International Business Research; Vol. 13, No. 6; 2020
ISSN 1913-9004 E-ISSN 1913-9012
Published by Canadian Center of Science and Education

From Local Academic Spin-Off to International Firm: The Case of VisLab

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Received: April 7, 2020 Accepted: May 8, 2020 Online Published: May 22, 2020

doi:10.5539/ibr.v13n6p100 URL: https://doi.org/10.5539/ibr.v13n6p100

Abstract

Universities play an important role in developing and transferring technology. In Italy, much innovation takes place where universities are located outside large towns, as in the case of VisLab.

VisLab, the Vision and Intelligent Systems Laboratory, founded by Prof. Alberto Broggi of Parma University, is a pioneer in perception systems and autonomous vehicle research. It is also the spin-off of the University of Parma acquired by Silicon Valley company Ambarella Inc., in July 2015 for $30 million. After the deal, VisLab remained in Italy and all the staff, about thirty researchers, were hired by VisLab for the Parma location.

This paper examines the university-industry interaction and, in particular, academic spin-off, as a source of economic growth, pointing out the importance of the context. The study describes the main characteristics of the VisLab case, including the possible alternative strategies, the structure of the final M&A deal and the advantages deriving from Parma and surrounding area.

Despite, or perhaps because of its originality, the VisLab case seems to confirm the rule. It suggests that universities can play a key role in technology transfer: universities provide knowledge and trained personnel to firms, facilitating interaction between research and industry. Thus, policy makers should promote the commercialisation of research outcomes.

Keywords: spin-off, Mergers and Acquisitions (M&A), university, technology transfer, synergies

JEL codes: G30, G32, G34

1. Introduction

Transfer of knowledge from universities to industry is a key issue. Technology transfer contributes, in fact, to promoting economic and social development, competitiveness and business innovation (Guldbrandsen and Smeby, 2005). And universities too benefit from cooperation with the markets, e.g. in terms of funding financial resources (Mustar et al., 2008; Miyata, 2000).

In European countries, over the past decade, policymakers have fostered university-industry collaborations, including through the creation of academic spin-offs (Lockett et al., 2005; Moray and Clarysse, 2005). In Italy, 750 startups are active in the "PNI Cube network", the Italian association of university incubators, as of 31 December 2017. There are also 1 200 entities from the public research area. The average turnover is 260 000 euros and 5% of the startups have an annual turnover higher than a million euros. As for geographical distribution, 46% of startups are found in Northern Italy, 34% in the South and 20% in Central Italy. The protection of intellectual property involves almost half of the new companies: 40% of the projects are supported by at least one patent, but only 35.4% have started a business partnership. It is interesting that although Italy has, in general, a productive specialisation oriented more towards traditional sectors than hi-tech sectors, the ICT sector is the closest to the market, having the highest number of registered patents (45.5%) – Source: IlSole24ore.

In this paper we examine a success story from the Emilia Romagna region in Italy, which is considered by the European Commission as one of the most important in Europe with regard to start-up research firms. This is the case of VisLab (Vision and Intelligent Systems Laboratory), which is a spin-off of the University of Parma. The

University of Parma is a local university characterized by close links with the area. These take different forms: education, continuous interaction with local firms, provision of trained personnel, research and consultancy collaborations, technology discover and transfer. Our paper focuses on the relevance of University and its positive impacts on the surrounding area. We thus address the following research questions: (i) *What are the main consequences of university-industry interaction on the global and local economies? What is the particular role of academic spin-offs?* (ii) *In this context, why can VisLab be considered a success story?*

In order to answer our questions, we analyse the most important literature on the transfer of technology developed in the university sector into a national innovation system. Given the importance of the context when studying innovation and entrepreneurship, we also examine the main advantages for firms located near to universities and research centers. Among different mechanisms by which university transfers knowledge to industry, spin-offs play a key role. Focusing on academic spin-offs, we describe their impact on economic development. Finally, we present the VisLab case study, highlighting main characteristics and success factors, in the light of the local context.

We contribute to the literature by introducing a case of an academic spin-off which started in Italy and, in particular, in a provincial town, demonstrating that the local level can be an important distinguishing factor. It is a clear example of how universities interact with regional context in achieving results at national and international level. Moreover, we identify key aspects and steps that made VisLab an international enterprise, highlighting the important role that Italian universities play in the internationalization process of the economy. Findings from the VisLab case study may provide useful insights for the local context and for the national and international development of successful academic spin-offs.

