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# Networks in Entrepreneurship: The Case of High-technology Firms

Tom Elfring  
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**ABSTRACT.** The value of networks as an integral part of the explanation of entrepreneurial success is widely acknowledged. However, the network perspective does not specify the role of networks in the emergence and early growth of a venture. We have distinguished three entrepreneurial processes in new venture development, i.e. discovery of opportunities, securing resources, and obtaining legitimacy, which are of importance for survival and performance. This paper examines how these processes are influenced by strong and/or weak ties and whether the degree of innovation (incremental versus radical) acts as a contingency factor in the way network ties support entrepreneurial processes. In this explorative study three cases on high technology firms in The Netherlands provide empirical material enabling us to develop a number of propositions on the network effect, in particular the mix of strong and weak ties, on the three entrepreneurial processes.

## 1. Introduction

In the 1980s and early 1990s, some researchers shifted the emphasis from the heroic and “atomistic” entrepreneur to someone with a personal history embedded in a network. They addressed the distinctive role played by personal and business networks in the start-up and (early) growth of technology-based firms (Birley, 1985; Aldrich and Zimmer, 1986; Johannisson, 1987). As they see it, a network is one of the most

powerful assets that anybody can possess: it provides access to power, information, knowledge and capital as well as other networks. The overall notion is that a more developed network, in terms of the number of ties and the quality of the ties, is more beneficial to a start-up than a less developed network (Larson and Starr, 1993).

Although the value of networks as an integral part of the explanation of entrepreneurial success is widely acknowledged, there is considerable confusion and disagreement as to the role particular network characteristics play in the performance of emerging firms (Johannisson, 2000; Hite and Hesterly, 2001; Rowley et al., 2000). It is not fully clear what the various dimensions of a network are, nor what their impact is on the early development of a venture (Bloodgood et al., 1995; Steier and Greenwood, 2000). There are, for example, conflicting results: “Both strong and weak ties are argued to be positively related to performance” (Rowley et al., 2000, p. 369) and in some cases strong ties are considered a disadvantage rather than a benefit (Gargiulo and Benassi, 1999). Efforts have been made to reconcile these opposing views. For example, Burt (2000) argues that they are not necessarily conflicting, but they play different roles, which are valuable for different populations or purposes. However, the mechanisms and processes by which particular ties play a role in the development of an emerging firm remain unclear. It is our aim to shed light on the way the different ties benefit emerging ventures. In particular, we identify three processes that link the network ties with performance. The proposed “process” model accentuates various entrepreneurial activities, and helps to account for the different contributions of strong and weak ties to the performance of ventures.

Our overall aim in our proposed model is to improve the understanding of the causal mecha-

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nisms between the network structure and performance. There are three aspects to the proposed model. First of all, we focus on the mix of weak and strong ties, each of them contributing in a particular way to the entrepreneurial process. Strong ties are associated with the exchange of fine-grained information and tacit knowledge, trust-based governance, and resource cooptation (Krackhardt, 1992; Starr and MacMillan, 1993; Rowley et al., 2000). Their advantages are different from the benefits generated by weak ties. Weak ties are beneficial as they provide access to novel information as they offer linkages to divergent regimes of the network (Granovetter, 1973, 1982; Burt, 1992). We focus on the mix between strong and weak ties since each has qualities that are advantageous for different purposes. Thereby we build on the work of Uzzi (1996, 1997), Hite and Hesterly (2001) and Rowley et al. (2000) who conclude that a key issue in the determination of network benefits is the search for the optimal mix of strong and weak ties.

Secondly, instead of linking the network structure directly to performance, we distinguish three entrepreneurial processes that are affected in a positive or negative way by the presence of weak and strong ties. These three processes may be seen as intervening processes that regulate the key performance outcomes and are labelled as entrepreneurial processes. As entrepreneurship is concerned with the discovery and exploitation of profitable *opportunities* (Shane and Venkataraman, 2000), the first process is the discovery of opportunities. The discovery process is affected by prior knowledge (Shane, 2000) and information regarding the opportunity (Fiet, 1996). The network of the start-up gives access to relevant information about markets, ways to serve these markets and ways to deal with customers. The second process deals with the ability of the start-up to acquire *resources*. In the early phase firms must access, mobilize and deploy resources in order to exploit the opportunities they have spotted (Garnsey, 1998). Securing resources is one of the crucial tasks of the entrepreneur(s) in new ventures and their key relationships have to be used to get "privileged" access (Starr and MacMillan, 1990). The third entrepreneurial process involves obtaining *legitimacy*. When an entrepreneur embarks on something that is

innovative, it has to secure legitimacy (DiMaggio, 1992). A new venture has to deal with the "liability of newness." The more innovative it is, the greater its need to organize institutional support and legitimacy (Stinchcombe, 1965; Baum et al., 2000). The venture has to mobilize its network to overcome the legitimacy barriers (Aldrich and Fiol, 1994; Van de Ven, 1993).

