

# **When do Start-Ups stop being Start-Ups? A business network perspective on four cases of university spin-offs**

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## **ABSTRACT**

In this study we are interested in answering to one intriguing research question: when do start-ups stop being start-ups? There are many available studies which have examined the origins of new ventures, how they develop, how they commercialize technologies, but there is a clear scarcity of contributions regarding how and when they cease to be start-ups and then change towards another entity. Within IMP studies the investigation of such research issue might contribute to understanding the new business venture development and evolution. By taking an industrial network perspective we focus on analyzing the role played by the business relationships in initiating, developing and shaping new ventures. We refer to a group of several theoretical “dimensions” which could support the investigation of our research issue. As for the empirical ground, this study includes four qualitative cases from Uppsala University, one of the Swedish leading organizations both in education and research, with strong ties to industry and several companies spun off in the last 30 years.

**Keywords:** university spin-offs, start-up, business network, new ventures

## INTRODUCTION

New ventures are often recognized as being small, new and blurry typology of business. They are entities without any formal relationships as well as track records (Ostgaard and Birley, 1999) and one complex issue for them is how to develop and cope with “counterparts”. Whereas a large amount of research has examined how new ventures, such as spin-offs, develop over time, we know much less about how and when they cease to be start-ups and then evolve towards becoming another entity, something we can tentatively term an “established firm”. According to Lambertz and Schulte (2012) when start-ups consolidate their market *position* they leave the nature of start-ups. Accordingly, it seems that acquiring customers might lead the start-up towards the “next” evolutionary process of development. Hence *levels of sales or profits* might be indicators of a new venture leaving the status of start-up. On the other hand, some studies point out that the notion of start-ups is related to the extent they still receive funds from venture capitalists as well as to the capability of reaching certain main goals usually reported into the initial business plan. Expanding these thoughts, more financially related indicators such as *risk of default* and *financial sustainability* can be used as markers of a change of status from start-up to established firm. Taking a firm-internal perspective also frequent changes in *activity structures*, *business models*, *targeted markets* and *technology applications* may be indicative of the fact that the venture is still in its start-up phase. Similarly, firms still dealing with developing or scaling-up their technologies can be regarded as start-ups.

These indicators tend however all to be firm-centric and to downplay the importance of the interface between the firm and its external network context in determining the development of a venture towards ceasing to be start-up. We argue that, in order to cope with the complexity of analyzing *when a start-up stops being a start-up*, a business network perspective may be suitable. By adopting a business network perspective, we shift the attention to the key role played by business relationship dynamics. How, the relationships of a start-up develop would accordingly be a key indicator of its change of status from start-up to established firm. Relying on industrial network theories, this issue can be approached by considering the fluidity of the firm’s *boundaries* (Snehota, 2011), the *network position* assumed by a firm, the *identity* attributed to it by the other actors, as well as the degree of *trust* it achieves in the network. Taking this approach would shift the definition of the status of start-up from objective but reductionist indicators to more holistic and relativistic ones, where the status of start-up is very much “in the eye of the beholder”, namely the other network actors. The overall paper’s aim is to identify suitable “dimensions” for investigating when a start-up is no longer start-up. In this respect, this paper addresses the following research questions: When does a new venture stop being a start-up? Which criteria and dimensions can be used to determine the transition from being a start-up to becoming “something else”, an established firm?

The paper contributes to the academic debate on “new business ventures” as initiated by the IMP school in response to the already existent studies belonging to the entrepreneurship tradition. As for the empirical setting, it is based four academic spin-offs originated from Uppsala University. The paper is organized as follows: the next section presents our theoretical perspective and key concepts, then we present and discuss in separate sections the case material. In our conclusions we provide answers to the aforementioned research questions based on the analysis of the four empirical cases.

## THEORETICAL BACKGROUND

As we are interested in discovering when start-ups stop being start-ups, we are looking for certain “dimensions” which we consider relevant in order to address our research goal. By comparing the entrepreneurship and the IMP literature, our aim is to end up with such a set of key indicators which can support us to develop a set of research propositions.

### Contributions from entrepreneurship literature

From entrepreneurship studies several definitions of startup emerge. According to Blank and Dorf (2012: p. 17), a startup is a “temporary organization in search of a scalable, repeatable, profitable business model“, whereas Ries (2011) highlights the nature of a startup in terms of “human institution” that by operating under uncertain conditions is aimed to deliver a new product to the market.

Criscuolo, Nicolau and Salter (2012) point out that startups are firm under 5 years of age with at least 10 employees. In a similar vein, Swinney et al. (2011) point out that startups are small firms quite unstable where the risk of failure is rather high. They took the financial perspective showing how a startup when entering a new market needs not only extra financial support by investors than the more established firms, they also have to cope with major risk of failure.

What is widely recognized within entrepreneurship studies is that startup means to create and develop a new business. Examples of new businesses are born-globals, spin-offs, corporate ventures, and joint ventures. In this paper we are particularly interested in the phenomenon of academic spin-offs (ASOs), that is, a company coming from one university (the university plays the role of parent organization). Usually, ASOs are generated from university to transfer and then commercialize scientific discoveries (Steffensen, Rogers and Speakman, 1999); one or more university researchers take these inventions with such as aims as further development or commercialization (Carayannis et al., 1998). Lowe (2001) and Di Gregorio and Shane (2003) highlight that ASOs are founded on a contractual agreement transferring from a university to a company the rights to commercialize an invention.

