) scientific peer reviewed publications.

gives an overview of the nano-related IPPs, depicting some of the key parameters.

The first two factors are fairly straightforward to establish. We know that the number and impact of publications is comparable to other FOM research projects. Due to the independent scientific assessment according to regular FOM procedures the scientific quality of the granted IPP projects is high [7]. This could be an asset that draws firms to the IPP. Also, the number of PhD students and Post-docs can be easily monitored. It will be interesting to see in the coming review whether PhD students and post-docs have found a job at the company they collaborated with in an IPP.

The question how knowledge transfer is successfully achieved is harder to answer. Exactly what the impact is of university–industry partnerships on the innovation process appears to be a matter of debate [8].

Knowledge transfer should not be measured only by the number of patents. While we have experienced that for some of our industrial partners the potential to generate new patents is the prime reason to be involved in an IPP, several other partners have different drivers to participate in an IPP, which is also the common perception for industries liaising with public research institutes. Work by Cohen *et al.* [9] shows that knowledge transfer activities from universities to industry are of a much broader spectrum than the activities related merely to the commercialization of intellectual property rights. Access to tacit knowledge that resides in the programme (people, institutes, and infrastructure) is an important reason for companies to engage in collaborations. Less formal activities such as informal contacts, networking, and university–industry mobility of researchers have been mentioned as important drivers in knowledge transfer [10].

Encouraged by these signals, it has been suggested in the UK to use an agreed wide set of knowledge transfer metrics to establish the effect of knowledge transfer into the commercial sphere [11]. Examples of these metrics are the length of the relationship, number of researcher exchanges, number of research training for industries, number of participants in industry–academia network events. In qualitative terms, several of these aspects will be discussed further on.

Who are the scientists involved in an IPP? We can see that scientists who are most successful in obtaining basic research grants at FOM are also most successful in an IPP. Ambos *et al.* have shown that most researchers tend to prefer a traditional academic publishing career over a career that is more open to producing commercial outputs, but also that scientific excellence is significantly associated with the generation of successful commercial outputs [12]. Also most FOM scientists pursue an academic career in fundamental research and scientific excellence. This is a pool of great potential. With the focus of the IPP on basic research, we can draw from the large pool of basic scientists. The IPP "utilizes" what comes naturally to the basic researchers, without expecting them to become all application-driven scientists or entrepreneurs. However, awareness by the researchers for the application perspective is desired to facilitate communication. This sometimes implies a cultural change for some researchers.

One aspect that stands out is the commitment to the programme of the companies, which can probably partly be ascribed to their in-cash contribution of at least 50%. This makes that they make available time and resources, for example, in the form of mirror project leaders, bilateral meetings, or research infrastructure and support.

It is worth mentioning here the secondary results of an IPP. A significant spinoff from the FOM group at Philips is the fact that the scientific group leader obtained external funding for another two PhD and two post-doc positions from FOM and EU programmes (not indicated in Table 11.1). Besides, it has resulted in a PhD thesis of one of the Philips employees. These spinoff activities have more or less doubled the scientific impact of the FOM group.

In the remainder of this paragraph I will focus mainly on this less tangible area of knowledge transfer, networks, and interorganizational relationships.

11.3.2 *The Network*

As I discussed in Section 11.1.2 interorganizational networks are an important aspect in innovation. Network formation is key in the transfer of tacit knowledge through people. Geographic proximity facilitates network formation. "Geographic, cultural, and institutional proximity leads to special access, closer relationships, better information, powerful incentives, and other advantages in productivity and innovation that are difficult to tap from a distance. The more the world economy becomes complex, knowledge based, and dynamic, the more this is true" [13].

The IPP has contributed to the strengthening of the network on a micro level, viz. between companies and individual physicists. Once involved in a collaboration we see those physicists frequently maintain their contacts with that company and start new programmes. Besides, they often extend their connections and collaborations to other companies, and, vice versa, companies extending their links to other research groups through the initial contact.

On a macro level the IPP office focuses its efforts at the R&D ecosystem. Since the Netherlands have nine universities and institute AMOLF involved in nanoscience and nanotechnology research that are all within a few hours travel, this facilitates greatly the network formation. Besides, the Netherlands have a national nanotechnology research network NanoNed and a research infrastructure NanoLab [14]. Through FOM, companies have access to the entire physics and a good deal of the nanotechnology community.

