Strategic Partnering Between New Technology Based Firms and Large Established Firms in the Biotechnology and Micro-electronics Industries in Belgium

Jean-Pierre Segers

ABSTRACT. There is an increased emphasis on New Technology Based Firms (NTBFs) and on Strategic Partnerships. The number of strategic partnerships between large, established firms and NTBFs has multiplied over the past few years, due to a growing trend towards technological and marketing relationships between large and small firms. In this contribution, the strategic — predominantly technology — partnering (also referred to as interfirm technology cooperation) experiences of a small number of Belgian NTBFs in the biotechnology and micro-electronics industries will be analysed. The analysis presented here derives from the region-specific technology policies in Belgium.

A multiple case study design was chosen to develop an understanding of the impact of strategic partnering on New Technology Based Firm-survival and growth in Belgium. To improve the reliability of conclusions in the research presented here, a small number of cases will be investigated for the construction of a theoretical model.

Introduction

In this contribution, the strategic — pre-dominantly technology — partnering experiences of a small number of Belgian New Technology Based Firms (NTBFs) in the biotechnology and micro-electronics industries will be analysed. Micro-electronics is taken here as a core technology instead of being defined as a subfield of information technology. This is due to the fact that the analysis presented here derives from the region-specific technology policies in Belgium (Segers, 1992), where technology policy efforts have been focusing on biotechnology and micro-electronics.

There is an increased emphasis on New Technology Based Firms (Bollinger *et al.*, 1983; Rothwell, 1983, 1984; Anglo German Foundation, 1988; Oakey *et al.*, 1988; Rothwell, 1990) and on Strategic Partnerships or Alliances (Contractor and Lorange, 1988; Doz, 1988; Knight, 1989; Syed Tariq, 1991). The number of strategic alliances between large established firms and small firms — in particular New Technology Based Firms (NTBFs) — has multiplied over the past few years. Small firms in general and New Technology Based Firms in particular are contributing a far greater share of the overall growth of the economy than has been recognized. Theoretically, the combination of a small firm's know-how with a larger firm's resources opens opportunities for synergies that can contribute to both firm's competitive advantage (Niederkofler, 1991) and to the creation of a regional growth potential (Donckels and Segers, 1990).

Research hypotheses and methodology

A multiple case study design (Yin, 1984; Niederkofler, 1991) was chosen to develop an understanding of the impact of strategic partnering on New Technology Based Firm-survival and growth in Belgium. To improve the reliability of conclusions in the research presented here, multiple cases will be investigated for the construction of a

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Doctoral Research Fellow MERIT
Maastricht Economic Research Institute
on Innovation & Technology
University of Limburg
Maastricht, The Netherlands

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theoretical model. Thereby, this research will follow Glaser's and Strauss' (1967) recommendation for the development of "grounded theory", which lets theory emerge from the data. One of the primary concerns in this study is to design a model based on empirical observations that captures as much as possible the "real world" of NTBF-creation in the biotechnology and micro-electronics industries in Belgium.

The hypotheses for the research presented here are as follows:

Hypothesis 1 Belgian NTBFs in their survival or growth phases gain from entering into a strategic technology partnership with large established firms.

Hypothesis 2 A number of potential partnership pitfalls can be identified. Therefore, a successful strategic technology partnership constitutes an optimization of the potential synergies and the dynamic complementarities between large, established companies and small — new technology based — firms.

Hypothesis 3 Strategic technology partnerships enable NTBFs to successfully commercialize their innovations and products and to significantly expand their future viability in terms of growth potential.

Review of literature

Before proceeding, it is important to clarify the meaning of the terms "New Technology Based Firm" and "Strategic Partnering". Small firms are a very complex and heterogenous population, especially in the case of innovation. As such, *New Technology Based Firms* are only a limited subgroup of the total population of start-ups. According to Shapero (1972) the tech starter is "an individual or a group, that takes the initiative in forming an organisation to produce a product and/or service in the area of high-technology, managing with relative autonomy and sharing the risk of success or failure". Rothwell and Zegveld (1982) state that small firms are responsible for a disproportionately large share of radical innovations in certain industry sectors. Bollinger *et al.* (1983) hypothesize that while regional policies do play a part in attracting high technology industries to an area, the greater influence lies in sector differences.