The available literature focuses on two themes: the spin-off creation and development over time (Mustar et al., 2006). By analyzing the “connections” between the creation and the development mechanisms we could understand how the spin-off evolves toward “other” forms leaving the status of start-up. To our knowledge, there is a lack of studies which goes in that direction except for Vohora, Wright and Lockett (2004) who analyzed how university spin-out companies evolve towards the status of “established firms” by facing “critical junctures”. The “critical junctures” represent “a complex problem that occurs at a point along a new high tech venture’s expansion path preventing it from achieving the transition from one development phase to the next (ibid: 159)”. The critical juncture named “sustainability” is interesting because it deals with the capability of the organization to go beyond instability and hopefully to become established as a firm.

Back to the importance of highlighting the factors relevant for analyzing when the start-up evolves to a more established organization, we found in the entrepreneurship literature the following dimensions: (1) how different categories of resources, as defined by Barney et al. (2001), are combined and exploited over time; (2) how the business model (Chesbrough and Rosenbloom, 2002) and the financial sustainability of the start-up changes over time; (3) the

links between parent organizations and spin-offs as a central aspect which affects the creation and development of these young companies. This dimension might be considered as the learning process which happens and takes off between the parent organization and the spin-off (Sapienza et al., 2004); (4) how the methods of commercialization (Pries and Guild, 2007) unfold as well as the extent to which the spin-off attracts and keep customers.

### Contributions from IMP studies

How new businesses, such as start-ups, are created and then evolve over time is gaining increasing attention among IMP researchers (Snehota, 2011; Ciabuschi, Perna and Snehota, 2012). Studies have been carried out by focusing on the business relationships as central element for the growth of companies by taking a network perspective (Håkansson and Snehota, 1995; Håkansson et al., 2009). However, there is evident dearth of studies which problematize how and when start-ups step into the next level, viewed from a network perspective.

One contribution comes from Aaboen, Dubois and Lind (2013) who identify how academic start-ups deal with the development process by analyzing the changes in their resource structure for becoming more established. Becoming “established” means having developed a position in the surrounding business network, which enable the firm getting access to additional resources: this is an important practice that has to be continuously performed by especially new businesses.

Therefore, new businesses have to evolve toward a more established network position in order to cope with their survival by setting and developing business relationships. The network position, which is defined by the number, type and strength of firm’s business relationship (Johanson and Mattsson, 1992), is an important dimension that can be analyzed for investigating “when” a new business is no longer in its start-up stage.

In relation to the above dimension, in another work Aaboen, Dubois and Lind (2011) have investigated how start-ups can enhance their network position by getting embedded into existing contexts. This is a big issue for “new” companies, which have to solve the problem of how to make offerings available to buyers. Consequently, the new company has to get embedded into already existent structures in order to be perceived as a “more established” company.

The creation and then the development of customer relationships represent another important challenge. As long as the new business develops customer relationships from initial interactions, the opportunity of learning and lifting up the network position may improve. In the meantime, other actors within the business network will start to “recognize” and attribute an identity to the new company.

But when initiating the customer relationships, new ventures must be aware about the difficulty to plan and program the potential development of the relationship. In this sense, the beginning of relationships and their value is very difficult to forecast (Perna and Baraldi, 2014). Therefore, the new business has to achieve a certain level of trust within the business network in order to become an established firm. This task indicates that the new company has to connect pre-existing resources and activities with those of other counterparts in order to be able to develop and evolve over time (La Rocca et al., 2013).

The development of new ventures, especially if university spin-offs, is moreover tightly related with that of the technology they aim to commercialize. Therefore, the transition of these start-ups to becoming an established firm corresponds to the completion of the innovation process, including an economically viable and widespread use, of their technologies. More precisely, completing this innovation journey (Van de Ven et al., 1999) means that the new technology and the new firm, viewed as interacting resources (Håkansson & Waluszewski, 2002; Baraldi, Gressetvold & Harrison, 2012) have become embedded simultaneously in the three settings of development, production and use (Håkansson & Waluszewski, 2007; Baraldi, Gregori & Perna, 2011). In sum, being embedded in developing, producing and using settings can be considered as an indicator that a start-up has become an established company. This type of embedding is in turn also positively related to the network position, identity and trust of the firm.

## **A NOTE ON METHODOLOGY**

This study includes four qualitative cases (Yin, 1994) from Uppsala University, one of the Swedish leading organizations both in education and research, with strong ties to industry and several companies spun off in the last 30 years. The four selected cases are Solibro (solar cells), Chromogenics (electrochromic films), Piezo Motors (micro motors), and Olink (protein analysis), all spin-offs characterized by academic researchers playing an important role in their initiation and development. The four companies also share the characteristic of an initial purpose aiming to commercialize a cutting-edge technology. Our specific sampling of these cases, which we had already encountered and analyzed for other purposes and this paper's, was motivated by the fact that the four companies followed clearly different development paths, with one companies still being a start-up despite being over a decade old. Moreover, the other three companies stopped being start-ups apparently for very different reasons, thereby enabling us identify a broader set of dimensions in relation to our purpose.

The main data source consists of semi-structured interviews. In total, we collected 25 face to face and phone interviews between 2012 and 2014, while one of the cases (Olink) has also been followed by one author since the company's start via informal conversations and meetings. Company founders, researchers, managers of innovation-supporting units, and people involved in technology development have been interviewed. Also, we collected secondary data through documentary sources (reports, business plan, annual reports, websites, press releases, etc.). In two out of the four cases the authors have also paid visits to the companies' premises and performed direct observations.

We collected data with the explicit task to identify the critical dimensions that characterized, for each of the investigated spin-off, first the scientific discoveries at Uppsala University and then the creation, development and evolution of the four companies. Moreover, our interviews dealt with such issues as the goals that induced the various actors to start-up the companies, the interface with customers on the market side and with suppliers, as well as the key business relationships.

## **EMPIRICAL MATERIAL: FOUR CASE STUDIES OF START-UPS**

This section presents the four case studies of start-ups originated from Uppsala University, stressing the different development paths of these companies as well as the specific set of business relationships that influenced them. We start from solar cell producer Solibro, moving

then to electrochromic film developer Chromogenics and PiezoMotor, to conclude with the protein analysis company Olink.