Thirdly, we introduce the distinction between radical and incremental innovations as a new contingency. A number of researchers utilize a contingency approach to reconcile the different network benefits. For example, the industry context is introduced as a contingency factor by Rowley et al. (2000) and Hite and Hesterly (2001) show that as ventures progress from emergence to growth the evolving resource needs require a shift in network structure. Start-ups based on radical innovations require a different mix of strong and weak ties from those pursuing incremental innovations. We argue that this degree of innovation affects the way firms approach their network relationships and seek to benefit from them. By taking this contingency into account, we address the challenge posed by Leenders and Gabbay (1999) to look for particular contingencies in network benefits.

Most research on network benefits for start-ups has focussed on the dynamic relationship between networks, resources and growth (Hite and Hesterly, 2001; Yli-Renko and Autio, 1998). We also include the particular contribution strong and weak ties make to the scanning of opportunities and of gaining legitimacy through networking.

The unit of analysis in this study is the emerging venture. A new venture is initiated by a single entrepreneur or by a team, as is often the case in new technology-based firms (Roberts, 1991). We focus on the way high-technology ventures use their personal and business networks to get started, and to create the conditions for growth (Dubini and Aldrich, 1991). In this paper the leading research question is the following: *How do networks, and in particular the mix of strong and weak ties, affect the ability of the high-technology start-up to discover opportunities, to obtain resources and to acquire legitimacy?* We will present three case studies, two of which are based on Information Communication Technology (ICT) firms and one of which is based on a

biotechnology company. All three are Dutch firms. These cases provide empirical material from which we develop a number of propositions concerning the effects of networking on the success of high-tech start-ups.

## 2. Venturing through networks

The presupposition of this paper is that high-tech entrepreneurs and their ventures are embedded in ongoing social and economic relations, including personal and professional ties, (non-)equity partnerships and other networks, all of which affect the way their career and their firm develop. Economic transactions between firms do not take place in a vacuum but rather, are often based upon a history of past dealings and ongoing social interactions (Granovetter, 1985; Uzzi, 1997). Furthermore, economic transactions may produce social networks as well: arm's length ties may eventually be transformed into embedded ties (Uzzi, 1996). These networks are vital when it comes to gaining access to opportunities, collecting the resources needed to build a new enterprise and obtaining legitimacy (Birley, 1985; Aldrich and Zimmer, 1986; Johannisson, 1987; Dubini and Aldrich, 1991).

The structure of networks may vary from a loose collection of ties to close-knit business groups, in which the focal organization is embedded. In our study, we examine the effect of a particular mix of strong and weak ties in entrepreneurial networks, because this mix allows for an analysis of support networks in terms of both the depth and width of relationships. Granovetter (1972, 1982) specifies the intensity and diversity of relationships, i.e. the difference between strong and weak ties, on the basis of four criteria: namely, the frequency of contacts, the emotional intensity of the relationship, the degree of intimacy and reciprocal commitments between the actors involved. While weak ties provide access to (new) industry information and to new business contacts, strong ties are relations one can rely upon both in good times and in bad times.

Strong ties tend to bind similar people in longer-term and intense relationships. Affective ties with close friends and family members may provide a shortcut to or even preclude the search for useful knowledge and access to critical

resources. In other words, strong ties contribute to "economies of time" (Uzzi, 1997, p. 49): the ability to capitalize quickly on market opportunities. The manifestation of strong bonds will also reduce the time spent on monitoring and bargaining over agreements: free-riding is discouraged and transaction costs are lowered. Strong ties are more likely to be useful to individuals in situations characterized by high levels of uncertainty and insecurity, e.g. amidst radical innovations. In such complex settings, individuals rely on close friends and family members for protection, uncertainty reduction and mutual learning. Krackhardt (1992, p. 238) has elaborated on the affective component of strong ties by arguing that commitment, loyalty and friendship within an organization will be critical to an organization's ability to deal with major crises. In short, a relational governance structure based on strong ties will promote the development of trust, the transfer of fine-grained information and tacit knowledge, and joint problem-solving (Uzzi, 1996; 1997; Rowley et al., 2000).

Strong ties have shortcomings too. There is the risk of *overembeddedness*, i.e. of stifling economic performance (Uzzi, 1996). Close ties within and among business communities are vulnerable to exogenous shocks and may insulate such commitments from information that exists beyond their network. There is the danger of being blind to new developments or being "locked-in" (Johannisson, 2000).

Weak ties refer to a diverse set of persons working in different contexts with which one has some business connection and infrequent or irregular contact. These loose and non-affective contacts increase diversity and may provide access to various sources of new information and offer opportunities to meet new people. Weak ties represent local bridges to disparate segments of the social network that are otherwise unconnected and may open the door to new options (Granovetter, 1973, 1982; Burt, 1992). In short, both strong and weak ties are useful and contribute to the emergence and growth of firms, although they are beneficial in different ways and at different stages of a company's development. Therefore, the ideal entrepreneurial network includes a particular mix of strong and weak relationships (Uzzi, 1996, 1997). We have distin-

guished three entrepreneurial processes, the ability to discover opportunities, the ability to secure resources, and the ability to gain legitimacy, in which network ties play a role (see Figure 1).