Oakey *et al.* (1988) define NTBFs as "small firms with a higher inherent innovative potential than large firms and small firms in general". They play an important role in the emergence of new, high technology sectors. A significant number of basic innovations have originated in small firms. Small firms often play an important role in industries characterized by a particularly high rate of growth and technological change. According to Schmidt (1988) NTBFs are "interpreted to include users and producers of new technologies including research and development, innovations (product-, proces-, . . .), diffusion and adoption measures . . . and it covers the phases of invention, modification and continuing information on new products, production processing, organizational methods and social or personnel innovations". Samson (1990) defines NTBFs in a narrow sense as science-started-ventures (scientist-turned-entrepreneurs).

Roure and Keely (1989) identified the following factors as important facilitators of technology availability or market opportunities in the process of the creation of NTBFs:

- The presence of 'incubator' type companies in the area
- Attractive potential market, if possibly, nearby
- Universities with a strong interaction with firms
- Government purchase contracts, research projects and incentives or subsidies to innovation

Figure I expresses the creation process of a New Technology Based Firm according to Roure and Keely (1989).

There is a growing trend towards technological and marketing relationships between firms. Partnerships and alliances are becoming more and more important in the light of an increasing globalization of markets and technology (O'Doherty, 1990). There is however, no consensus on the definition of *Strategic Partnering*. Partnering spans a continuum of working relationships. On the left end is the purely transactional relationship, i.e.

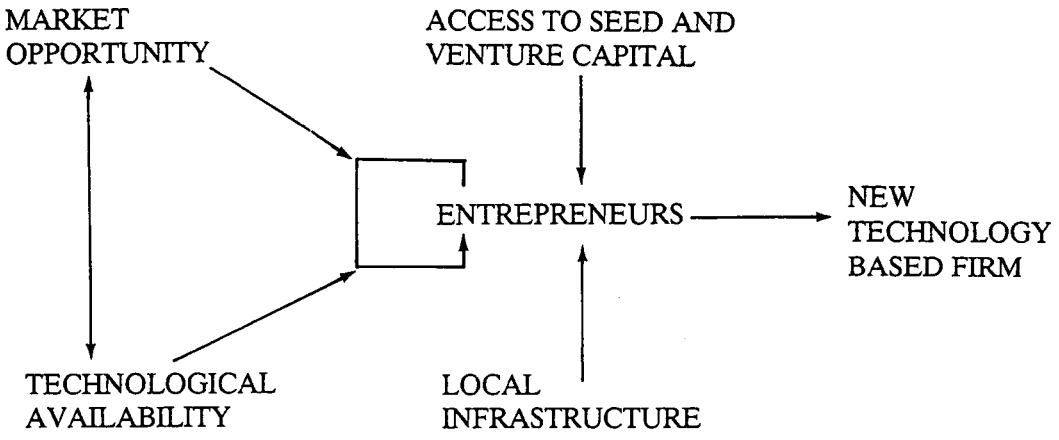


Fig. I. The new technology based firm.

exchange of product(s) for competitive prices. On the right end is the purely collaborative relationship, the ultimate in partnering where customer firm and supplier firm have strong "social, economic, service and technical ties over time ... thereby achieving mutual benefit" (Anderson and Narus, 1991). The lack of a clear definition makes it best to define the concept of strategic partnering as broadly as possible. Harrigan (1988) defines a strategic partnership as a cooperative agreement in which two or more businesses are actively involved in the management of a venture. The spectrum of agreement types varies from subcontracting and licensing over joint ventures and strategic alliances to consortia and acquisitions. The independence of the entrepreneur is usually decreased as one moves down the list (Knight, 1989). Strategic alliances are partnerships among firms that work together to attain some strategic objective. Joint ventures create a jointly owned entity, while nonequity forms of cooperation do not.