The paper is structured as follows. Section 2 sets the theoretical background and explains why university-industry interaction is important for the local and national economy. Section 3 presents the VisLab case study, a story of success of an Italian academic spin-off. Section 4 discusses the main lessons from the VisLab case, showing that regional specificities may generate opportunities for universities and entrepreneurship evolution. This is possible however, only if people involved in the challenge show confidence, knowledge, expertise and take an open and forward-looking vision.

2. Theoretical Background

2.1 University-Industry Interaction: A Source of Economic Growth

Entrepreneurial innovation is an important source of economic growth and national competitive advantage. Today, with increasing competition and globalization, it has become essential.

A critical component of a national innovation system is the transfer of technology developed within university sector (Mueller, 2006; Lundvall, 1992; Nelson, 1993). Universities play a key role in promoting the upgrading of knowledge and skills, spreading culture and changing traditional thinking. Specifically, universities perform two important tasks: basic research and human capital creation (Audretsch et al., 2005). It follows that academic research underlies industrial innovation and contributes to wealth and economic development (Mansfield, 1991, 1995, 1998; Mustar et al., 2008).

Academic research has long been considered a public good (Callon, 1994; Etzkowitz, 1998) but the role of the university is not limited to this. Academic objectives need to incorporate the "service to society", or the economic exploitation of their research results (Reitan, 1997). Since the late 1970s, in fact, universities have enhanced and consolidated what is called the "third mission", consisting of the transfer of knowledge to industry and the local community, in addition to the traditional missions of education and scientific research (Florida and Cohen, 1999; Gulbrandsen and Slipersæter, 2007). In this respect, Bozeman (2000) introduces the concept of "cooperative technology paradigm".

There are several reasons for the growing importance of university-industry interaction (Fini et al., 2011). First, knowledge is becoming even more multidisciplinary. Secondly, alliances between large firms and smaller and dynamic firms with qualified scientific bases, such as academic spin-offs, are growing because of the need to remodel the organization of R&D activities. Thirdly, governments are promoting entrepreneurial universities because of their important socioeconomic impact on the development of the modern knowledge economy (Urbano and Guerrero, 2013). Finally, new legislation encourages universities to create new firms and transfer technology to the community.

Muscio and Pozzali (2012) state that university and industry cooperate despite their "cognitive distance", described as "differences in the sets of basic values, norms and mental models in universities and firms". Many factors have contributed to the development of the entrepreneurial role of university, including focus of research

projects on users' needs, and linkages between researchers and research users (Landry et al., 2007). Furthermore, universities themselves also benefit from university-industry collaboration. Guldbrandsen and Smeby (2005) demonstrate, in fact, that university-industry collaboration has positive effects on academic research.

2.2 Academic Spin-Off: One Way of Transferring Knowledge and Technology

There are numerous mechanisms by which universities transfer knowledge to industry. They include recruitment of university graduates, joint research, contract research, consulting, patents, licensing, personal involvement of faculty and spin-offs (Perkmann et al., 2013; D'Este and Patel, 2007; Thursby and Thursby, 2003, 2004; Salter and Martin, 2001; Cohen et al., 2002; Lee and Gaerther, 1994; Baldini et al., 2006; Baldini, 2011; Breschi et al., 2008; Lissoni et al., 2008; Baldini, 2010; Colombo et al., 2010; Lockett et al., 2005; Moray eyt al., 2005; Nosella and Grimaldi, 2009). Research transfer needs to be distinguished as either commercialization or academic engagement. Commercialisation of knowledge means that an academic invention is exploited to make a profit. It generates a prime academic impact because it is measurable market acceptance for outputs (Markman et al., 2008). To support commercialization, universities often establish specialised structures, such as technology transfer offices or incubators (Siegel et al., 2003; Cesaroni and Piccaluga, 2016). Academic engagement in knowledge transfer consists of inter-organizational collaboration linking universities with other organizations (Bonaccorsi and Piccaluga, 1994; Meyer-Krahmer and Schmoch, 1998; Schartinger et al., 2002). In fact, interactions between universities and firms are complex. Bodas Freitas et al. (2013) identify two forms of governance of university-industry interactions: (i) institutional governance, which consists of formal relationships and contracts with a university and (ii) personal contractual governance, which consists of direct contract-based arrangements with university researchers. Bodas Freitas et al. (2013) find that personal contractual interactions are used more by small firms involved in open technology and innovation development strategies.