To promote the integration of industry and academia into a physics network, FOM

- may offer relevant industries a seat in the FOM executive board, the board of governors, and the thematic counsels.
- involves industrial researchers in the organization of large scientific conferences.
- organizes problem-solving workshops and site visits between academic and industrial researchers.
- partners with the leading technology institutes in the Netherlands; [15] these public-private research institutes form an additional scientific tie between FOM and industry.
- maintains an alumni network.

These activities are important for the visibility and proper functioning of the "R&D-ecosystem." Besides, it creates trust and helps maintaining our long-term relationships.

We recently observe a better visibility and participation of the company's researchers in the FOM network, for example, by higher participation in our national physics conference and network events and by an increase in bilateral contacts. I ascribe this to both increased external activities of the firms because of the open innovation paradigm, and to our efforts mentioned above.

11.3.3 *Knowledge Transfer*

While knowledge transfer is generally realized through publications and invention disclosures, channels for the transfer of tacit knowledge are formal meetings and reports, exchange of students in laboratories, and informal bilateral contacts [16]. According to Perkmann and Walsh we can distinguish three kinds of relationships between industry and academia that drive the innovation process: technology transfer mechanisms, human mobility, and interorganizational relationships [17].

The formal IPP progress meetings are a stepping stone for further contact, especially the exchange of researchers and the informal bilateral meetings wherein materials were exchanged, research infrastructure was used, and measurements conducted, add to the knowledge exchange.

Aspects that we find instrumental in the exchange of knowledge are as follows:

- Establishing mirror projects and project leaders at the company who are contact persons for the academic researchers and are instrumental in embedding knowledge at the company. In the regular progress meetings, all project leaders and mirror project leaders, and often other researchers from both the company and academia, attend the meeting
- The availability from the companies of resources like relevant in-depth information, expertise, and technologies
- Problem-solving sessions, and scientific cases with realistic data from the companies
- A stay of the PhD students and post-docs for a longer period (months) at a company to apply the knowledge

- Additional training of PhD students and post-docs by spending time in a lab of one of the partner industries

We incorporated several mechanisms into the IPP that should help manage expectations of both parties on the outcome:

- The company is involved in writing of the programme proposal (closed IPP) or in the screening of preproposals (open IPP). In this way it can determine the main lines of research.
- The agreements about goals, confidentiality, and publications must be explicitly discussed during the first meetings of a new programme. This is important to build confidence and trust among the participants.
- Awareness among research staff regarding the objectives, value, and significance of intellectual property protection is important in helping to understand a company's strategy. This means that it offers IP and business courses to its graduate students and post-doc researchers. Besides, it has other programmes to support entrepreneurs that build on spill-over results stemming from the projects.
- During meetings also the companies present themselves and their motivation and their specific research questions.

11.3.4 *IPR*

The IPR strategy is aimed at establishing and maintaining long-term relationships with R&D firms. This implies that we transfer the rights in IP to the companies and that we make the revenues thereof available to the inventors for research purposes.

Currently, FOM does in principle not pursue a licensing strategy by building up a portfolio of patents since the breadth of research themes covered by the IPP would lead to a scattered patent portfolio. Besides, this would be a cost- and resource-intensive activity, which the IPP office at FOM is not equipped for.

FOM always remains the right to apply for a patent if the company decides it will not do so. FOM will do so when IP is of clear strategic importance, for example, with the aim to establish start-ups or as a spin-off from long-term relationships with certain industries, for example, in the field of nanophotonic structures, and EUV multilayer optics. With the gradual emergence of these naturally evolving portfolios, and the expected role of FOM in fundamental energy research, FOM may reconsider its current IP strategy, also in light of the strategic role IP has in open innovation.

As I described in the previous paragraph, a difference between open and closed IPP is the output of patents. A trend that is apparent from the whole range of IPPs (not depicted in Table 11.1) is that closed programmes tend to create more IP than open programmes. We ascribe this to the nearness to the market (see Section 11..2.3). In Table 11.1 you can see that the number of patent applications varies also among the different closed IPPs (see difference between Carl Zeiss and FEI). This hints at the notion that IP is merely one of the reasons for a company to participate in an IPP.