According to Doz (1988), partnerships usually offer large firms a channel to tap into the innovative and entrepreneurial potential of smaller companies. The strategic contributions of joint ventures are numerous (Contractor and Lorange, 1988): larger firms offer their smaller partners funds, established manufacturing facilities, distribution channels and general management skills (Knight, 1988; 1989). In most of the observed partnerships, smaller firms perform research and development for the larger firms and/or transfer innovations to them. The complementarity is obvious. However, Doz (1988) and Niederkofler (1991) point out that strategic partnerships have to deal with a number of managerial pitfalls. Research has shown that most partnerships fail to meet the objectives of the large established bureaucratic companies and their smaller, entrepreneurial partners. Partnerships are on the other hand more frequent, since the obvious alternative for it, i.e. acquisition of smaller firms, is the least likely to succeed of the partnership types and usually ends with the entrepreneurs leaving the large corporation, as Knight's research (1989) which was based on a sample of 140 NTBFs in Canada suggests. The alternative is to form a strategic partnership of alliance which is essentially a joint venture.

With respect to technology, Hagedoorn and Schakenraad (1990) limit strategic partnering to *interfirm technology cooperation*, i.e. those forms of inter-firm collaboration for which joint development of new technologies and or agreements aimed at improved innovative performance (on this behalf, see Kleinschmidt and Cooper, 1991) are at least part of the agreement. In that context, strategic partnering is defined as those agreements that focus on a long-lasting effect on the product-market positioning of the participating companies. The definition of terms as it is derived for the research presented here is as follows (see Table 1).

Rothwell (1983) states that the main advan-

TABLE 1
Definition of terms

1. New technology based firm		
► University spin-off	→	University based NTBF
	→	Science-started-venture
► Industry spin-out	→	Industry based NTBF
2. Strategic Partnering (Interfirm Technology Cooperation)		
► University spin-off + Large established firm	→	Strategic (technology partnership)
► Industry spin-out + Large established firm	→	Strategic (technology partnership)

tages of small firms are 'people embodied', while those of large firms are predominantly 'resource embodied'. Small NTBFs often enjoy the advantages of dynamic, entrepreneurial management embodied in a system that is flexible and highly responsive to change, and who are willing to accept financial, technological and marketing risk. Large firms contain the financial, technical and production resources that enable them to undertake innovation, but because of potential problems of bureaucracy, internal inertia and risk aversion, they often lack the dynamism and flexibility necessary for the initiation and successful conclusion of radical innovation. Small NTBFs tend to be run by technically trained individuals.

These firms often lack the management skills and other resources to successfully commercialize their innovations. Large firms, on the other hand, often lack the entrepreneurial talents to generate innovations to expand their product lines, using their superior resources, such as funds, established manufacturing facilities, distribution channels and general management skills (Knight, 1988; 1989). According to Acs and Audretsch (1989) a strategy of product innovation can at least partially compensate for the inherent size disadvantage of small firms. They found that the innovative strategy explains a significant proportion of the variation in the presence of small firms.

Van der Auwera and Eysenbrandts (1989) compiled a set of specific advantages of small versus medium/large NTBFs in Belgium (N = 130). Small NTBFs have a greater job flexibility and less hierarchy. The flow of information between management and production is faster. They have a better view over the innovation process. The organizational structure is more rapidly adapted to market needs or to new products. Small NTBFs have a direct relationship with suppliers and customers. They respond more rapidly to direct demand from abroad. Medium/Large NTBFs can recruit more easily specialists and know-how. They dispose of larger promotion- and marketing budgets. They have better options for product differentiation. There is an accumulation of information within the network of specialized units or departments of these firms. Relative to price, their bargaining position with suppliers is stronger. They dispose of a better infrastructure and better foreign contacts in the case of exportation. They have larger R&D-budgets.

From the above, it may be hypothesized that a successful strategic (technology) partnership constitutes an optimization of the potential synergies and the dynamic complementarities between large, established companies and small — new technology based — firms. Dynamic complementarities (Rothwell, 1983) are of major importance for the future perspectives of NTBFs. The rate by which an NTBF grows will be determined to a great extent by its ability for complementarity and the attached cost/benefit analyses. NTBFs can grow rapidly and through dynamic complementarities with other organisations (i.e. universities, other small — new technology based — firms, large firms), they can generate regional growth. However, their innovatory potential varies between sectors and across the industry cycle as does their growth creating potential (Rothwell, 1990). Many new discoveries and advances in science occur in universities and government laboratories, while the application of this new knowledge to commercial and useful public purposes depends largely upon action by large and small — new technology based — firms.