Among different forms of knowledge and technology transfer, academic spin-offs play a strategic role. Through spin-offs, in fact, universities can sell knowledge grounded in scientific exploration (Franklin et al., 2001). Originally, academic spin-offs were found only in the United States, but today they can be found in all advanced economies, including Italy (Clarysse et al., 2005; Ndonzuau et al., 2002; Bellini and Zollo, 1997; Chiesa and Piccaluga, 1998, 2000).

University spin-off firms are considered in the literature as one of the key drivers of economic growth and technological progress (Bercovitz and Feldman, 2006; Druilhe and Garnsey, 2004). It follows that fostering academic spin-offs is at the core of national economic policy (Kroll and Liefner, 2008; Rasmussen, 2008). Pirnay et al. (2003) define university spin-offs as "new firms created to exploit commercially some knowledge, technology or research results developed within university". The aim is to transform academic research results into economic value by creating a firm. This process begins with a development stage composed of a technological development (i.e. the production of a possible prototype) and commercial development (i.e. the business plan). At this phase, financing is very important and, at the same time, often problematic. The next step is the creation of the new firm. Two kinds of resource have to be considered: intangible and tangible. Intangible resources are people surrounding the spin-off (doctoral students, professors), their know-how and expertise (Mustar, 1997). Intangible resources are often the main source of wealth in academic spin-offs, although tangible and financial resources are also important (Mian, 1997). By their nature, academic spin-offs are short of resources in the start-up phase (Clarysse et al., 2007). Information asymmetry, uncertainty and transaction costs can all discourage the intervention of private venture capitalists (Lockett et al., 2002). In the early years, skills in networking with investors and customers are crucial (Hackett and Dilts, 2004; Hoang and Antoncic, 2003; Walter, 2006).

Vohora et al. (2004) identify two main differences between academic spin-offs and other high-tech start-ups. First, academic spin-offs originate from a non-commercial environment and they often lack resources required to transform an idea into a product or process innovation. Second, stakeholders involved in the start-up phase of an academic spin-off (e.g. university, management team, venture capital) might have different objectives, thus causing difficulties for business development (McAdam and McAdam, 2008). An academic spin-off permits formation of a firm and the transfer of innovation from the university to the market place. Zahea et al. (2007) argue that university spin-offs and corporate spin-offs differ in the so called "knowledge conversion capability", or the capacity to transform research discoveries into successful products that can be sold efficiently to create value.

Many researchers (Radosevich, 1995; Roberts and Malone, 1996; Carrayannis et al., 1998; Steffensen et al., 2000) analyse how universities try to promote the creation of spin-offs. O'Shea et al. (2008) identify a set of

determinants of spin-off activity: individual attributes, organizational aspects, institutional behavior, as well as broader economic factors, such as access to venture capital, legal assignment of inventions, industry structure and infrastructure level in the region.

Ndonzuau et al. (2002) examine the main issue raised by the inception of university spin-offs from the standpoint of public and academic authorities. They also identify four stages of the spin-off process: (i) generating business idea from research; (ii) finalizing new venture projects out of an idea; (iii) launching spin-off firms from projects; (iv) strengthening the creation of economic value by spin-offs.

Bathelt et al. (2010) highlight the importance of knowledge perspective, and link the phenomenon of university spin-offs to regional development in a dynamic perspective. Many researchers (Rogers, 1986; Etzkowitz et al., 2000; Wright et al., 2004; Muscio, 2009) in fact acknowledge the significance of university spin-offs as a technology transfer mechanism for generating and sustaining the local economy.

2.3 Academic Technology Transfer and Local Context

Autio et al. (2014) highlight the importance of context when studying innovation and entrepreneurship. Previous studies (e.g. Boschma, 2005) confirm that knowledge transfer is more effective when senders and recipients are in geographical and institutional proximity and can share common understandings, perspectives and goals. Moreover, some researchers (Etzkowitz and Leydesdorff, 2000; Cooke, 2001) suggest the importance of regional networks to achieve success at global level and recognize the importance of systemic innovation at the regional level.