### Solibro: stopping being start-up by turning into a joint-venture

Professor Lars Stolt had been conducting research about new generation, thin-film solar cells since the beginning of the 1980s. After defending a thesis in electronics at Uppsala University (Sweden) in 1992, he took a position as a leader of a small research group at the Department of Solid State Electronics at KTH, the Royal Institute of Technology in Stockholm. Their research, supported by the governmental body Swedish Energy Agency, was aimed at developing knowledge about a new particular type of solar cells based on the combinations of four elements – copper, indium, gallium and de-selenide – which together constitute the CIGS material.

Stolt and three other key persons took themselves the first step towards commercialization of this technology: in 1994 the company Nordic Solar Energy (NSE) was founded as a spin-off of the research carried out at KTH. The two patent applications based on the results of the KTH research group were folded into NSE. But in 1997 NSE suddenly had to stop all its activities because money had run out: NSE was close to bankruptcy. In the meantime, Stolt had reestablished his contacts with Uppsala University, which led Uppsala University's holding company (UU AB) to step in and purchase NSE in 1997, as a way to avoid its bankruptcy and save its intellectual properties such as patents. UU AB was a limited company, entirely state-owned, founded in 1995 with the specific task of commercializing projects and scientific knowledge related to Uppsala University. Stolt and his research group needed more funding for making their research results close to the commercialization path.

A fundamental breakthrough was the establishment at Uppsala University of a research program named Ångström Solar Center I (ASC I). ASC I program was founded by MISTRA (the Foundation for Strategic Environmental Research) and the Swedish Energy Agency. The program's first round, between 1996 and 2000, was explicitly focused to support energy-related research projects. Stolt and his group wrote a research projects and gained SEK 34 million: over the 5 years of ASC I several scientific possibilities were exploited and positive results in terms of the reliability and technical potential of CIGS were finally achieved. But in 2000 ASC I was drawing to a close and one important issue showed up: a major goal of the program was that it should lead to finding a commercial actor interested in making use of the results achieved. Several attempts were made in order to find a potential Swedish partner, this research turned out to be very frustrating.

At this point professor Stolt, took the initiative of establishing a commercial venture named Solibro that at the end of 2000 was incorporated, becoming one of the first spin-offs at Uppsala University. This turned out to be a suitable, and probably the only available solution in order to exploit the patents and the know-how as well as provide a commercial path for CIGS.

In the early start-up phase, Uppsala University Holding (UU AB) and another public funder, Innovation Bridge Foundation Uppsala, invested about SEK 2,5 million in NSE: that money was only a small portion of the large funds that would be necessary to refine the production technology for CIGS. Therefore, the possibility of starting to set up a small production facility was quite far.

In 2003 several organizations, both public and private, directly invested in Solibro and its CIGS technology a total of about SEK 32 million: the two main investors were the Swedish public pension fund (6th AP Fund) and the Norwegian venture capital fund Energy Future Invest (EFI). This money allowed Solibro at least to get started with the difficult and complex process of scaling up the CIGS technology outside the University. Step by step and piece by piece, Solibro was building up a complete industrial co-evaporation system for CIGS capable of working at a small production volume scale. The equipment was installed and implemented in a commercial facility outside Uppsala.

Between 2003 and 2006 the Uppsala University spin-off Solibro was supported by 6th AP Fund and EFI: the CIGS technology and the process for producing modules were ready, but the main problem was to finding money for setting up a large scale production, capable of reaching large volumes so to contain unit costs. Establishing a production system was a totally new challenge for Solibro, both because the needed money and for the lack of capabilities. Prof. Stolt and his collaborators did not succeed in involving the existing shareholders in this new phase: unfortunately no Swedish actors were ready to invest. The alternative was to seek a partner abroad. An opportunity materialized in the summer of 2006, when Q-Cells one of the world's leading producer of silicon-based modules, based in Thalheim, showed an interest in Solibro. Rather soon and after a business meeting in Sweden, representatives from Q-Cells made an economical proposal to Solibro. The deal was arranged in terms of a joint-venture agreement established in November 2006. A new company was created named Solibro GmbH. Since its beginning, this company had a clear task: to scale up the production of the small Swedish pilot plant created by Solibro AB a few years before. Two-third of Solibro GmbH were owned by Q-Cells, while the residual one-third by Solibro AB.

Solibro GmbH became the first real manufacturing company after more than 20 years of research in the CIGS thin film technology. The technology assets and intellectual properties of Solibro AB were transferred in another new company, founded in Sweden and named Solibro Research AB, fully owned by Solibro GmbH. Q-Cells invested Euro 60 Million in cash in Solibro GmbH, mostly for setting up production activities, and it held a share of 67,5% of this company.: The small number of modules produced by Solibro GmbH were sold from 2008: the sales were managed by Q-Cells as an external service offered to Solibro. In 2009 another huge investments was carried out in order to turn into profitable the production activities of Solibro GmbH: a second manufacturing plant of CIGS modules was built for a total investment of almost Euro 165 Million. Moreover, between 2008 and 2009, while the second plant was still under construction, the Q-Cells management had been thinking about taking over 100% of Solibro GmbH by acquiring their Swedish joint-venture partner Solibro AB. Unfortunately in 2009 the energy market entered in crisis and a number of companies all over the world turned into financial issues: Q-Cells included. In 2011 Q-Cells started an attempt at financially restructuring its debt, but 2012 was the critical year: on April 3, Q-Cells had to file for insolvency. The executive board of the company worked together with the insolvency administrator in order to secure the continuity of the company. An idea for enhancing the value of the technological portfolio of Q-Cells was to keep Solibro's technology and facilities alive, even though they had being weighed by very high losses through all operating years, because CIGS represented the most promising technology owned by Q-Cells. The Chinese Hanergy appeared at this point on the scene as a particularly interested prospective buyer. Representatives from Hanergy visited Q-Cells facilities and a deal for acquiring Solibro was soon setup. In June 2012, Hanergy Holdings agreed to acquire Solibro from Q-Cells and the acquisition was completed in September. The total cost of the

transition was a small fraction of the sum invested for setting up the original joint-venture Solibro GmbH.