On the one hand, radical technological innovations often originate from state-of-the-art research, that is often conducted in small, new companies which are spin-offs from university research centres. The transfer of this know-how to large firms with more traditional technologies enables the latter to leapfrog their competitors. On the other hand, the large partner firms possess distinct strengths that are of vital importance to

their smaller partners, such as national or global systems of distribution channels and established reputations, which permit a rapid market penetration on a large scale. According to Niederkofler (1991), this logic explains why the number of strategic partnerships between established large companies and small — new technology based — firms has been on the rise.

Factors for assisting new technology based start-ups locally

Bollinger *et al.* (1983) describe a number of factors and policies that are most critical for countries that wish to encourage the growth of New Technology Based Firms. They are:

- Regional policy
- Sector differences and product versus process innovation
- Technology-oriented complexes
- Other factors such as information flow, existence of financial markets and capital constraints and government or large firm procurement procedures

However, for the purpose of this contribution, we limit ourselves to *region-specific technology policy in Belgium* (Segers, 1991). Technology policy in Belgium emphasizes the creation of infrastructures to promote and provide information on the importance of new technologies for industrial development, the purpose of which is to create an environment suitable for the mobilisation of all innovative forces in the region and to attract foreign investment. A sectoral strategy for technological innovation reflects the desire to establish industries in sectors which allow interfacing university and technological research with the needs and/or the potential of the industry. Consequently, region-specific technology policy has been organised around two focal points, i.e. the existence of a high potential for research in universities and other centres of excellence and the support for New Technology Based Firms.

A wide range of incentives have been created for stimulating the diffusion of technological innovation and for assisting New Technology Based Start-ups locally, such as financial and fiscal incentives including soft loans, capital grants and state guarantee, seed and venture capital funds, financing of pre-competitive and competitive research, prototype development aid, interest subsidies for R&D-loans, accelerated depreciation, government-supported laboratories and industry-specific collective research centres, infrastructural incentives, support for selected technologies, public sector procurement (national, European and international technology programs; on this behalf see Roscam Abbing and Schakenraad, 1991), science parks and innovation & incubation centres for stimulating and assisting university spin-offs and university based NTBFs. Regional technology policy measures have provided an important initial stimulus for the emergence of a number of New Technology Based Start-ups in generic technology industries in Belgium such as biotechnology and micro-electronics (Segers, 1992). Due to a growing trend towards technological and marketing relationships between large and small firms, interfirm technology cooperation (formalized in strategic technology partnerships) has become increasingly important for the survival and growth of a number of NTBFs in Belgium, as the case-based evidence will show.

Strategic partnering experiences of NTBFs in Belgium

As analyses of the emerging biotechnology industry in Belgium offers proof for the hypothesis that strategic technology partnerships may have a significant impact on the survival and growth of Belgian NTBFs. The basic inventive activity in the biotechnology industry in Belgium has occurred mainly in university based NTBFs (science-started ventures), i.e. small, new companies which are spin-offs from university research centres performing state-of-the-art research. Increasingly, venture capital companies have participated in or formed joint ventures with large international chemical or pharmaceutical firms, who are at a growing rate establishing joint ventures with university research centres and small university based biotech firms (on this behalf see also Faulkner, 1986 and Oakey, Faulkner, Cooper and Walsh, 1990). This logic has resulted in a number of strategic technology partnerships between Belgian NTBFs and established large international companies. Examples are:

- Plant Genetic Systems (Bel) with Japan Tobacco, Clause (France) and Hilleshög (Sweden)
- Corvas NV (Bel) with Plant Genetic Systems (Bel) and Corvas International, Inc. (USA)
- Eurogenetics (Bel) with Tosoh (Japan)
- IRE-Celltarg (Bel) with the Liposome Cy (USA)
- IRE-Medgenix (Bel) with Bio-Assay Systems (USA)
- Phytotec (Bel) with Native Plant International (USA)

The same logic is true for the micro-electronics industry in Belgium. Examples of recent strategic technology partnerships are:

- Imec (Bel) with Teknekron (USA)
- Mietec Alcatel (Bel) with Imec (Bel)
- Softcore (Bel) with Apple (USA) and Advent (Bel)
- Cobrain (Imec spin-off) (Bel) and Matrix Integrated Systems, Inc. (USA)
- UCB Electronics (Imec spin-off) (Bel) with Japan Synthetic Rubber

In the following section, case-based evidence will be used to develop an insight into the relationships between Belgian NTBFs and their strategic (large) partners. Table 2 presents an overview of the cases on Plant Genetic Systems and Corvas NV (biotechnology industry) and on Imec and Mietec (micro-electronics industry) that will be discussed hereafter.