Several authors (Nelson, 1959; Fujita and Thisse, 1996; Masfield and Lee, 1996; Fischer and Varga, 2003) recognize the advantages firms can accrue from being in proximity to a university. Firms in fact tend to concentrate near to universities (Audretsch and Lehman, 2005; Rodrguez-Pose and Refolo, 2003). Many researchers (Jaffe, 1989; Krugman, 1991; Feldman, 1999), focussing on the US, demonstrate that industry innovation is strongly and positively affected by proximity to universities. Other scholars (Piergiovanni and Santarelli, 2001; Piergiovanni et al., 1997) find similar results for Europe. Algieri et al. (2013) focus on determinants of spin-off creation in Italy. Lazzeroni and Piccaluga (2015) analyse three cases of European small and medium-sized cities, Oxford, Leuven and Pisa, finding that the presence of a university is an important asset for knowledge and urban development. The presence of a university also contributes to the increase of cultural capital of the surrounding area, making it more open to change and more resilient. Universities comprise attractive small cities for young and qualified individuals and may cause a kind of urban transformation in terms of building of new infrastructures and restructuring existing areas. These effects are particularly clear in small and medium-sized cities (Lazzeroni et al., 2013).

Universities start the development process from cities where they are located, and continue to promote it over a wider area. They may play an important role in the internationalization of local economy. Colombo et al. (2010) analyze circumstances under which universities located in a geographical area contribute to the growth of academic new technology-based firms. They find that the scientific quality of the research performed by universities has a positive effect on the growth rates of academic new technology-based firms. Conversely, a commercial orientation of research has a negative effect.

Universities are sources of knowledge for regions and providers of trained personnel to local firms (D'Este et al., 2012; Lawton Smith, 2007). In particular, among their other functions, academic spin-offs provide a way of strengthening relationships with local business communities and, thus contributing to the growth of regional economies (Charles, 2003; van Burg et al., 2008). Mustar et al. (2006) and Friedman and Silberman (2003) state that research-based spin-offs have become an important aspect of the technology transfer process at a regional level. Moreover, Zhang (2009) suggests that technology transfer through spin-offs is mainly a local phenomenon. In other words, universities can become poles of local economic development.

Fini et al., (2011) analyse the role of University Level Support Mechanisms (ULSMs) for the creation of spin-offs and the way they interact with Local-Context Support Mechanisms (LCSMs), available in the regional area in which universities operate. They find that ULSMs have a significant impact on academic spin-off productivity and that universities are negatively affected by regional government R&D expenses. Moreover, the effect of ULSMs change according to the contribution made by different LCSMs. It follows that universities need to consider the joint impact of different forms of support when assessing how to encourage the creation of spin-offs. The local context may, in fact, influence the development of young firms (Beck et al., 2005) including academic spin-offs. Local government can provide for entrepreneurial support initiatives such as small loans and physical infrastructures (Feldman, 2001). Moreover, the level of the local financial system, technology, social environment and the industrial composition are conditioning factors (Baharami and Evans, 1995; Di Gregorio

and Shane, 2003; O'Shea et al., 2005). Specific industry characteristics facilitate the creation of academic spin-offs. These include the effectiveness of patents and a low level of the technology base. In short, interaction between universities and companies is necessary to improve reciprocal competitiveness.

Academic literature on the role of universities mainly focuses on the context of the US. It is thus interesting to examine the contribution of university activity in a country like Italy, where there are regional clusters in traditional industries and family-owned firms (Becattini, 1990; Camuffo and Grandinetti, 2011; Piccaluga, 1992).

3. The VisLab Spin-off

3.1 A Distinctive Story

This paper focuses on the transfer of science and technology developed within universities and demonstrates that a local university can contribute to the internationalization of the economy. To prove this, we present the case of VisLab, a spin-off of the University of Parma, one of the oldest universities in the world. In July 2015, in fact, VisLab was sold for 30 million dollars to the American company Ambarella, a NASDAQ-listed company active in the field of video compression and image processing, reaching one of the highest prices of the year for an Italian startup (Source: economyup.it).

VisLab, the "Vision and Intelligent Systems Laboratory", is an Italian company working on computer vision and environmental perception for vehicular applications. In essence, VisLab works with automatic driving of vehicles. The idea is not new, but VisLab is innovative in creating the technology to make it possible. In particular, VisLab is involved in basic and applied research developing machine vision algorithms and intelligent systems for the automotive field. Its core business concerns unmanned ground vehicles (UGVs).

VisLab started in the early 1990s when it was founded as a research laboratory of the University of Parma, Department of "Ingegneria dell'Informazione". Its founder was Alberto Broggi, a professor of Computer Engineering, who together with other researchers of the University embarked on a twenty-year success story.

VisLab started with involvement in the EUREKA PROMETHEUS Project in 1990 and has always focused on vehicle applications. It has always conducted both basic and applied research, including the perception of the surrounding environment in vehicle applications using cameras and fusion with other sensors. Its researchers contribute to fields such as artificial vision, image processing, machine learning, neural networks, robotics and sensor fusion.