In 2013 as the management of Solibro started to interact actively with the Chinese owner, some cultural mismatches emerged. One critical decision was taken by Hanergy in order to fully control Solibro's selling activities: basically, in the present organization Solibro does not have any sales office, only production in Germany. Further, Hanergy announced the opening in 2014 of one manufacturing plant in China based on CIGS technology. It is not clear whether the plant will belong to Solibro or another sister company, but Solibro and its technology are expected to contribute profits within the frame of the large Hanergy Group.

Chromogenics: still being start-up after 12 years

*“...these materials (electrochromic films) open the possibility of developing highly energy efficient windows whose transmittance of solar radiation can be automatically tuned to an optimum level governed by the requirement of maintaining a suitable air temperature or lighting level in the room” (Svensson and Granqvist, 1984).*

The above quotation sums up the business idea which led Prof. Granqvist to setup in 2003, after about 20 years of research on “electrochromics”, an academic spin off at Uppsala University named Chromogenics AB. Prof. Claes-Göran Granqvist gained his Ph.D. degree at Chalmers University of Technology in 1974 and after having spent a couple of years in US came back in Sweden. At Gothenburg University he setup a research group focused on electrochromics and after a while they coined the terms Chromogenics materials as scientific term to identify certain materials with optical properties. These optical properties can be changed and varied gradually and reversible by an electric current. The range of applications within the field of energy efficiency would have been large, for instance this material when applied of surfaces (such as glass) can regulate the transmittance of solar radiation.

In 1993 Prof. Granqvist moved to Uppsala at the Department of Engineering Sciences where he became research leader of a group of researchers focused on improving the result about electrochromics. Prof. Granqvist came up with the idea that the electrochromic materials might be exploited for developing and producing energy efficient window technologies (smart windows): the important breakthrough was to create a thin, flexible plastic film with electrochromic material instead of using the expensive glass as substrate. By using the plastic could also allow to manufacture the electrochromic layer “on a roll” and then cut and applied to different products such as visors, ski goggles, large windows.

In 1996 a research program at Uppsala University called Ångström Solar Center (ASC) and supported by MISTRA (Swedish Foundation for Strategic Environmental Research) and the Swedish Energy Agency began. One specific goal of the program was to support the commercialization of three specific and promising technologies within the energy research field. Prof. Granqvist and his collaborators involved in the development of smart windows got financed.



The goal of commercializing the electrochromic plastic film led to the birth of Chromogenics AB. The company was registered in 2002 and in 2003 received an equity financing by Uppsala University's holding company (UU AB) of SEK 360.000. Prof. Granqvist was one of the founders. Two important decisions taken by Prof. Granqvist were (1) to search for a person able to run a startup company (2) to get the production activities out of the University. In January 2004 Mr. Bengt Åkerström was employed by the company as CEO with the explicit task of providing money for setting up the first small-scale production plant. All the experiments and attempts to simulate the production process in a small scale were performed at Uppsala University by renting space and equipment.

The period 2004 turned out to be positive since Chromogenics raised money (grants and soft loans) in total for about SEK 2 million from several organizations such as the Swedish Energy Agency and other public organizations. This money was invested for proving that the technology was reliable for the first consumer application, targeted to the producers of helmet visors. The company realized that helmet manufacturers might be a suitable target, and Chromogenics tested its technology with the helmet producer Lazer. Sputtering equipment was also purchased for producing small size foils (30 x 30 centimeters).

In March 2005 the company moved to its first own premises. According to the business plan, by the end of the same year Chromogenics had to prove to the investors that the production process could be scaled-up. Moreover, three important private investors came into the picture in 2005, Volvo Technology Transfer and Du Pont Ventures, together with the public Innovation Bridge Foundation Uppsala. Those three organizations invested in equity capital SEK 18 million supporting the company in the so called "Round A" aiming to the construction of the first pilot plant.

The three main investors were attracted by the potential applications of the technology and asked Chromogenics to setup a small production unit for visors in order to start getting close to potential customers. But new sputtering equipment was necessary to settle down. It was selected one supplier and the new equipment was installed into Chromogenic facility: but as soon as the early production activity started, technical issues arose mostly linked to the reproducibility of the process.

In 2007 one Swedish financing institution (Industrifonden) and BankInvest (a Danish investment company) invested equity capital for M. 30SEK. This money was raised for recovering part of the future potential process and on deciding about process development process. The issue was that the production line had not been validated. In 2008 a new round of funding for about SEK 25 million was supported by the existing investors and it was officially allocated for product development.

In 2009 important changes happened. After 5 years Mr. Bengt Åkerström exited the company and was replaced by a new CEO, Mr. Thomas Almesjö. At that time Chromogenics that employed about 15 people changed its strategy: the board decided to leave the idea of visor applications for developing a larger size of the product for windows applications. The first reason dealt with that the board, even pushed by the main investors Volvo and DuPont, did not believe anymore in the profitability of the visor market. Secondly, the production capacity

of the company would have been rather small for producing revenues stream unless the production process and strategy was totally shifted toward the setup of the “roll to roll” process. This process would lead the company to scale up the production process and reaching profits.