TABLE 2
Strategic partnerships between Belgian NTBFs and (large) established firms

Belgian NTBF	Strategic partner(s)	Agreement type
Plant Genetic Systems (Biotn)	▶ Corvas International Inc. (USA)[1]	▶ Partnership Spin-off Firm
	▶ Hilleshög (Sweden)	▶ Co-marketing and Licensing Agreement
	▶ Japan Tobacco	▶ Joint Venture
	▶ Clause (France)	▶ Joint Venture
Corvas NV (Biotn)	▶ Plant Genetic Systems (Bel) and Corvas International Inc. (USA)	▶ Product Development
Imec (Me)	▶ Teknekron (USA)	▶ Co-marketing Agreement
Mietec Alcatel (Me)	▶ Imec (Bel)	▶ Joint Venture

Biotn: Biotechnology Me: Microelectronics

[1] Corvas International, Inc. has also entered into a strategic alliance with Centocor, Inc. (USA). See Figure II.

Case I: Plant Genetic Systems

The case of *Plant Genetic Systems* is an excellent illustration of the impact of strategic technology partnerships on NTBFs in Belgium. Plant Genetic Systems (PGS) is a Belgian NTBF working on the leading edge of the new wave biotechnology industry. PGS originates initially from academic incubators, i.e. the genetic engineering laboratories of the universities of Ghent and Leuven. The same logic is true for other new biotech firms in Belgium. PGS is Europe's leading agricultural biotechnology company, renowned for its product development capabilities. The NTBF was founded in 1983 to develop new plants with high-added value traits. Through genetic engineering the company "designs" plants that offer major economic benefits to the food, feed, pharmaceutical and chemical industries. It currently employs over 125 people. Plant Genetic Systems was initially a technology driven company. Due to the strategic technology partnerships it has stepped into, PGS is becoming increasingly market driven.

PGS' business strategy shows the potential gains an NTBF can obtain by entering into one or more strategic technology partnerships. Its business strategy is to secure its position as a major supplier of its genetic engineered plants (hybrids) through extensive patenting of its commercially important technology. The company opens marketing channels for its products by establishing joint ventures, co-marketing agreements and licensing arrangements with large international seed companies. Plant Genetic Systems is now fostering dynamic complementarities between technology and science and the niche-markets it is positioning itself on.

For this purpose, PGS has entered into a number of strategic technology partnerships with leading American, Japanese and European large established chemical and/or pharmaceutical companies. In 1987, PGS signed a licensing agreement with Hilleshög A. B., the largest plant breeding and seed company in Europe. Benefits include access to markets for production that reaches the commercialization stage. In April 1989, PGS announced a major joint venture with Japan Tobacco, Inc., a 22 billion dollar corporation with interests in agribusiness and pharmaceuticals. Japan Tobacco currently owns 10% of PGS stock. Also in 1989, PGS signed a joint venturing agreement with the French seed giant Clause. In March 1991, Plant Genetic Systems entered into a strategic partnership agreement with the Californian biopharmaceutical company Corvas International, Inc. (see case 'Corvas NV'). In Table 3, the stepping stones in the start-up, survival and growth of Plant Genetic Systems are displayed.

TABLE 3
The stepping stones in the start-up, survival and growth of Plant Genetic Systems

NTBF-Incubators

- Genetic engineering laboratories of the State University of Ghent and the Catholic University of Leuven

Start-up-Phase

- Plant Genetic Systems (Bel): development stage company
- Technology driven
- Product development with high added value
- Absence of products

Survival-Phase

- Continuing operating losses
- Patenting of commercially important technology: hybrids
- *Strategic partnerships*:

1987: Co-marketing and licensing agreement with Hilleshög: plant breeding and seed company

1989: Joint venture with Japan Tobacco, Inc.: agribusiness and pharmaceuticals

1989: Joint venture with Clause (France): seed company

1991: Product development agreement with Corvas International, Inc. (USA): biopharmaceutical company. Partnership Spin-off: Corvas NV (Bel). Public stock offering (Nasdaq, February 1992).