11.3.5 *Experiences from Industrial Partners*

Besides access to knowledge and expertise, reasons to engage in research partnerships for firms are their access to the network, research infrastructure, highly educated human capital, and the one-to-one learning option. Many of the relevant companies (viz. mostly multinationals with own R&D facilities) in the Netherlands, and some firms in neighbouring countries, collaborate in an IPP.

Sometimes a company aims to develop a new area of expertise and to build up new knowledge, for example, a company that makes a move from traditional bulk chemistry products to advanced coating applications and needs to acquire colloid or polymer physics expertise. We observe that several companies traditionally not linked to physics, including chemically oriented companies like Shell, DSM, and AkzoNobel are partnering in our IPP.

I present here some quotes from interviews [18] we held with our industrial partners about the IPP that display the breadth of motivations and opinions. This is not intended as a comprehensive and quantitative overview:

Tata: “The biggest asset of the programme is probably the structural contact that occurs between experts from different perspectives — physics and chemistry, the steel industry, oil recovery, and the chemical industry — who are all working on the same problem [...] The real exchange of knowledge does not occur via reports and books but via people. This is also why the PhD students do not remain in their own laboratories but undertake internships at the participating companies. In that way they develop a feeling for the pivotal problems, and we gather an idea of what their capabilities are."

FEI: "We have assigned four senior scientists to act as contact persons. About once every two weeks they spend a day in the laboratory of the so-called scientific partner. Compared to the formal progress meetings we spend the whole day talking to each other. The exchange of information is more profound; you get a better feeling for what is going on, can exert more influence and you gain more from the partnership."

Shell: "The secret lies in the one-stop shopping.... The IPP office gives Shell access to the entire physics community in the Netherlands, because in some way or other all physicists are connected with FOM. None of the hassle of eight different contracts with eight different professors."

These opinions reflect my conclusions from the preceding paragraphs about the importance of the network, the role of the IPP office, and the fact that tacit knowledge is an important driver for companies to participate and that it is transferred through informal contacts.

11.3.6 *Experiences from Academics*

The academic community was somewhat sceptical at the start of the IPP in 2004. Researchers feared a potential loss of academic freedom and less budget for free basic research. Since then, we gradually observed an "image" improvement of the IPP: research projects are considered still free in execution with interesting physics and research budgets have doubled due to the 50% in cash contribution.

From an academic perspective, reasons to participate *a priori* are the opportunity for additional funding and the social relevance of the research. Once researchers are involved in an IPP, several other benefits appear:

- The extension of the network and the potential for new relations, collaborations, and funding
- The access gained to new infrastructure and expertise
- The access to realistic data for their models
- An interesting feeling for issues at stake in companies, an understanding of their strategies, and the awareness for patent opportunities
- Training of young researchers in an industrial environment
- A motivating connection between fundamental research and the use of this knowledge by industry

To get a feel for the experience of the scientific project leaders that are involved in the programmes I have cited some quotes [19]:

"The beauty of this programme is that the focus is on fundamental physics [...] I am happy to see that Shell finds it as important as we (scientists) that the scientific quality of the projects is high."

"We bring together different disciplines of chemistry and physics together in one programme [...] I get inspired to convert my fundamental research results into industrial practice."

11.3.7 *Summary*

Measured by the large cash contribution from companies, that exceeds the contribution from FOM and by the fact that companies start new IPPs, it can be concluded that the IPP is a successful instrument. This is supported by the fact that several firms extend or renew their relationship with FOM. The impact of IPP on innovation must not just be measured by its output in terms of patents and publications, but as well by the involvement of companies, networking, and interaction between researchers of companies and academia. A review of the IPP based on a broad set of metrics should quantitatively show the scientific impact and to what extent and how the IPP contributes to the innovation capabilities of the industrial partners.

The main reasons for researchers to join in an IPP are conducting groundbreaking basic science of social relevance and additional research funding. Companies' motivations are access to excellent research results, new knowledge, networks, and trained people.

The IPP instrument is a symbiosis of these two motivations. Fundamental research projects with high scientific excellence and the possibility to publish and of knowledge transfer activities and invention disclosures.

The commitment of companies in an IPP is high, next to their cash contribution they put in time and resources.

