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EPO TECHNOLOGY TRANSFER CASE STUDIES | BLUBRAKE

Cycling safely into the future

A collaboration between a Politecnico di Milano research team and e-Novia, a company creator, led to the development of new technology for ABS control systems and the creation of a disruptive spin-off company Blubrake, with some of the inventors later becoming involved in the management of the company.



Blubrake's integrated ABS system
for e-bikes and e-cargos

From lab to market

In 2015, a research group led by Professor Sergio Matteo Savaresi, full professor of automatic control at Politecnico di Milano (Polimi), was working on the development of a braking control system for e-bikes when they were approached by e-Novia. Milan-based e-Novia, which was co-founded by Savaresi, is dedicated to the creation of deep tech spin-offs. Its engineers and managers scale up technologies by identifying untapped potential and then create specially designed spin-offs to which they assign the technology. e-Novia had previously collaborated with Polimi on other projects, including smart mobility.

e-Novia had the idea of forming a company to commercialise an innovative ABS controlling system for e-bikes. They saw market potential in Polimi's technology and approached a group of researchers in the electronics department. e-Novia's technical staff and Polimi researchers started to collaborate, with the goal of developing a marketable solution.

TAKEAWAY

ENTREPRENEURIAL MINDSET

Good researchers and good inventors can also become good managers in the right environment, for example when provided with proper training.

In the same year, Blubrake was formed as a spin-off of Polimi and e-Novia. Under a collaboration agreement, Polimi agreed to share its intellectual property (IP), while e-Novia became the main shareholder and the provider of the engineering services and capabilities needed to develop a market-ready solution. Blubrake became the hub for the long process of R&D development, prototyping and, ultimately, manufacturing and selling.

The value of collaboration

The technology at stake refers to AI-powered algorithms controlling a mechatronic braking system. There were significant complexities to overcome in order to apply the controlling technology to bikes and turn it into a commercial product. It required the specific expertise of the bicycle industry to develop relevant use cases (e.g. e-bikes, e-cargo bikes) and meet the manufacturing requirements of bike producers and their suppliers, as well as the expected product market price.

e - NOVIA

In 2015, a group of entrepreneurs in northern Italy created e-Novia, a large operation made up of an élite mix of innovators, including engineers, designers and business experts, who scale up technologies by identifying untapped potential and create especially designed spin-offs to which they assign the identified technology.

e-Novia acts as a start-up accelerator, promoting and growing innovative companies in the areas of robotics, artificial intelligence and mobility. It builds upon intellectual property that is created together with research institutes and international corporates. and invests in coaching technical people on how to become managers.

e-Novia's enterprises focus on deep technologies and operate in three main strategic areas:

- “Collaborative mobility”: products, services and solutions for future vehicular mobility, impacting performance, safety and comfort
- “Augmented human”: wearable devices helping humans to augment their perception and capabilities
- “Humanised machines”: technologies for automated and smart systems to increase efficiency and flexibility in factories and industrial environments.

e-Novia's business model is based on the idea of leveraging IP from multiple sources and combining it with competences and financial resources to create businesses with international ambitions.

More specifically, e-Novia sees universities, start-ups and corporations as potential providers of ideas to create new business, according to a service factory model. The standard process of company creation follows a clear path from idea (generating innovation), to invention (transforming innovation), to enterprises (transferring innovation).

So far, e-Novia has generated 35 entrepreneurial projects and created 20 active enterprises, including Blubrake. The company provides a full range of engineering services to both portfolio companies and external clients. It also endeavours to introduce technical people to business and trains them to become managers.

TAKEAWAY

INVENTORS' INVOLVEMENT

The involvement of the research team in the technology's industrialisation helped the company to address technical problems effectively such as fitting the ABS system in the bike chassis without compromising other functions, and thereby become more credible to original equipment manufacturers (OEMs).

It was therefore crucial to the success of the technology transfer for the academic researchers and e-Novia professionals to combine their respective skills and expertise. The Polimi research team provided expertise in control systems and optimisation of the braking system's controlling algorithms and developed the seminal technology on the ABS control system. However, the braking system is also made out of hardware components that must be adapted to the bike and to its subsystems, including batteries and gearshifts. Its design and implementation requires skills in design, engineering, manufacturing, quality control and supply chain management – all of which were within the capabilities of Blubrake and its professional team.

But, first and foremost, e-Novia was responsible for the managerial growth of the young technical people and PhD students involved in the project, turning them into entrepreneurs. It is therefore not surprising that some of the inventors took on managerial responsibilities within the company. Fabio Todeschini, a former PhD student at Polimi, and an employee of e-Novia when the company was set up, played a particularly important role. He became a co-founder of Blubrake, acting as a link between Savaresi's team at Polimi and the start-up, and later taking on the role of Blubrake's general manager.

TAKEAWAY

MULTI-LAYERED TECHNOLOGY TRANSFER

Technology transfer, including the transfer of knowledge by people, is important for market success. Inventors can become co-founders and take over management functions.

“IP is important in two main respects. Firstly, it helps to attract investors when companies are mature enough to grow. Secondly, it is important for exit purposes as it increases corporate value.”



Fabio Todeschini
Co-founder and general
manager of Blubrake

A disruptive approach to IP

From the outset, Blubrake's solutions were developed with a view to generating IP. The team learned to identify new inventions and seek adequate protection. However, Blubrake and Polimi did not file their first jointly owned patent on the control system for e-bikes ABS until 2016. This is unusual for a university technology transfer: universities will normally file a patent as a prerequisite for testing the technology on the market and to allow scientific publications. In contrast, Blubrake was created from the outset around a specific USP and a specific market (e-bikes). This enabled the company to have trade secrets and to draft the first patent more in terms of tailored technology features and design. Of course, strict confidentiality had to be maintained during the development stage.