- Technology/Market driven

Growth Phase (projected)

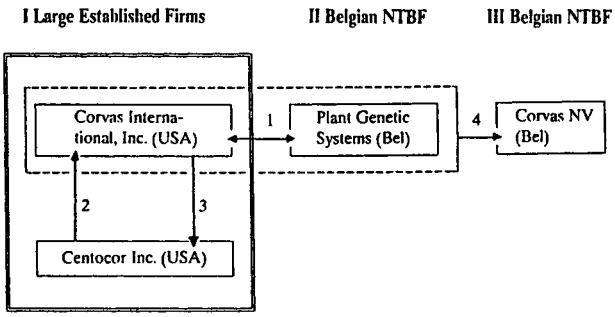
- Market driven
- Fully integrated manufacturing concern (as an independent venture?).

Case II: Corvas International Inc. and Corvas NV

Corvas International, Inc. (further abbreviated as Corvas Int.) is a biopharmaceutical company located in San Diego, California (USA), engaged in the design and development of a new generation of therapeutic agents in the field of thrombosis and associated vascular diseases. The company intends to commercialize synthetic drugs for the improved treatment and prevention of major cardiovascular diseases, including among others heart attack and stroke. The company has developed proprietary drug design technologies which have yielded several lead compounds. Its first drug candidate, Corsevin M, is currently in phase I clinical trials. Corvas Int. is a development stage company, founded in 1987. The company has not completed the development of any therapeutic product and, accordingly, has not begun to market or generate significant revenues from the commercialization of products. The company's strategy for the research, development and commercialization of certain of its products includes entering into various arrangements with corporate partners, licensors, licensees and others. Because Corvas Int. is focusing its resources on proprietary synthetic pharmaceuticals rather than on monoclonal antibodies, in November 1991 it entered into a strategic alliance with Centocor, Inc. in the area of monoclonal antibody products. In connection with this alliance, Centocor made an additional equity investment in Corvas Int. and in turn acquired a license to Corsevin M and an option to license other present or future monoclonal antibody products. Corvas Int. has retained exclusive commercial rights to all non-antibody products under development. All this is of major importance to Plant Genetic Systems since PGS seeks to strengthen its position in the market niche of biotechnological pharmaceuticals. In March 1991, Corvas Int. and Plant Genetic Systems entered into a strategic technology partnership agreement. Corvas Int. acquired certain assets and research and development projects of Plant Genetic Systems in

exchange for a certain amount of shares of preferred stock. The assets acquired included laboratory equipment and prepaid services. Corvas Int. conducts its proteïn engineering programs, including the research and development projects acquired from Plant Genetic Systems through its Belgian partnership spin-off *Corvas NV* to complement its medicinal chemistry programs in San Diego.

As Figure II clarifies, Plant Genetic Systems is indirectly related to Centocor, Inc. through the Centocor-Corvas Int. partnership and the Corvas Int.-PGS alliance via Corvas NV.



1 Strategic Technology Partnership
2—3 Strategic Technology Partnership
2 Equity Investment
3 Licensing Agreement (monoclonal antibody products)
4 Partnership Spin-off (proteïn engineering programs)

Fig. II. Plant Genetic Systems and Corvas NV.

Case III: Imec and Mietec

Micro-electronics is of strategic importance to every industrialised country, because integrated circuits are found in almost every product and production process. The R&D however is very demanding both in capital equipment as in manpower. The regional government of Flanders (Belgium) therefore created Imec as part of a science and technology programme to promote research and applications of micro-electronics, in the fields of very large scale integration systems design methodologies, advanced semi-conductor processing and micro-electronics education and training.