In the early years, the research group designed, realized and tested ARGO, a passenger car able to perceive the environment through the use of micro cameras, analyze the surroundings, plan a route and drive itself on normal roads. It was tested in 1998 in the "MilleMiglia in Automatico", a 2000+ km tour around Italy. In this test, the vehicle drove more than 94% of the time in automatic mode. It was the first test in the world to use off-the-shelf and low cost technology, consisting of a Pentium 200 MHz PC and two low-cost video-phone cameras, in normal conditions of traffic, environment and weather.

Seven years later, in 2005 the TerraMax vehicle took part in the DARPA Grand Challenge; with VisLab's vision system as its primary means of perception. And in 2007 a new version of TerraMax qualified for the DARPA Urban Challenge, although this was not completed due to a fault.

The two DARPA competitions were a success and consolidated the vision of VisLab, that of aiming higher and going further. The company motto is, "Never stop", "Do something never done before".

In 2009, eleven VisLab researchers started a spinoff company, named VisLab srl, to launch the results of their research on the market and transfer technology to companies. In 2009, VisLab also successfully ran a new test in Rome, following a city route within the capital, starting from the Campidoglio and arriving at the Colosseo. It was a success and was enthusiastically received by the media and public opinion. It stimulated the researchers to accept a new challenge and in Rome, VisLab announced a new adventure called VIAC. This was the VisLab Intercontinental Autonomous Challenge, a 13,000 km test run for autonomous vehicles, from Italy to China. This was the first autonomous driving test on an intercontinental route and lasted three months.

In VIAC, 4 identical self-driving vehicles left Parma and after 3 months arrived in Shanghai, China, during the closing days of Expo 2010. They paraded in front of representatives of many different countries. Once again, the VisLab slogan was "No one has ever done this before".

On 12 July 2013, VisLab tested the BRAiVE vehicle in downtown Parma. BRAiVE successfully negotiated two-way narrow rural roads, traffic lights, pedestrian crossings, speed bumps, pedestrian areas, and tight roundabouts. VisLab engineers activated the vehicle in Parma University Campus and stopped it in Piazza della

Pilotta, in downtown Parma. This was a 20 minute run in a real environment, with real traffic at 11am on a working day, and absolutely no human intervention was required.

On 31 March 2014 VisLab unveiled the new autonomous car, DEEVA, which features more than 20 cameras, 4 lasers, GPS and IMU, with all sensors hidden.

In order to fully understand VisLab, it is important to consider its essential characteristics and initial business model. The number of people employed at VisLab from 2009 grew to 25/30 people in 2013/2014. They were mainly researchers, some on temporary contracts, often mainly driven by keen interest in the scientific project. This positive growth was supported by a simple business idea: selling consultancy and advice. To finance its business, buy vehicles and IT equipment, and pay staff, VisLab sold services of technical business advice and reinvested revenue in its business. VisLab has always focused on hi-tech and innovative development. It has aways been dynamic, enterprising and dared to take risks. It has been successful thanks to its ability to take up new challenges. Its goal is "Not high-level, but Number One". Characteristics such as these in fact make VisLab similar to Silicon Valley companies. As noted above, until 2015 its turnover was based on services and consultancies with companies all over the world, and profits were entirely reinvested into internal strategic projects. This model allowed VisLab to rewrite the history of the UGVs sector (1998, 2005, 2007, 2010, 2013).

It should be noted that, until 2005, VisLab was widely thought to be "a crazy bunch driving cars automatically". But after the DARPA Grand Challenge, interest in the sector grew, and there was increased media coverage. Interest reached its height in 2010 when Google entered the sector and made well-publicized investments in autonomous driving. At that time there was no interest by car manufacturers and not until 2013 was there interest from Nissan, which announced it would start selling automatic vehicles in 2020. Shortly afterwards, however, all the major car manufacturers started to show interest in automatic vehicles, and today they are starting to invest in the sector.

With the entry of big players, the VisLab business model stopped being sustainable. VisLab ran the risk of no longer being competitive against big players with enormous resources, and now needed to change gear and go faster to compete and develop.

Interest by potential partners however was meanwhile rising for a number of reasons. VisLab's scientific credibility was globally recognized, and its skills were publicized thanks to intensive media exposure. VisLab continued to work on very hot hi-tech themes and its business idea remained clear and promising.

The following section describes the stages of the deal that led VisLab to "change gear" and be acquired by Ambarella.