### 2.1. Opportunities

An important source of new ideas and lucrative opportunities may be the networks, in which the entrepreneur is actively participating. Hills, Lumpkin and Singh (1997) find that about 50 percent of entrepreneurs identify ideas for new ventures through their social network. In addition, in the process from idea to the actual start of a venture, prior knowledge (Shane, 2000) and information (Fiet, 1996) are important. According to Fiet (1996, p. 429): “use of networks may be viewed as a way of tapping into an information channel to obtain risk-reducing signals about a venture opportunity.” Both variables are closely linked to networks, as network relations can be seen as ways to gain access to knowledge and information. In one of the first studies on this aspect, Birley (1985) carefully documents how often entrepreneurs seek advice and feedback on the core ideas of their business plan, when they turn to friends and family for local issues, and when they use formal ties to look for financial support. The start-up was seen as an iterative

process in which the number of informal and formal ties affect the success of the entrepreneur in finding a lucrative opportunity.

The environment and the opportunities it contains are diverse and uncertain. The network of an entrepreneur is a source of information helping the entrepreneur to locate and evaluate opportunities. Networks and in particular weak ties provide access regarding a diverse set of topics, ranging from potential markets for goods and services to innovations and promising new business practices. Weak ties are supposed to lead to a more varied set of information and resources than strong ties can (Bloodgood et al., 1995), and consequently weak ties enhance the ability of entrepreneurs to spot opportunities.

### 2.2. Resources

Providing access to resources is an important contribution of networks to the venturing process. Entrepreneurs rarely possess all the resources required to seize an opportunity. One of the crucial tasks in a new venture is to access, mobilize and deploy resources (Garnsey, 1998). This is a difficult task in the initial stages of a start-up with limited financial resources and hardly any ability to generate internal resources and revenues. Close social support networks (e.g. spouse, family ties)

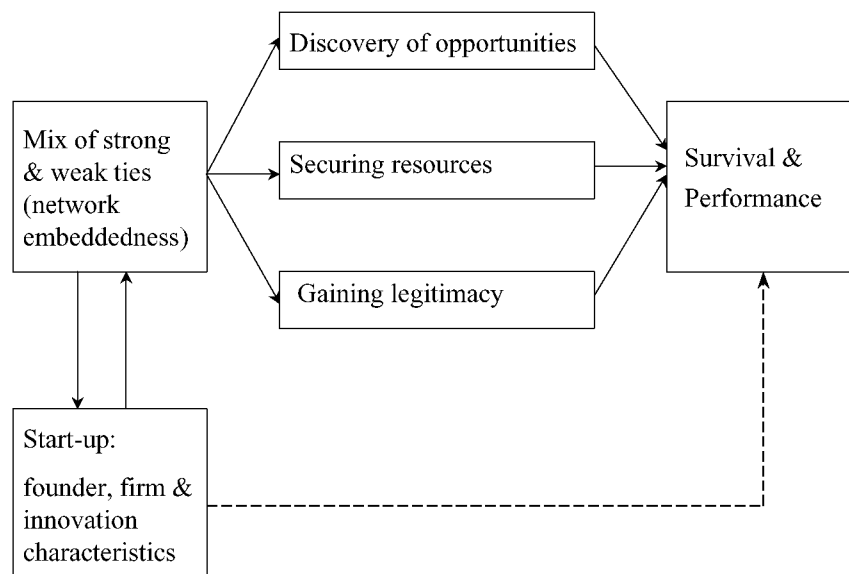


Figure 1. Venturing through networks.



may provide the founder/owner with the resources (e.g. financial and human capital) he or she is lacking, and hence provide stability to the new firm in its early stages (Brüderl and Preisendörfer, 1998). Additionally, sparse networks facilitate the search for critical asset providers (e.g. investment and technology partners and key customers), who may offer the start-up further access to financial resources, production know-how and complementary technology, distribution channels, etc. Furthermore, there is initial uncertainty about the growth of the venture and the resources it requires (Chrisman et al., 1998). In the case of staged investing by venture capitalists in technology start-ups, the amount of uncertainty about a venture declines as it survives and grows.

One of the key survival strategies is “asset parsimony” (Hambrick and MacMillan, 1984). The required resources need to be secured at minimum cost. Paying the market price for resources, such as labor, materials, advice and commitment is often too expensive. Social transactions through network ties play a critical role in the acquisition of venture resources. These resources can be acquired far below the market price, the entrepreneurs (as well as intrapreneurs) employ social assets such as friendship, trust, and obligation (Starr and MacMillan, 1990). In particular, network members representing strong ties are more motivated to help the entrepreneur than those with whom the entrepreneur has weak ties. Potential entrepreneurs assess their ability to obtain the required resources at relatively low cost on the basis of their strong ties.