The *Interuniversity Micro-Electronics Centre (Imec)* is an originally science-started-venture. It currently employs over 370 people and was founded in 1984. It strengthens the research potential of the Flemish universities with electronic engineering departments (universities of Leuven, Ghent, Brussels, Antwerp and Limburg). Imec makes available state-of-the-art design software for integrated circuits by offering the possibility of fabricating custom and semi-custom integrated circuits and sensors and by carrying out joint national or international research projects, with or without industrial involvement. With other research institutions outside Belgium, Imec cooperates in large projects where the complementary know how of several laboratories is required. It carries out R&D for the European Space Agency and in the framework of the Joint European Submicron Silicon Initative.

Imec has developed into a major independent research resource for industry. This has opened opportunities for university-industry linkages and for technology transfer. Several industrial companies have scientists working at Imec. Among the university-based research potential in Flanders cooperating with Imec are ESAT (Department of Electrical Engineering, Leuven), MICAS (Medical and Integrated Circuits and Sensors, Leuven), MI2 (Machine Intelligence and Imaging, Leuven), LEA (Laboratory of Electromagnetism and Acoustic, Ghent), LEM (Laboratory of Electronics and Metrology, Ghent), APD (Applied Physics Department, Brussels), IRIS (neural networks, . . . , Brussels).

In May 1986 the Imec-Spin-off Cell was created in order to strengthen the interaction between the research centre and the industry. To meet this objective, a number of actions have been developed such as the transfer of information to the industry with respect to potential industrial applications of technologies developed at Imec; an identification of industrial research needs in the field of micro-electronics; informing and supporting potential foreign investors of the research facilities and the contract research possibilities offered by Imec; licensing agreements for Imec technology and software with third parties for commercialisation of design, device modeling and measurement software. The major objective of the Imec-Spin-off Cell is however to identify the technologies that can lead to spin-offs. To do this, the spin-off cell helps to prepare market analyses, investment calculations and complete business

plans up to finding the appropriate required financial input either through seed or venture capital or by attracting industrial partners to set up (joint) industrial units based upon technologies developed at Imec. The spin-off cell spents a large effort on informing Belgian small firms on the different possibilities for benefiting from Imec's R&D-effort.

Imec helps to create a scientific environment needed by high tech companies to start, survive and grow. On the other hand, Imec can play an important role in the decision of micro-electronic companies to invest in Belgium. The latter creates opportunities for regional growth. An industrial research park together with an incubation and innovation centre is available in the proximity of Imec for the start-up of research-based firms and industrial research institutions.

In the Fall of 1991, Imec and the American company Teknekron signed a cooperative agreement for the joint marketing of products, technology and consultancy of micro-systems. The establishment of a mutual spin-off firm is under consideration. The strategic technology partnership will follow Teknekron's marketing approach in which potential customers point out potential applications of micro-systems. In November 1991, Imec stepped into a strategic technology partnership with *Mietec Alcatel.* Mietec is an industry based NTBF that develops, manufactures and markets technologies and products in the niche-market of ASICs (Application Specific Integrated Circuits). The company was established in 1983 by Bell Telephone Mfg., a Belgian subsidiary of Alcatel and by the Investment Company for Flanders. In January 1990, a 100% shareholding was acquired by the Alcatel Group, Europe's number one telecommunications company, to form the current Mietec Alcatel, that is now the group's strategic partner for micro-electronics. Mietec works together with Imec for all technology developments, especially in defining process steps and analysing techniques. Mietec participates with other companies and research labs in various European science and technology programmes.

One of Imec's strategic goals is to provide incentives for new industrial ventures based on technology (research and development) developed at Imec. Next to its strategic technology partnerships with Teknekron and Mietec, Imec has thus given rise to a number of new technology based start-ups in Belgium. They are:

- UCB-Electronics (1986)
- Cobraïn (1987)
- European Development Centre (1989)
- Soltech (1989)

In the course of 1990, Cobraïn entered into a strategic partnership with Matrix Integrated Systems, Inc. (USA) and UCB-Electronics closed a joint venturing agreement with Japan Synthetic Rubber.

In Figure III, the logic behind strategic partnering between Belgian NTBFs and large established firms is presented in a model based on empirical observations that capture as much as possible the "real world" of NTBF-creation in the biotechnology and micro-electronics industries in Belgium.