A large scale production line was planned as to be built for windows size. It was a big investment, with a planned budget up to SEK 30 million. An unexpected issue showed up in 2010 when one shareholder of the company (Industrifonden) had to be replaced. In only 3 weeks K-Svets Förvaltnings AB, under a large private company operating in several industries, accepted to invest in Chromogenics becoming one of the owner together with Volvo and BankInvest. Moreover, the managing director of Scandinaviska Glassystem, one of K-Svets’ companies, took position into Chromogenics board.

During 2011 Chromogenics focused on refining the product development process as well as the way the production line should be arranged for producing smart windows. Other money was necessary for setting up and then builds the “reference plant for scale up the process”. A proposal for obtaining financing was written and sent to the Swedish Energy Agency and in December 2012 Chromogenics obtained a conditional loan of nearly SEK 64 million, which covers 40% of the total investment in production. The 60% has to be financed by the main investors. However, beyond the boost in confidence from the public and private organizations that surround Chromogenics, the road to the commercialization of the technology is well under way. As of today, Chromogenics has about 20 employees (2014), but basically no sales and it has cumulated losses every year since its birth, although averaging at around SEK 30 million in the last four years.

#### PiezoMotor: stopping being a start-up without being profitable

Stefan Johansson got a Phd in Micromechanics in 1988 at Uppsala University and began to make research that soon was focused on developing piezoelectric micromotor. These micromotors are driven in piezoceramic material that originates stepwise movements which can reach high dynamic velocity range regulated by frequency variations: the motors can be applied to a range of products such as cameras, mobile telephones, electrical appliances, etc. It is fair to say that the piezoelectric effect as phenomenon was observed a century ago by the French brothers Curie.

In 1993 Stefan was financed for carrying research on medical instrumentation and employed one graduated student as collaborator, Mats Bexell. One patent was filed and the two researchers developed motors for medical applications. Between 1993 and 1998 Stefan built up at Uppsala University one research group composed by 8 people including a full time engineer. The group was basically operating into the field of microsystems and mainly it was financed with grants coming from Swedish public organizations. A breakthrough was made in 1995 when Stefan and Mats developed a piezoelectric rotating micromotor that was 4 mm in diameter and 4 mm long. One year later, in 1996, they were rewarded in the Swedish Innovation Cup for developing a rotary, piezoelectric micromotor, which was quite unique in terms of size and strength. Moreover, since the piezoelectric micromotor did not need of clutches or gear boxes had an enormous advantage in terms of precision compared to the already existent technology of traditional electromagnetic motors. Moreover, this motor was conceived for keeping low the maintenance costs for the final user.

PiezoMotor AB was co-founded in 1997 by Stefan and Mats as a spin-off from the Department of Engineering Sciences, 3 years before he was appointed as Professor of material science at Uppsala University. The initiative to create the company was triggered by Johansson's goal of going beyond university for commercializing its research projects. In the very beginning the company got SEK 450.000 from various sources and two patents were filed. The first investor came into the company in 1998 when Mr. Adam Dahlberg, who has been running his own venture capital investment company since the beginning of 90's, invested SEK 2,5 million. PiezoMotor in 1998 employed Prof. Johansson and Mats Bexell for running research projects, while the first CEO came from industry. Later the Innovation Bridge Foundation Uppsala, an organization dedicated to support the commercialization of science generated within the Uppsala region, invested in PiezoMotor SEK 2.5 million. This Foundation decided to invest because PiezoMotor was strategically oriented to supply OEM with high-tech products. However, already in 1999 the Foundation chose to make an exit, something which was not so dramatic as Mr. Dahlberg himself, who was never pleased to this actor in the company's capital, bought all the left shares and even invested an additional SEK 3,5 million.

However, the money raised was not enough for developing the company further and the management looked at opportunities of engaging more investors. The company's main goal was to develop rather simple linear piezo motors and at Uppsala University a very small product was realized that was not possible to put into production.

Nonetheless, the capacity of PiezoMotor of developing a simple and "cheap" linear piezo motor attracted the attention of a mobile multinational company operating in electronics. In 2000, this company was producing one of the first generation of cameras for mobile phones and it appeared as an attractive customer not only for its very well-known brand, but also because they were looking for small micro motor to be produced in very high volumes. In order to cover all costs necessary for approaching larger customers PiezoMotor made a large share issue and hired a marketing manager who had been working with the Swedish Atlas Copco.

In 2002 PiezoMotor employed 12 people working full time and sold project assignments for SEK 5 million. In the same year the first product, a linear piezo motor named Piezo LEGS, was shipped to customers. The implementation of the pilot line started in the same year and in 2003 the company was preparing the ground for supplying the mobile producer customer: the company was located outside Uppsala and the facilities were a test laboratory, a prototype workshop and manufacturing plants.

At that time the customer had a relationship with a Taiwanese supplier for the delivery of camera devices. The components of the camera were supplied to the Taiwanese company by a large Japanese firm which provided plastics, lenses and mechanics for moving lenses. This latter component was indeed supposed to come from PiezoMotor. However, despite PiezoMotor had worked intimately and trustworthily with the Taiwanese party, the Japanese company secretly setup a manufacturing plant for producing micro motors made in piezoelectric materials. According to Prof. Johansson PiezoMotor was too small as sub-supplier for such huge scale production. The market for these products did however not grow as expected and the whole business was closed. It was a serious blow, but the technology developed was further exploited in order to find out different applications and customers.

In 2004 PiezoMotor developed collaboration with an American corporation, a leading producer of optics and laser technologies. The total value of the project sold was SEK 1 million, and PiezoMotor also sold products for SEK 1 million. The year after, an interesting and fruitful collaboration started together with the German part of a Japanese company PiezoMotor entered into an engineering collaboration and license agreement to develop and market linear and rotary type piezo motors with this company. In the meantime, PiezoMotor

gained money from the Swedish Agency Vinnova for developing a new concept based on the camera motor which led to a new product named Piezo Wave motor. In 2005 the PiezoWave became a product widely commercialized and in July 2006 the company was awarded by the prestigious Frost & Sullivan consultant company.