### 2.3. Legitimacy

The third contribution of a network to the success of a start-up is the way it opens possibilities to gain legitimacy. Gaining legitimacy is imperative in starting something that is considered innovative (DiMaggio, 1992). Stinchcombe (1965, pp. 148–150) has introduced the concept of the *liability of newness*, or simply stated, young organizations face higher risks of failure than old ones. Established organizations have a set of institutionalized roles and tasks, stable customer ties, experienced constituents, a surplus of capital and creativity (slack), and a shared normative framework at their disposal, all of which contribute to

an effective provision of goods and services and their ultimate survival. New firms and novel organizational forms, on the other hand, are more likely to fail just because they still have to develop and acquire those prerequisites (Baum et al., 2000). Faced with the aforementioned “liability of newness”, a new venture has to organize institutional support and legitimacy. This appears to apply especially to (relatively) radical innovations, where young technology companies need the endorsement of (some of) the prominent players in their industry (Stuart et al., 1999). In order to enhance their visibility and gain recognition, new ventures seek to obtain a prestigious business affiliate to build up a strong link with and eventually hope that, through this key contact, they will have access to new customers and partners. Furthermore, biotechnology companies in particular establish large supervisory boards with well-known industry experts and academics.

Suchman (1995, p. 574) defines legitimacy in a broad sense as “a generalised perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions.” Aldrich and Fiol (1994) draw a distinction between cognitive and socio-political legitimacy. Understanding the nature of the new venture is referred to as cognitive legitimacy. It has to do with the spread of knowledge regarding the new business concept. To overcome this legitimacy barrier, network actors, such as competitors, distributors and universities, must be mobilized to create partnerships in order to achieve a wider understanding of the new concepts. The second, and related, type of legitimacy is labeled socio-political legitimacy and refers to the extent to which key stakeholders accept the new venture as appropriate and conforming to accepted rules and standards. Achieving socio-political legitimacy is particularly difficult when the new venture is very innovative and challenges existing industry boundaries. In those cases changes in the institutional framework are often required. Organizing socio-political legitimacy requires collective action, negotiations with other industrial constituents and joint marketing and lobbying efforts.

### 3. Contingencies and network benefits

Recently, the contingency argument has been used to reconcile opposing views on networks. Both strong and weak ties may be beneficial to emerging firms, albeit for different purposes and at different times. For instance, it has been proposed that in the initial or even nascent stage, family and other strong ties play an important role, while later on formal contractual relations become more dominant (Birley, 1985; Bloodgood et al., 1995; Hite and Hesterly, 2001). In addition, in the study by Rowley and associates (2000) the industry context was introduced as a contingency. They show that in a highly dynamic environment weak ties have a positive impact on the performance of firms, while in a stable environment it is strong ties that appear to do so. In our present study another contingency is introduced, namely the degree of innovation of an entrepreneurial venture.

The degree of innovation, radical versus incremental, may be a contingency factor affecting the beneficial effects of a particular mix of strong and weak ties on the key entrepreneurial processes. A radical innovation makes different demands from a network than an incremental innovation. Radical innovations disrupt the existing economic conditions and require a change in the business context, instigated by a persuasive entrepreneur (Schumpeter, 1934). Radical innovations can be characterized by exploration and competence-destruction (March, 1991; Anderson and Tushman, 1990). The existing knowledge base is made obsolete and experiments with new technologies and alternative user groups are promoted. Incremental innovations, on the other hand, are far less disruptive and are brought to market and exploited by alert entrepreneurs (Kirzner, 1997). Incremental innovations have more to do with exploitation and competence-enhancing measures, enabling the entrepreneur to build on existing routines and skills. Cheah (1990) has suggested that the entrepreneurial processes for these two types differ. The realization of radical innovations in new ventures is confronted with a great deal of uncertainty. It is a bumpy ride rather than a linear process: The entrepreneur will find it harder to convince stakeholders to adopt a radical innovation than an incremental one. These differences

in terms of the degree of innovation are expected to have an impact on the network benefits for the various entrepreneurial processes. Thus we will examine how the mix of strong and weak ties has contributed to the three entrepreneurial processes (see Figure 2).

#### 3.1. Case research questions

The discovery of opportunities is usually associated with access to new information. Weak ties provide this novel information more frequently than strong ties. However, strong ties may be of importance when it comes to evaluating and discussing the feasibility of the opportunity and determining its nature in greater detail. Nevertheless, the overall notion from the literature is that weak ties are important for recognizing opportunities. In our case studies, we are interested in differences in network benefits for start-ups pursuing incremental versus radical innovations. The first case research question is as follows: *Do start-ups based on radical innovations benefit from a different mix of strong and weak ties from those realizing incremental innovations?* Radical innovations often require outsiders, as insiders are blinded by existing practices. To get to know these outsiders weak ties are needed. Start-ups discovering incremental innovations are driven by competence enhancement. Therefore well-known insiders may also be able to provide the information needed to determine the nature of the opportunity.