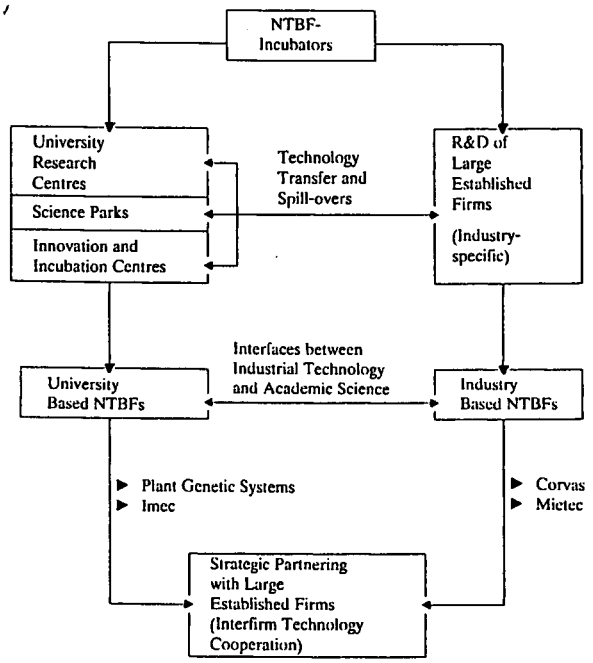


Fig. III. Strategic partnerships between (large) established firms and Belgian new technology based firms.

Conclusions

The data from the cases suggest that strategic technology partnerships can have a significant impact on New Technology Based Firms in Belgium that are in their survival or growth stages. The partnerships with established large firms offer

Plant Genetic Systems, Corvas NV and Imec/Mietec access to the superior resources of their strategic large partners. The research and development, marketing, financial and managerial resources are formalized in equity, product development, co-marketing and/or licensing agreements (*Hypothesis 1*). If these NTBFs are not able to establish strategic partnerships, they could encounter delays in introducing their products into certain markets or find that the development, manufacture or sale of their products in such markets is adversely affected.

A number of potential pitfalls can be identified for the survival and growth of these NTBFs:

- the absence of products
- the need for additional capital (seed and venture capital, public stock offering)
- continuing operating losses during the early stages of development
- no assurance of regulatory approval
- rapid technological change and competition
- uncertainty regarding patents and proprietary rights
- dependence on others: the amount and timing of resources that the strategic large partner(s) will devote to its contractual partnership responsibilities are not within the NTBF's control
- uncertainty about expected revenues that will be derived from the strategic partnership
- manufacturing, clinical trial and regulatory compliance capabilities of the NTBF and if not dependence of the strategic partner
- retention and attraction of key personnel

It is clear that a number of these potential pitfalls are directly linked to the involvement of the NTBFs in strategic (technology) partnerships (*Hypothesis 2*). The cases on Plant Genetic Systems, Corvas NV and Imec/Mietec seem to suggest that a workable strategic partnership constitutes an optimization of the potential synergies and the dynamic complementarities between the large, established firm and the small — new technology based — firm. However, despite the considerable success of these Belgian NTBFs in establishing strategic partnerships, the nature of the market involved, the long lead times and the uncertainty which characterizes these firms suggest that they are unlikely to become fully integrated manufacturing concerns — at least not as independent ventures. The new biotechnology firms reviewed here are heavily dependent on established companies, especially for marketing outlets, for manufacturing resources when they reach the commercialization stage and for continuing product development efforts. The microelectronics firms reviewed depend heavily on both public (national, European and international) and industrial R&D contracts and on the public research system. However, both types of NTBFs are important interfaces between industrial technology and academic science.

As stated earlier, the combination of a small firm's know-how with a larger firm's resources opens opportunities for synergies that can contribute to both firm's competitive advantage and to the creation of a (regional) growth potential. If the pitfalls mentioned earlier can be avoided by entering into a partnership agreement, the small — new technology based — firm will stand a better chance to expand its future viability in terms of successful commercialization of its innovations or products and of its growth potential (*Hypothesis 3*).

With respect to regional technology policy, the findings from above lead to the conclusion that stimulating and assisting NTBF-creation is best put within the framework of European and/or international technology programs and the effects of this for small countries such as Belgium.

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