When turned 2007 the PiezoMotor's story radically changed. A participation and cooperation agreement was signed at the Hannover trade fair (the world's biggest industrial fair) in April with Faulhaber Group. This company was founded in 1947 in Germany and it operates as producer and distributor of microsystem technologies. The US-based company, Micromo, also took part as US distributor of PiezoMotor products. Both Faulhaber and Micromo are major shareholders in PiezoMotor since 2007.

In 2008 the company reached SEK 6 million in sales. This higher demand from customers stimulated increased process development efforts that resulted in a stable and predictable process. A long term research project focused on product quality was initiated at this stage. Afterward the yield and the control of the production process increased, and in 2009 the company sold for SEK 12 million. As of today, PiezoMotor employs 32 people (2012) and sells for about SEK 20 million (a 60% increase from 2012), even though sales have been oscillating a lot over the years. PiezoMotor has financially strong owners who well aware of the fact that it takes time and resources to build a successfully technology company. Large amounts have been invested in PiezoMotor since the start and the owners are positive that PiezoMotor will become a good and profitable investment case in a near future.

Olink: from science-based start-up to becoming embedded in production and use

Prof. Ulf Landegren's research group at Uppsala University had in the early 2000s reached worldwide recognition in the area of genetic and protein analysis (genomics), thanks to several highly ranked international publications. Both the professor and his colleagues (Mats Nilsson, Simon Fredriksson etc.) had also patented through the years several technologies for genomics and proteomics, some of which had been licensed by large instrument-making corporations such as Applied Biosystems (OLA test for cystic fibrosis) and ParAllele (padlock probes for DNA analysis). Despite the commercial success of these technologies, this group of researchers and inventors also felt that the best opportunity for commercializing their many discoveries would be provided by creating an own company, focusing especially on the area of proteomics: this was the ground for starting-up Olink Biosciences AB, in September 2004, in Uppsala. Björn Ekström, one of the cofounders with long-term experience from life science companies (e.g., Pharmacia Biotech, Pyrosequencing) was appointed CEO. At the very time of foundation, Olink received minor financings from BeijerInvest and UUAB (SEK 1 million), but the first year entailed finances enough only for a couple of fully employed people. The solution to the financing issue should come from a relatively unusual strategy.

In fact, Olink's initial business model relied on (1) licensing out technologies (both genetics and proteomics) taken from the broad pool of nearly 20 patents which the founders had assigned to the newly started company, and (2) starting as soon as possible selling own reagent kits for proteomics, that is, detection of proteins, to researchers in academia and in pharmaceutical firms. The choice of licensing out these patented technologies turned out to be successful, with a first significant license deal signed in 2005 with the biotech firms ParAllele (later purchased by DNA analysis giant Affymetrix). Eventually, licensing these technologies, together with EU research grants, enabled Olink to finance itself basically without the need of venture capital during its first years, while its reagents product platform was being developed.

Venture capitalists, including American ones (e.g., Agilent Ventures), had indeed showed a great interest in Olink in 2004-5, but the resolute aversion of some founders to move the company to the US (as requested by these financiers) and the satisfactory finances simultaneously obtained from licenses meant that starting up the company never really needed venture capital.

Next to providing important revenues, Olink's strong patent portfolio attracted the interest of several established biotech companies, leading to the creation of relationships already in 2005-6 with ParAllele/Affymetrix, Applied Biosystems and Dupont. The latter was especially important because it allowed Olink to obtain Dupont's IPRs over some details of its protein analysis technology, in exchange for granting Dupont joint rights to use it for foodstuff analysis. As for Applied Biosystems, they had been interested since the very beginning in using Olink's upcoming reagent kit in their protein analysis machines, so when it became ready in 2007 Olink granted this company, which later was merged into the colossus Life Technologies, licensed it for exclusive use in their machines, adding an additional revenue stream to Olink.

Despite the importance of these licensing and technology-partnership relationships, they were however not yet the relationships to the actual users and customers Olink was aiming at, namely academic and pharma's laboratories conducting proteomic analyses. In order to build these sales generating customer relationships Olink had to develop and launch its first product. This happened in 2007 when its 1st generation kit (Duolink) was introduced to market: it enables to analyze one protein per kit in tissue samples and was mostly addressed to academic researchers. Over the following years this product would reach thousands of users/customers around the world. In 2011 Olink released its 2nd generation product, still able to analyze one protein per kit, but now also in blood samples, which reached out to hundreds of customers. Finally, in 2013 came the 3rd generation product "Proseek Multiplex", enabling to analyze 92 proteins per kit in 96 samples simultaneously. While the first two product generations were of the do-it-yourself type, as customers needed to fix themselves several details before using the products for their specific needs, the third generation works out of the box, so that customers can use it as soon as they receive it. With more adaptation work conducted by Olink for customers and a higher purchase frequency per user, third generation products entail for Olink a much stronger possibility to build closer business relationships to customers.

In fact, in selling its first two products a typical challenge for Olink has been how to reach customers, due to their small size, small purchase orders and spread across the world. As a direct sales model would not have worked for this type of customers, Olink historically relied on several distributors, trying also various types of business models, none of which was however deemed satisfactory. Therefore, in 2013 Olink chose to utilize a single, although very large and renown distributor, Sigma-Aldrich, to cover worldwide sales for these products, while retaining control of sales in Sweden, still the major market, especially for the newest product. Moreover, in 2013, Olink signed an agreement with Fluidigm to improve the compatibility between Olink's reagent kits and Fluidigm's analysis instruments, which are gaining a strong market presence and are expected to support also the diffusion especially of the 3rd generation product.