Securing resources very often depends on the presence of strong ties. Family and friends very often provide start-up capital and give "privileged" access to labour and other resources. The strong tie benefits are associated with social cooptation and the cost saving on resource acquisitions. These benefits are valuable to all start-ups. Another strong tie advantage is related to the ability to exchange tacit knowledge. This mechanism may be particularly important to start-ups realizing more radical innovations. They are confronted with a new combination of resources from various backgrounds. The deployment of these complementary assets requires the exchange of tacit knowledge. Therefore the second case research question we pose is as follows: *Is it true that the more radical the innovation of a start-up is, the*

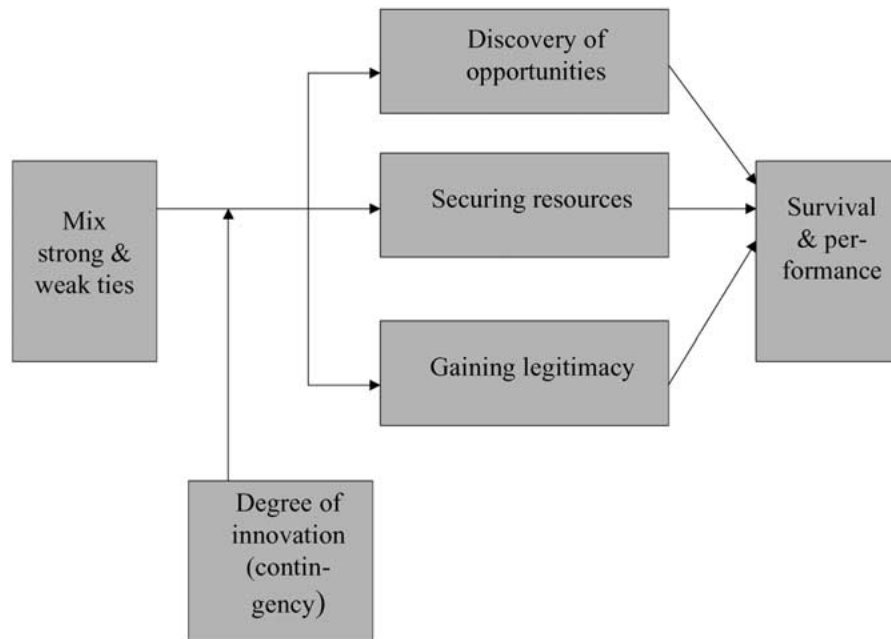


Figure 2. Research framework.

*more important strong ties become to secure resources?*

Strong ties are an important asset in gaining legitimacy, because they enable start-ups to associate themselves with other people or institutions with good reputations. This mechanism is relevant to both incremental and radical innovations looking to gain cognitive legitimacy. The issue of socio-political legitimacy is a more complex one as it also involves outsiders such as trade associations and the general public. The activities of the venture have to be accepted or, even better, endorsed by a much wider audience. This endorsement mechanism may very often imply weak ties, as they are usually outsiders to the start-up's immediate network. Concerning the mix of strong and weak ties the third case research question is thus: *Does the realization of radical innovations require a different mix of strong and weak ties?* We expect that the mix does not change, as both strong and weak ties tend to become more important when radical innovations are involved. The association mechanism becomes more difficult as the risks and uncertainty of the start-up are higher; thus start-ups really rely on strong tie benefits. Similarly the endorsement mechanism through weak ties may be more difficult because of the

risks and uncertainties associated with some radical innovations.

#### 4. Cases of high tech start-ups

##### 4.1. Methodology

The objective of this exploratory study is to contribute to theory-building concerning the way a particular mix of strong and weak ties contributes to the ability of new ventures to discover opportunities, secure resources and gain legitimacy. In line with the more exploratory rather than hypothesis-testing nature of the research, we put forward propositions after the empirical research (Yin, 1984). The data collection and analysis are guided by the research questions (Pettigrew, 1990) and a research framework (Eisenhardt, 1989). This case-based research project was divided into four steps. The first was to develop specifications of constructs relevant to high-technology ventures and networks. The second step was to select young technology firms from the Netherlands. This was not a random process, but one that was based on theoretical sampling (Eisenhardt, 1989). We wanted firms from different high technology industries (ICT and bio-technology) as well as



polar cases (Pettigrew, 1990) with respect to the degree of innovation (incremental: Noldus versus radical: Pharming and Digicash) and performance (success: Noldus, survivor: Pharming, failure: Digicash). The third step concerned the collection of data and analysis. This part of the study was conducted through interviews and discussions with founders and senior managers (two per company), and analysis of company briefings and industry data. Finally, the cases were prepared and written between March and December, 2000. These multiple data sources were used to check the validity of the data and constructs. The last step concerned the analysis of the data. For each case and across cases the particular network effects were analysed. According to the replication logic (Eisenhardt, 1989) comparison across the various cases (which represent different situations or even polar types) may confirm particular emergent relationships between constructs and thereby improve the validity of the relationship. When case findings disconfirm a relationship, it provides an opportunity to refine and extend the theory. However, for future research it is interesting to reformulate our propositions into testable hypotheses for a larger sample of high technology ventures.

#### 4.2. Noldus

Noldus' main products are standard software packages, such as *The Observer*, *EthoVision* and *UltraVox*, which facilitate the collection and analysis of data of human and animal behavior. The company's mission states that these products help scientists, engineers and practitioners to study the behavioral processes, to automate measurements, to improve the quality of their data, and to increase their productivity. Applications to study human and animal behavior can be found in a large number of disciplines (e.g. neuroscience, pharmacology, veterinary sciences, ergonomics, industrial engineering, and sports research), which can be found in many companies, government agencies and universities. Noldus has over 1,500 clients in more than 65 countries. In its ten years existence, Noldus has grown from a one person – entrepreneur – company to a high-tech firm of around 40 employees and sales of about 2.5 mEuro. Important clients are Bayer, Organon, Microsoft, Oracle, Ericsson and Volvo.