3.2 The Deal

With its goal of being “not just high-level, but Number One", VisLab has been successful. Its characteristics make VisLab similar to Silicon Valley companies. Silicon Valley of course is the principle home of technology start-ups world-wide. Apple, Google, HP, Intel, Adobe, Ebay and many other technology giants have their headquarters there, and continue to develop projects, invest, hire collaborators and conquer new market shares. The area is also a stimulating environment for companies that want to start "thinking like startups". Like the companies in Silicon Valley, VisLab followed some basic rules: have and share a dream, have and communicate passion, think different, be innovative and measure success, benefit from the environment. VisLab was fully motivated and felt it could achieve its ambition to become Number One in its field.

Table 1 shows a SWOT analysis for VisLab. It is interesting to note that some elements proved decisive in choosing the methods of finance and business development.

Table 1. VisLab SWOT Analysis

STRENGTHS	WEAKNESSES
- 20+ years experience / respected in industry - Vision expertise (24 PhDs) - Automotive experience - Breadth (front, rear, lateral, mono, stereo, ecc.) - Leverage low-cost camera sensors - Access to core research through university - Database (better testing and better algorithms) - Software, algorithms - Embrace, understand fusion - Economic R&D location	- Changing business model - Existing revenue with customers - Location - No partnerships with Silicon Valley firms - Automotive quality testing

OPPORTUNITIES	THREATS
- Strong migration to autonomous driving, stereo - Vehicle interior (Gaze, HMI/UI/UX, face, gesture, ecc.) - Legislative mandates / China adoption - Technology adjacencies (Navigation, route planning, platooning) - Aftermarket / insurance - Market adjacencies / new verticals (Robotics, security, drone, ecc.)	- Well funded competition - Competitor's incumbency, leverage in market - Satisfaction with ADAS, monocular - Slow China adoption - Market acceptance of autonomous vehicles / Accident - LIDAR innovations / Google push on LIDAR - Testing effort exceeds expectations

(Source: Pre-deal company documents).

With the goal of developing more rapidly, various alternatives (Table 2) were explored, from 2013 onwards, at first independently, and subsequently with the support of consultants. Each alternative was assessed on the basis of a number of financial considerations, including: risk profile, amount of control, potential return, and cultural fit. For each alternative, the associated costs were assessed and the most advantageous one was chosen. External consultants took into account development strategy, taxation, legal and financial aspects. Their greatest contribution lay in the process of evaluating the company and support in negotiations. In particular, the consultants successfully led the negotiations in terms of Intellectual Property rights. The acquiring company was mainly in fact acquiring know-how and expertise which required adequate protection.

Table 2. Financing Options

1) self-financed ("theoretical" alternative)
2) IPO – Initial Public Offering ("Unicorn" – very rare)
3) internal development with the support of venture capitalist/business angel
4) merger with an industrial partner
5) transfer of the shares of the company
6) intervention of a financial partner

In 2015, the final decision was taken as dictated by the structure of VisLab, its history and its identity as an innovative and atypical startup. It was decided to transfer company shares. Timing played a decisive role. On the one hand, competitors with only a slight technological delay but with very significant financial resources were entering the field. On the other, legislation was evolving rapidly.

The negotiations first considered the most receptive markets for the technology developed by VisLab. This meant Silicon Valley companies, which, as noted above, were very similar in terms of characteristics to VisLab. There was therefore contact with potential partners and analysis of the advantages and disadvantages of the various open alternatives. In the end, VisLab shares were sold to the partner which appeared most credible and functional in terms of affinity of business and industrial technology. In 2015, VisLab was acquired by Silicon Valley NASDAQ-listed company Ambarella Inc., with a capitalisation of USD 3.2 billion (2015 data). Ambarella is a fabless semiconductor design company which focuses on video compression and image processing products of low power, high definition (HD) and Ultra HD. Ambarella products are used in a variety of HD and Ultra HD cameras, including security IP cameras, sports cameras, wearable cameras, drones and video processing solutions for cars. Ambarella compression chips are also used to broadcast TV programs all over the world.

The negotiations between Ambarella and VisLab lasted about 6 months, and covered the following points: (i) term sheet, (ii) evaluation, (iii) due diligence, (iv) contract structure (with particular attention labor law, intellectual property and criticality), (v) different payment methods, and (vi) taxation.

The first phase involved the drafting of the non-binding term sheet (or letter of intent). A term sheet is a document setting out the relationship between the two parties and comprises a roadmap to reach the actual agreement. As an operating practice, the term sheet between VisLab and Ambarella provided for the establishment of specific confidentiality agreements and sanctions in the case of violation of confidentiality agreements.