Next to thousands of users in academia, which led to Olink's products being featured in over 700 academic publications and thereby obtaining strong legitimacy in the field, Olink is selling all its three products also to pharmaceutical firms. Among its customers are all top 10

pharmas and some other 50 key players. Finally, next to selling its kits to customers for use in their labs, Olink also provides analysis services by running the customer's samples in its own facilities at its Uppsala site.

On the suppliers' side, Olink initially faced the problem of finding reliable suppliers of high quality enzymes, a key component in its product: they were eventually found in the US West coast. As for the other key component, antibodies, Olink faced earlier on the dilemma of either buying standard, cheaper antibodies, which would allow detecting only standard proteins, or expensive ones, customized to specific proteins selected by Olink or some of its customer. However, in the last few years, one single major antibody supplier has gained a dominant position in the industry, and this can be a problem if Olink's reagent kit will ever enter clinical diagnostics, where the quality and reliability of antibodies will be even more important.

As already mentioned, when Olink was created it was endowed with a considerable patent portfolio covering a range of technology with strong commercial potential. While some of these were licensed to key industry players, Olink chose to pursue the commercialization of two major other technologies on its own, by creating two spin-offs companies, both spun-out from Olink's main business in 2008 and assigned the relevant Olink's patents: Halo Genomics, with a specific focus on genetic analysis (sample preparation for large scale DNA sequencing), and Q-linea, focusing on pathogen detection and diagnostics. Even if Q-Linea was able short after its foundation to sell its biological threat sensor to the Swedish and French armies, its main goal is developing a genetic analysis system capable to trace antibiotic-resistant bacteria, which is a product still under development, but being tested with Swedish hospitals. Halo Genomics, on the other hand, could rely on a relatively ready technology to gain a number of large customer assignments at major research labs, mostly in Sweden. Given the positive market acceptance of Halo Genomics' technology, Olink was able in 2011 to sell for SEK70 Million this subsidiary to Agilent, one of the three-four major players in the field of instruments and tools for life sciences.

2011 was an important year also for the ownership of Olink itself: in fact the Uppsala based investment company Next2Be acquired 51% of Olink's shares from the owners, namely the founders and UUAB. Entering in the Next2Be sphere means expanded financing possibilities for the expansion phase Olink has been planning, including also the long-term goal of entering the diagnostic market, with sales to hospitals and patient analysis labs, ideally of FDA-approved analysis kits relying on Olink's proprietary technology.

Today (2014) Olink has 35 employees, signing a steady increase during the last 10 years. Sales (including license revenues) have been constantly increasing from about SEK 3 million in 2005 to 32 million in 2012. Profitability has however been achieved only one year since foundation, in 2011, with a profit of as much as SEK 48 million, much dependent on the revenue from the sale of Halo Genomics. However, Olink relies on a strong customer base including thousands of customers among academic researchers and over 50 major pharmaceutical firms.

## **DISCUSSION AND ANALYSIS**

The four companies in our cases share the fact that they have been founded at least 10 years ago; therefore they all have since long passed the age, 5 years, and the number of employees,

10, that Criscuolo, Nicolau and Salter (2012) indicate for a start-up (see Table 1 for a summary of key dimensions of the cases). However, other dimensions found in the entrepreneurship literature suggest more caution: Solibro and Chromogenics have never been profitable and the latter does not even appear to be financially sustainable, at least if analyzed at this point in time. Further Chromogenics present such a high degree of instability in its activity structure and business model that, despite being 12 years old, it can be classified still as a start-up. We opt instead for considering no longer as start-ups the other three ventures, even though for different reasons that will be discussed below.

	<b>Solibro</b>	<b>Chromogenics</b>	<b>PiezoMotor</b>	<b>Olink</b>
<b>Age</b>	2000 (14 years)	2002 (12 years)	1997 (17 years)	2004 (10 years)
<b>Current employees</b>	150 (stable)	20 (decreasing)	32 (increasing)	35 (increasing)
<b>Current sales</b>	Large volumes, NA	No sales	SEK 17 M, but oscillating	SEK 32M and growing
<b>Profitability</b>	Possible, but constant high losses	Not within reach, constant losses	Within reach, but constant losses	Yes
<b>Financial sustainability</b>	Possible in a larger corporate group	Not at the moment	Partly	Yes, fully
<b>Business model</b>	Stable, but open to imposed changes	Still instable: changed frequently	Approaching stability	Rather stable, after initial changes
<b>Network position</b>	Consolidated	Weak	Being defined	Strong
<b>Identity</b>	Established	Unclear	Being established	Established
<b>Trust</b>	Moderate to strong	Weak	Moderate	Strong
<b>Resource embedding</b>	Yes in develop. and prod. settings, less in using	Only in develop. Setting	Mostly in develop. and prod. settings, partly in using	Yes, in all three settings
<b>Still a start-up? Why?</b>	No, because of embedding in larger firms via JV and acquisitions	Yes, due to lack of network embedding and high internal instability	No, because of partial network embedding	No, because of network embedding in all three settings

**Table 1: Key dimensions of the four cases**

Our discussion of the four cases focuses on the network related dimensions (network position, identity, trust and resource, embedding in Table 1), but we start from the *business model* which is somehow a bridge between the network level and the company-internal features (age, employees, sales, profitability and financial sustainability).

Solibro's business model is basically stable since it was acquired fully by Q-Cells: the company only deals with development and production of solar cells, while sales to customers are taken care of by other companies, Q-Cells first and the new owner Hanergy then. However, despite apparent stability this business model might change due to changes imposed by the new owner as for which subsidiary will own production capacity in the future. Also Olink has a rather stable business model, grounded on a single global distributor and direct sales to selected major customers. PiezoMotor currently still adjusts its business model (project sales and product sales via global distributors), but it is approaching stability. Instead, Chromogenics business model is still constantly changed and far from stability.