The initial fear of loss of quality and academic freedom that existed within the scientific community gradually disappeared when researchers got involved in an IPP.

The network is an important asset. FOM works on the R&D ecosystem and focuses its attention on the individual level and on the institutional level. It has several schemes to maintain and develop this network.

11.4 Conclusions and Outlook

Universities and research institutes are an important source of knowledge and human capital, and, as such, they have a stake in the innovation process. Ultimately their scientific breakthroughs often are at the basis of new nanotechnology related products.

With the embracing by many firms of open innovation, they increasingly rely on interorganizational relationships like public private collaborations as a tool to enhance their innovation capacity. At the most fundamental level, a public research organization can contribute to the innovation process without compromising its core business of research and teaching. An example of such a public–private collaboration is the Industrial Partnership Programme, which was established to contribute more visibly to the Dutch knowledge-based economy, and is particularly aimed at multinational firms with R&D laboratories.

11.4.1 *Conclusions*

Judged by the growth in budget to 50 M€, of which more than 50% is contributed in cash by industry, and by the fact that companies return to FOM to renew their collaboration, the IPP is a successful instrument. The companies who participate in an IPP show a firm commitment to the programme. The majority of relevant companies in the Netherlands collaborate with FOM in some form of IPP.

Success should not only be measured by the number of patents, scientific publications and PhD defences. Access to tacit knowledge that resides in the programme through informal contacts, networking, and university–industry mobility of researchers are also metrics that should be considered when measuring success. Besides, there are secondary spin-off effects from IPPs like additional funding for researchers, or new contacts for both industry and universities.

The IPP is a collaboration model that is founded on basic science projects that have been granted in competition. This works well: it attracts many scientists to send in proposals, especially the better scientists in their fields, which makes it also scientifically a successful programme. The difference in culture could be a potential obstacle in public–private collaborations. Whereas the protection of knowledge tends to be more important for companies, scientists attach more importance to data collection and publishing in the public domain. We think that the IPP is successful in uniting these two "opposing" interests. Companies understand well that an IPP evolves around basic research and what they can expect from partnering in an IPP. With a clear policy on confidentiality, publications, and intellectual property, the output is a balance between the dissemination of public knowledge by publications and of intellectual property rights and commercialization.

The IPP "utilizes" what comes naturally to the basic researchers. The fact that the academic community was critical at the start of the IPP but gradually became more positive seems to support this view. Although the programme is aimed at drawing from the large pool of basic scientists, we sense a raised awareness toward the value of patents and commercialization from these scientists compared to research programmes without involvement from industries.

The IPP office has a major role in knowledge brokerage, matchmaking, in facilitating knowledge transfer, and in the administration of IPPs. Considerable effort is spent on building up confidence and trust among participants, especially among new partners. Besides, the IPP office also focuses its activities on sustaining and extending the network by organizing conferences, network events, workshops, and by involving firms in the FOM organization.

The Netherlands are a relatively small area, with a high concentration of research activities; a "physics region." This proximity is an attractive dimension for R&D firms since it supports the collaborative character of the IPP.

11.4.2 *Outlook*

Current developments in the (open) innovation landscape [20] may trigger the IPP office to take an even more active role in knowledge brokerage, since firms need to seek new partners and knowledge and their research funding at universities will probably increase. They may also cause FOM to reconsider its current IP strategy since IP has a more strategic role in open innovation.
Concerning the development of new strategic partners I see two options to extend the IPP concept:

- Collaborations with R&D firms in the vicinity of the Netherlands, that are still in practical reach. Currently, we have fruitful collaborations with BASF in Ludwigshafen and Carl Zeiss SMT in Oberkochen.
- With the IPP specifically aimed at the larger firms, that have fairly long innovation horizons, SMEs are kept out of range. We are currently working on schemes to also get the innovative SME's on "board."

Could the IPP concept be a valuable instrument in other countries or for other scientific fields? Besides the criteria mentioned in Section 11.2.2, I think there are three aspects that are vital in setting up similar activities and that were discussed in this chapter:

- The innovation region (geographical proximity as to facilitate collaboration and the transfer of knowledge)
- A dedicated office that develops activities like knowledge brokerage, networking, management
- First and foremost, scientific excellence

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