One of main contributions of the consultants concerned evaluation: the measurement of value, which required a great deal of analysis, was in fact very difficult because VisLab business is based on intangibles, mainly

intellectual property. VisLab was a company characterized by two value drivers: (i) one linked to consulting, now consolidated and with expectations of continuous growth, (ii) the other linked to intangible assets consolidated during the last 20 years of research activity. Consulting and research have generated a synergistic effect which today generates a continuous and future growth income. It is an important "intangible asset" consisting of patents, data-base and know-how.

VisLab was a healthy and revenue-generating company, with an annual profit of over €1 million and an EBITDA close to €350 000. However, its true value was not revealed its balance sheet, because the internal goodwill created through continuous research activity did not appear in financial statements. One reason for this is that Italian legislation does not allow for internal goodwill to be recorded in financial statements. Evaluation was even more difficult because there were no similar competitors in terms of similar features. VisLab was an extremely traditional consulting business in the way it was delivered, but in a very specific niche sector. In other words, VisLab was a prototype. Potential competitors in the market were mostly listed companies, which were not strictly comparable. The real driver of VisLab were its intangible assets, which were mainly intellectual property rights. It was necessary to quantify the value of these intangibles to the fullest.

For reasons of confidentiality technical details of the evaluation cannot be reported here, but in general terms, two approaches were adopted at the same time. The cost approach looked at costs incurred in the 20 years of activity, and the income approach looked at the profits from consulting. For the valuation of VisLab's "intangible assets", criteria based on the market and income approach were not applicable. The most appropriate approach was to look at costs, and in particular the replacement cost criterion. And this led to the company being valued at around 30 million dollars. The agreement also provided for an incentive plan for management (i.e., stock option plan) linked to company performance.

The next, more sensitive, phase was due diligence, investigating and deepening data and information about the object of the negotiation. The purpose was to assess the attractiveness of M&A for the two parties, and to identify the related risks and problems, in negotiating terms and conditions and preparing instruments for collateral, indemnity and compensation. The due diligence involved setting up a data room where all information describing VisLab and its business was made available in detail for the negotiations.

The real bargaining between the two parties in fact concerned the various M&A alternatives that became apparent after the due diligence phase. As noted above, the main focus of the negotiations were intellectual property rights, which are very complex. Ambarella aimed at the purchase of intellectual property only, while VisLab aimed at a sale of the entire company. After careful evaluation, an agreement was made to sell shares upon payment of a consideration. This solution satisfied both parties: Ambarella became the owner of VisLab and its intellectual property, while VisLab was able to make the most of its value, allowing the business to remain in Italy, in Parma. As we will see, all the existing staff were hired, and funds were found to invest in development.

4. Discussion and Conclusions

The previous section of the paper described the case of VisLab as a success of an Italian academic spin-off. As a company which carries out basic and applied research in machine vision algorithms and intelligent systems for the automotive field, its core business is in unmanned ground vehicles (UGVs). It is widely believed that UGVs will shape the future by providing improved safety and mobility. In fact, in the US the states of Nevada, Florida, California, and Michigan have already passed laws allowing the transit of autonomously driven cars. In Europe too, certain cities are planning to activate transport systems for driverless cars or have already permitted UGV tests in traffic.

In the complex and highly competitive UGV market, VisLab aimed to do something entirely new. Until 2015, revenues were based on advice and services to companies all over the world, and all profits were reinvested in internal strategic projects. This was a unique business model in the UGV sector. When big players moved into the UGV market, however, the model was no longer sustainable. Interest from possible partners arose naturally: VisLab's scientific credibility was recognized globally and its skills were also known thanks to heavy media exposure. The company works in hi-tech areas of great scientific and public interest, and the business idea was clear and promising.

The sale of VisLab in July 2015 to the American company Ambarella for 30 million dollars (plus a stock option plan) made it a robust and consolidated presence. The decision to grow through the sale of shares has brought undoubted advantages for Parma University and for university research, and also for the local economy of the Parma area.

It is clear that one of the main features leading to the success of VisLab was the originality and importance of the idea. The project under Alberto Broggi and his staff had high intrinsic value, and this was the key to the whole story. The capacity to innovate is in fact indispensable for a start-up firm. Other features were fundamental as the project developed and VisLab was acquired by Ambarella. Key aspects of VisLab strategy were as follows:

1. *Valorization of human resources*: Human resources were considered as the real value driver. Researchers themselves developed the business idea and made it credible with personal commitment and hard work. Strategically, the agreement acknowledged this, and the researchers were all hired on permanent contracts by Ambarella. They were thus able to work in continuation, remaining in the same local area with links to the University even after the acquisition.