The company was started by Lucas Noldus shortly after he obtained his Ph.D. from Wageningen University in 1989. The first product was a software package based on the software he developed during his Ph.D. research project on the behavior of wasps. Already during the final phases of the research, the interest of other animal behavior researchers for the software was substantial and provided a first indication that there might be a market for such software. In the last stages of his Ph.D., Lucas Noldus started to develop, in his spare time, a more general software application called *The Observer*. The University was supportive. Mr Noldus started his firm in an incubator building, and he benefited from the discussion with entrepreneurs from other start-up companies in that building.

Marketing for Noldus includes going to academic and business conferences to meet researchers, engineers, and practitioners who can use the software products to study behavioral processes. Most of the markets are vertical niche markets. The marketing strategy can also be characterized as a stepping stone approach. From the strong position in the pharmaceutical industry the company got in contact with researchers at conferences in the psychology and neuroscience field.

#### 4.3. Pharming

After the Dutch Ministry of Economic Affairs had granted Leyden University (RUL) an R&D subsidy of 1.5 mEuro to investigate the possible production of biopharmaceutical proteins by genetically manipulated cattle in 1988, GenPharm was established by Professor De Boer and Mr. Postma, the university's liaison officer. GenPharm located itself at the RUL Science Park and the university, together with its American strategic investors (Genentech and Chimera), participated in the company's stock. Initially GenPharm worked closely with the government's agricultural laboratory IVO-DLO, generating Herman, the first genetically manipulated bull in the world, and the breeding of transgenic cows (Herman's offspring) for the treatment of *mastitis* (a cow disease). In the early 1990s, concerns from animal rights activists concerning these cloning experiments generated pressure on the Minister to ban the

allegedly un-ethical activities. Since the biotechnology association NIABA had only recently been established, GenPharm itself had to instigate and organise the public discussion. Due to an aggressive awareness campaign, in which various associations of *captive* patients were mobilized, Parliament decided that there was no reason to prohibit the experiments with genetic manipulation. As a consequence, the Ministry of Agriculture granted GenPharm another subsidy in 1992 (approximately 1 mEuro) to continue its research.

In 1993, a new CEO was appointed to streamline the firm's activities and two years later, GenPharm was divested from GPI through a management buy-out. The resulting company, called Pharming received new funds from Dutch investors and the American Red Cross. Due to a final ban of the Dutch Ministry of Agriculture on animal cloning in 1998, Pharming was forced to scale back its dairy farm operations in the Netherlands and relocate them. Pharming set up a subsidiary in the U.S.A. (Rockville, Maryland), near its contract research partner, the American Red Cross, and in addition signed an agreement with Genzyme (an American biotechnology company) to develop and commercialize enzymes for the treatment of Pompe's disease (a rare but lethal medical disorder). Between 1997 and 1999, Pharming evolved into a public company, and was listed on the EASDAQ and AEX stock exchanges.

#### 4.4. Digicash

Between 1990–98 Digicash has sought to develop and commercialise safe and anonymous payment technologies for small money transfers over the Internet. In 1990 Digicash was established by Dr. Chaum (an international expert in the field of cryptography) and associates, as a spin-off of the CWI, the Netherlands Centre for Research in Mathematics and Computer Science. The main reason for establishing a company was a plan of the Dutch Government to develop a road-pricing system. Initially, Digicash started off with family capital of 1 mEuro. As it did not immediately have any tangible products to sell, the new firm had to rely on the revenues generated by consultancy and research projects. In 1995, Digicash was acknowl-

edged as a successful European start-up and awarded the Commission's IST prize for its outstanding contribution to promoting innovation. In the mid-1990s the future for Digicash looked promising: the company employed about 50 people, was making some profit, and it had embarked upon an internationalization strategy by establishing small subsidiaries in the U.S.A. and Australia.

In the early 1990s, the market for small-scale payments was still relatively open and fragmented, offering potential to new entrants, like Digicash. In the mid-1990s, however, large competitors appeared on the scene. Microsoft, Netscape and other software companies, supported by MasterCard and VISA, started to push for safe and secure electronic money and big banks began experimenting with chipcards and other smart payments. This diverse community started to work together in promoting the Secure Electronic Transaction (SET) standard, which by 1997 had become the *de facto* global norm. At home too, Digicash was left out in the cold. The company missed an opportunity to work with Dutch banks on the design of a system for facilitating on-line payments. Eventually the banks adopted the SET standard.

To gain a share of the lucrative U.S. market and to benefit from the state-of-the art knowledge concerning electronic commerce, Digicash decided to move its headquarters and research laboratory to Silicon Valley in 1997. The decision to relocate was strongly promoted by American and Dutch venture capitalists. At the end of 1998, Digicash' future looked bleak. Its Dutch subsidiary had to be closed, and after the only American bank testing its technologies abruptly closed the 3-year trial, Digicash also lost its toehold in the U.S. As a consequence, Digicash had to ask for a Chapter 11 filing and eventually went bankrupt.