These issues are also mirrored in the *network position* achieved by the four companies: Solibro's network position is *consolidated* via relationships with academia, suppliers and especially within the mother company (Hanergy), which controls Solibro's indirect relationships to customers. Chromogenics has instead a *weak* network position, based on

relationships only with academia and financiers, with lack of customer relationships. Piezo Motor's network position is still *being defined*: it has established relationships with suppliers and technology partners (some of which have however been historically troublesome, such as Fuji Films), and especially with distributors; relationships to customers appear although weaker. Finally, Olink presents a *strong* network position: it has many and strong relationships first of all with academia and customers, but also with selected financiers, suppliers, and with strong technology partners, licensees, and a key distributor.

As for the *identity* of the four companies, both Solibro and Olink have reached a clear and established identity in their networks, as the other actors know what they can expect from these companies and what they stand for in terms of technologies and values provided. On the contrary, Chromogenic's identity is far from clear as surrounding actors can hardly know what the company stands for and what areas its technology is really successfully applied to. PiezoMotor's identity is somewhat in between the Solibro and Olink, on the one hand, and Chromogenics: losing the Nokia deal was a serious blow to building an identity, but this is being established currently via distributors and a growing number of applications of Piezo Motor's technology and engineering competence.

Moving to *trust*, this dimension partly mirrors the identity of the companies. Once again Olink can boast a *strong* trust from external parties, built on the direct experience of thousands of users, hundreds of academic publications, and relying on major pharmas as reference customers. We interpret the trust enjoyed by Solibro as slightly less, that is, *moderate to strong*, since there are not as many customers as Olink's and being involved in a bankruptcy and the connection to a new Chinese owner might reduce the previous trust in the company as well as its technology, which had been built on strong technical performances and installed production plants. PiezoMotor can instead enjoy only *moderate* trust from external parties, due to a small amount of customers and also quality problems emerged recently in their products. Finally, Chromogenics' trust from other actors than financiers and academics, can only be weak as it has not yet fully defined its technical applications nor proved consistently how it can perform and satisfy customer needs.

Looking at how the companies and their resources are *embedded in developing, production and using setting*, Olink appears as the only company which has achieved an embedding in all three settings: connections for developing products are constantly activated, involving also academia and technology partners (machine producers), while a production structure capable to manufacture deliver both standard and customized products all over the world is in place; and finally use is widespread and becoming connected also with other existing technological platforms. Solibro and its technology appear instead connected mostly to development (academia and industrial labs) and production (two manufacturing plants and regular suppliers) settings, but connections to users are weaker, both due to limited sold volumes and the control of customer interface by the mother company. PiezoMotor presents a similar situation, with a clear embedding in developing and producing settings but less established connections to the using setting as customers are still rather few. Finally, Chromogenics is embedded only in a developing setting, since it has not yet installed its actual production line, nor established connections with any actual customer.

Considering the above discussion, we can conclude that Chromogenics, despite its age, *is still a start-up* because of high internal instability mirrored also by lack of network embedding. PiezoMotor is instead *no longer a start-up* because it is sufficiently, although not strongly, embedded in relevant parts of the external network. Solibro too is *no longer a start-up*, but it



stopped being that not so much thanks to embedding in an external network composed of customers and suppliers, but rather because it was transformed first into a joint venture with a major established player and then taken over by major counterparts. Finally, Olink is clearly *no longer a start-up* as the result of an “organic” process of embedding in all relevant settings of the external network.

## CONCLUSIONS

We can now provide answers to our two research questions, based on the analysis of the four cases. As for the question of *when a venture stops being a start-up*, if viewed from an industrial network perspective, the cases reveal that this can happen either when (1) the firm enters into a larger corporate constellation (the Solibro case) or (2) when it achieves a sufficient embedding in the external network (the PiezoMotor and Olink cases). In our cases, the second condition of network embedding applies also for the case of incorporation/acquisition: therefore, probably, the second path to stopping being a start-up is an even stronger condition, in the sense that a start-up being acquired may not stop being a start-up if the acquisition happens before its technology has been embedded in development or at least production settings.

As for the question concerning the *criteria and dimensions applicable to determine the transition from start-up to established firm*, the cases reveal that time is not a good indicator, nor the number of employees: the Chromogenics case reveals that it can take a very long time before even being near stopping being a start-up. Financial sustainability, especially if measured as a snap-shot or strictly venture-specific indicator, may not be either a perfect criterion: in fact the PiezoMotor case indicates that financial sustainability can be a lesser concern if highly convinced owners continue investing despite lack of profits for several years; and the Solibro case reveals that the established company is sustainable *only* within a larger corporate group, not as an isolated venture. Stability in the business model and structure of a venture may be a relevant dimension, but it is exposed to the limitations that any firm tends to change its business model and structure as soon as it meets external turbulence: for instance, Solibro’s business model may change, without making of it a start-up.

The criteria we propose here for assessing the transition from start-up to established companies are consequently *external* ones and therefore less affected by the internal dynamics of the firm, but capable to influence and partly explain them. Combining the analysis of our cases, we propose in fact, that start-ups stop being such when they reach *a strong or consolidated network position*, when they *gain a clear network identity* and when they *enjoy considerable trust* from several external counterparts. In turn, these three dimensions are positively related with *achieving an embedding* of the firm, its resources and its technology in relevant developing, producing and using settings. When a venture achieves such an embedding, the external connections tend to create also *internal stability*, both in terms of business models and structures, and to generate the revenue streams granting profitability and financial sustainability. Therefore, our study is a first step in addressing how external, network-related dimensions are indeed *explaining variables* of the classical internal indicators of when firms leave the start-up phase, such as financial sustainability or stable business models and structures. Clearly, more studies need to be made in this direction.

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