2. *Connection with the University*: Synergy with the University is one of the central points of VisLab's strategy. VisLab was originally set up as a university research laboratory and over the years it became autonomous as a company. But its university origin is an intrinsic characteristic.

3. *Connection with the local area*: The desire to remain in the local area is another key element in VisLab's success. The refusal of the research team to move to California, and their remaining in the place where the dream was born 20 years before was of great benefit to the University and the area of Parma. This is an important consideration at a time that the brain drain continues apace from Italy.

Going into more detail, the purchase price was extremely satisfactory for shareholders, including the University. The university in fact reinvested the money entirely into various forms of research. There is today a long-term collaboration agreement between the University of Parma and Ambarella, including five post-doctoral positions and other joint projects such as lectures and courses. Osmosis between VisLab and the University is ongoing and profitable to both sides. VisLab also continues to be physically a part of the University, and a new headquarters building was opened on the university campus in 2018. It was built using Xlam and lamellar prefabrication techniques with dry mounting. It consists of 1,100 square meters on three levels, and in future can be flanked by a twin pavilion to meet possible new development needs. The image and architectural criteria of the building are representative of the hi-tech business and sustainability. It is in fact in Energy Class A and produces photovoltaic energy of 33,750 kWh, so that 77% of energy requirements are met by renewable sources.

As noted above, at a time when the "brain drain" remains a worrying concern for Italy, the fact that VisLab and the intellectual property of the original spin-off remained in Parma is significant. The company has retained its structure of five teams, who now report directly to the CEO / CTO of the multinational in Santa Clara, CA. All collaborators and researchers previously working for VisLab were hired by Ambarella with permanent contracts valid under Italian legislation. Since 2015, the year of the sale, the VisLab team has continued to grow. Until March 2015 (before the acquisition), there were only 4 VisLab employees. The number of employees was much higher, as mentioned above, but most of them worked through consulting contracts and scholarships. With the acquisition, Ambarella hired 29 people with permanent contracts. In 2016, there were 31 engineers hired and 2 administrative employees joined them. Today the group has more than 50 employees and periodically open positions are offered. It should be noted that the creation of new jobs in Italy was also possible because the VisLab team, at the time of the acquisition, did not accept the request to move to California, but preferred to stay in Parma.

VisLab has always been an important research group in Italy. Since being sold to Ambarella, however, it has gained in strength and ambition and now works in synergy with key world technological poles of Silicon Valley, China and Taiwan. And the city of Parma, which has always been known for its ham, cheese, music and architecture is now gaining recognition as an important center for UGVs.

VisLab’s early success in the MilleMiglia in Automatico of June 1998, which was one of the first tests of a self-driving car, a Fiat Thema, on public roads, is still considered a milestone in the history of automatic driving. To celebrate the twentieth anniversary, Ambarella unveiled the new EVA (Embedded Vehicle Autonomy) prototype in May 2018 at the VisLab headquarters of the university campus of Parma. EVA moves with the help of six HD cameras connected to a unique small chip which reads the obstacles near the vehicle and at a distance of over one hundred meters. VisLab continued to be equally successful during and after acquisition. Today it is focused on product development, which has led to important advances. In 2019 the Italian Ministry of Transport issued VisLab with the authorization to test the first self-driven vehicle on public roads in Italy.

In conclusion, we have shown that among the various forms of knowledge and technology transfer from university to industry, academic spin-offs are a key element in sustaining regional economic development. It is thus desirable for economic policy to support the growth of spin-off firms. It is therefore desirable that economic policy should support the growth of spin-off companies.

The case of VisLab strongly suggests that universities play a key role in this area as "facilitators of the growth of ideas" as well as "incubators of ideas". Universities in which potentially interesting research groups exist can in fact facilitate their development. They should implement the processes of transforming research projects into spin-offs, supporting research groups with business know-how and skills. These skills can be found for example through the creation of networks of successful companies and highly qualified professionals. In short, it is important for high-level research with potential for growth, like VisLab's, to be helped "to take flight".

Finally, the results of the VisLab case study can provide useful insights for the local context and for the national and international development of successful academic spin-offs.

Acknowledgements

This research is dedicated to the memory of Prof. Loris Borghi, former Rector of the University of Parma, whose generous, enthusiastic and far-seeing leadership inspired and encouraged the VisLab story.

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