### 5. Analysis of cases

The cases are analyzed by looking at the way the three firms have developed and used their networks to discover opportunities, secure resources and gain legitimacy. In examining the three entrepreneurial processes within these firms, a distinction will be made between strong and

weak ties and their contribution to the emergence and early growth of these firms.

### 5.1. Opportunities

In the case of Noldus the search for a successful product was limited. An alert doctoral student discovered the market niche; he had developed the software package as part of his research and sold it to clients he met at conferences. The key process was the exploration of a network of weak ties, which was also used to get into contact with a more diverse set of large corporate accounts. Pharming also benefited from weak ties to discover new customer groups and the Digicash entrepreneurs were similarly able to spot lucrative opportunities for its novel technology when they were jumping from one project to another. Weak ties appeared to be important but not sufficient for the discovery of more radical opportunities. In those situations the availability or development of strong ties was seen to be crucial.

In its search for attractive business opportunities, Pharming was confronted with a high level of market uncertainty. It found an ideal strong partner in the medical complex and its constituents. On the basis of its acquired technology base and its network of strong partners, Pharming could spot other potentially attractive opportunities in the treatment of rare medical disorders. Pharming carefully used some strong ties to exchange tacit knowledge about its ability to satisfy emerging market opportunities and to get trustworthy feedback on the potential of a particular opportunity. Digicash failed to develop strong ties with key stakeholders in the SET standard setting procedures and consequently the company failed to exploit newly emerging business opportunities. The importance of strong ties and the relevance of the exchange of tacit knowledge and trusted feedback for the discovery of opportunities are results that we did not expect to find on basis of the literature.

#### **Proposition 1a**

For ventures pursuing incremental innovations, ventures using more weak ties than strong ties are more likely to discover opportunities than those that do not.

#### **Proposition 1b**

For ventures pursuing radical innovations, ventures using a balanced mix of strong and weak ties are more likely to discover opportunities than those that do not.

#### **Proposition 1c**

Strong ties are more important for ventures pursuing radical innovations as they enable “trusted” feedback and exchange of tacit knowledge on the nature of the opportunity.

### 5.2. Resources

The network of Wageningen University has been used by Noldus purposefully, for example to get qualified employees and to get hold of resources at relatively low costs. To secure resources, strong ties appear to be beneficial. However, the causal mechanisms are different for ventures based on incremental or on radical innovations. Where incremental innovations are concerned the emphasis is on exploitation and efficiency. Here strong ties are used to get a good deal. Networks are used to support a strategy of “asset parsimony”. Where radical innovation is concerned, the benefits from having strong ties are different. The Digicash and Pharming cases show that strong ties can be used to explore new research trajectories in close collaboration with partners. The exchange of fine-grained information and tacit knowledge is important and can only be accomplished in relationships based on trust.

Through its strong ties with Leyden University, the Dutch government and its American holding partners, Pharming had a head start with the provision of funds, academic staff, premises, and access to both public and private research laboratories. Over the years, while working on those large scale research projects, Pharming was able to develop proprietary knowledge and exchange tacit knowledge with its business partners. American partner firms (Genzyme) and research institutions (e.g. Red Cross) provided access to the skills and contacts needed to further the regulatory approval of its medical treatments. Digicash relied initially on the close ties with its source organization CWI by commercializing that organization's patents, hiring researchers and locating itself at the University's science park. Over the years,

Digicash increasingly focused on software for micropayment systems. The decision to move to Silicon Valley was inspired by the desire to get closer to some key resources. However, the time to develop strong ties in that region may have been too short and consequently it was relatively difficult for Digicash to benefit from the Silicon Valley knowledge base.

**Proposition 2a**

For ventures pursuing incremental innovations, ventures using more strong ties than weak ties are more likely to secure resources than those that do not.

**Proposition 2b**

For ventures pursuing radical innovations, ventures using substantially more strong ties than weak ties are more likely to secure resources than those that do not.

**Proposition 2c**

Strong ties are more important for ventures pursuing radical innovations as they enable the exchange of tacit knowledge in the deployment of resources.

### 5.3. Legitimacy

Achieving legitimacy was not a major hurdle for Noldus. Socio-political legitimacy was not a problem, largely because the market for standard software industry applications is well established. However, the type of software developed by Noldus was new and achieving cognitive legitimacy was important in order to convince clients to buy the software. The collaboration with some research fields and the close ties with a university helped to achieve cognitive legitimacy. Association with research institutes with a high reputation, such as universities, is helpful in obtaining cognitive legitimacy, i.e. the exploration and exploitation of the knowledge base, access possibilities for and broad acceptance of the new firm. This has been the case with all three of the companies. However, there is a difference between the Noldus case on the one hand and the Pharming and Digicash cases. In the Noldus case it is a new product for a new market niche, but it is also software, which is part of a relatively established

industry. Thus the demands on the network to improve awareness and trusted knowledge about the software are fairly limited. Where radical innovation is concerned, the required diversity of strong ties is much bigger, as in the Digicash and the Pharming case. Here new activities, which build upon a combination of different technologies and industries, have to be envisioned and understood first, before they can be implemented.

Pharming's goals and activities were very controversial and, as a consequence, the need to acquire legitimacy was high. Initially, the founders could draw upon their dense network in the R&D constituency: they had strong ties with the university and direct access to its holding partners. Despite recognition in the emerging biotechnology community and among its constituents in the agri-business, and later the health care domains, Pharming's cognitive and socio-political legitimacy was inadequate. To increase its credibility, Pharming had to run awareness programmes and lobby pressure groups and regulatory authorities. The new firm lacked an extended network of weak ties (e.g. patient organizations, farmers, and animal rights activists) to make its cause understood successfully.

The legitimacy of the micro-payments industry and start-ups active in that market (e.g. Digicash) was moderate. Although very much targeted towards its R&D network of contractors and research partners, with only limited attention to large business users and the general public, Digicash' cognitive legitimacy was reasonable. Almost everyone agreed on the need for safe and anonymous payment systems for electronic commerce (shopkeepers were more sceptical!). Digicash' socio-political legitimacy, however, was low. The firm itself did not put a lot of effort in making itself known in the market place and/or in the policy arena. In particular, it failed to work with key business partners from the credit card, banking and software industries or to seek support from governments to push for an international standard for micro-payments. Because unfortunately the firm had not developed ties with those parties it eventually found itself marginalized in the new Internet-based economy.

Digicash found itself too closely tied to the R&D community, and as a result the company was unable to break out and reach for market- and

product-oriented applications. Furthermore, the company was absent from the national and international regulatory arenas, which, supported by two major consortia of large software and credit card companies, the crucial decision was taken to support the joint SET-standard. Pharming, also, relied heavily on its strong ties with the research community and its health care and agri-business constituents. Moral concerns from animal liberation groups and activists and regulatory hurdles were clearly underestimated, eventually leading to a ban on the company's cloning activities. As both cases illustrate, strong ties had an adverse effect on the company's ability to gain socio-political legitimacy. Perhaps, if the two companies had developed a more diverse set of weak ties with different stakeholder groups, they would have acted differently and been more sensitive to societal and institutional concerns. The detrimental effects of strong ties and the beneficial role of weak ties to obtain socio-political legitimacy are results that we did not expect to find on basis of the literature.

#### Proposition 3a

For ventures pursuing incremental innovations, ventures using more strong ties than weak ties are more likely to gain legitimacy than those that do not.

#### Proposition 3b

For ventures pursuing radical innovations, ventures using a balanced mix of weak and strong ties are more likely to gain legitimacy than those that do not.

#### Proposition 3c

Weak ties are more important for ventures pursuing radical innovations as endorsement by outsiders is important in gaining legitimacy.

### 6. Concluding remarks

In this paper we developed a comprehensive framework in which the key entrepreneurial processes are distinguished. This framework enables us to examine systematically how these entrepreneurial processes may benefit from particular network ties. This paper addresses the question of whether the degree of innovation acts as a contingency factor in the way network ties support entrepreneurial processes. The results of the case studies partly reinforce existing insights in the literature. The importance of an embedded network of strong ties to secure crucial resources is widely acknowledged. Our research provides a different angle in that it explicitly recognizes the value of a particular mix of strong and weak ties for two other entrepreneurial processes: Discover-

TABLE I  
Comparison of high-tech start-ups and their networking activities

Type of innovation	Noldus Incremental	Pharming radical	Digicash radical
<b>Discovering opportunities</b>	Weak ties: stepping stone marketing	Weak ties: RUL and 2 ministries, new customer groups <i>Strong ties: trusted feedback and ex-change of tacit knowledge</i>	Weak ties: project-to-project <i>Strong ties: not sufficiently developed</i>
<b>Securing resources</b>	Strong ties: asset parsimony	Strong ties: exchange of tacit knowledge	Strong ties: exchange of tacit knowledge, however in Silicon Valley some difficulties
<b>Gaining legitimacy</b>			
• <b>cognitive</b>	Strong ties: association with university	Strong ties: leading R&D labs and partners	Strong ties: CWI + Amsterdam science park
• <b>socio-political</b>	Not relevant	<i>Strong ties: detrimental effects</i> <i>Weak ties: wider endorsement</i>	<i>Strong ties: detrimental effects</i> <i>Weak ties: too limited</i>
<b>Performance</b>	Success	Survivor	Failure

Text in italics: findings are not according to expectations on basis of literature.



ing opportunities and gaining legitimacy. These two processes also have an impact on a company's performance. Companies engaged in radical innovations were seen to benefit from an unexpected mix of strong and weak ties. The notion that in the opportunity discovery process weak ties play a dominant role has to be qualified for start-ups pursuing radical innovations. Strong ties turn out to be beneficial because of their ability to exchange tacit knowledge and trusted feedback on the nature and viability of opportunities. Where legitimacy is concerned, the opposite is found. Instead of the generally approved value of strong ties, we find that for radical innovations strong ties are detrimental in obtaining socio-political legitimacy and weak ties are needed for the more general endorsement of these new products. Our findings are based on a limited number of case studies. Future research can improve the generalization of the results by developing the propositions into testable hypotheses on basis of a large sample of new ventures.

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