This proved to be a successful avenue for a deep tech start-up. In 2017, Blubrake was already able to develop its first market-ready solution and to start commercialisation efforts. In 2019, the company's ABS control system for e-bikes was certified and it entered its first commercial agreements with early adopters, original equipment manufacturers (OEMs) such as manufacturers of braking systems, gearshifts sets and frames, and e-bike manufacturers in general. The company today employs more than 25 engineers, plus managers, and has been awarded a number of grants, awards and prizes over the years:

- Eurobike Winner in Bicycle Component category (2019)
- Bicycle Brand Contest Winner (2019)
- SME Instrument Phase 2 (2018)
- Intesa San Paolo Innovation Center Award (2018)
- Gaetano Marzotto Award (2017)

Financing the journey

e-Novia not only helped to create Blubrake but also played a key role in attracting financing and negotiating with the initial funders. Early financing was important for the deep tech start-up to finance four years of R&D before concluding the first contract. It took longer than expected to reach the market because the technology needed to be thoroughly tested to meet the strict safety requirements. In return for a majority share in the company, e-Novia agreed to support researchers with the funding of developmental activities and the filing and maintenance fees for the ensuing patent applications.

Until 2020, e-Novia, together with other early investors, funded Blubrake, which was also supported by a grant from the European Commission's Executive Agency for Small and Medium-sized Enterprises. At the end of 2020, the company raised EUR 5.2 million from private investors to finance growth. Due diligence from investors pointed to the importance of the proprietary solution, its protection with IP rights and the existence of a technical roadmap that would be matched by adequate, parallel patent protection. The newly raised funds were used to develop a second generation of ABS, miniaturised and fully integrated into the bike frame, which were launched on the market in Q4 2021.

IP as part of the framework agreement between Polimi and Blubrake

Under a framework R&D agreement, e-Novia and Polimi worked together to develop new technological products and companies. Regulating the relationship between Polimi and Blubrake before starting the collaboration research proved to be a crucial move as it reduced transaction costs and smoothed the process of IP generation. This is a key point, as many universities fail to effectively market technologies due to a lack of clarity on IP ownership or poor management of relationships with interested business parties.

One of the main advantages of the framework agreement between e-Novia and Polimi was that it regulated the ownership of the foreground inventions and ensured that the rights to file for patent protection belonged to the institutions and not to the single inventors involved in the research activities. While Italian patent law recognises the so-called "professors' privilege" when it comes to faculty-generated inventions, it also allows employers to own the patent rights when research funding comes from an external source. Individual researchers are consequently designated as inventors, but the patent rights are assigned to Polimi.

Under this arrangement, the patent application was filed in the name of both Blubrake and Polimi. Blubrake was not interested in being the sole applicant, as Polimi's name on the application added credibility and visibility. The technology transfer office (TTO) consented, as it too gained in visibility. For Blubrake, there is no risk that Polimi will share the technology with others or develop it in a different direction. There is an additional option for Blubrake to buy out Polimi's share of the patent ownership if required.

The same agreement acknowledged the company as an official spin-off of Polimi, a status which gave enormous advantages to the researchers involved. Under Italian law, academic professors and researchers, who are public servants, are permitted to become involved in companies and to engage in operative and executive roles while retaining their full-time position with their institution, but only in cases where the company itself is acknowledged as a spin-off.

When Blubrake became a spin-off company, the TTO managed jointly generated inventions and patents. Under the framework agreement between Polimi and Blubrake, it also managed the initial patent family's IP portfolio, but with Blubrake as licensee bearing the costs.

TAKEAWAY

COLLABORATION FRAMEWORK AGREEMENT

A well-defined collaboration framework agreement will smoothen the process of IP generation and its later use, reduce transaction costs and create incentives for all partners.

THE TECHNOLOGY TRANSFER OFFICE AT POLIMI

The TTO's core mission is to create economic impact at local, national and international level by enhancing and exploiting scientific and technological innovation. This is achieved by:

- seeking the most innovative research results
- using IP rights to increase the level of protection of the research
- increasing the valorisation and economic exploitation of the research results

The spin-off community is supported both by the TTO office and a university incubator known as PoliHub.

The TTO follows the spin-off and the associated IP protection issues and strategy from the start of the project. After the spin-off creation and accreditation, the IP rights owned by Polimi are licensed or assigned

to the new company under facilitated agreements. Polimi cannot directly take shares in the company. Typically, PoliHub takes an equity stake and also provides support through mentorship, entrepreneurship and acceleration programmes.

The recently established Poli360 – the Politecnico di Milano and 360 Capital SGR Venture Capital Fund - will help to support the development of entrepreneurial projects and stimulate collaboration with corporate partners in order to establish internationality and scalability – the basis of entrepreneurial success.

The TTO actively builds networks for the development of long-standing partnerships with other universities and research institutions and works closely with other TTOs and incubator associations such as NETVAL (the Italian TTO association) and PNI CUBE (the Italian Association of University Incubators).

The technology

The company develops and produces advanced mechatronic systems, focusing on braking and sensing applications for bicycles, in particular e-bikes and e-cargo bikes. Today, Blubrake is already producing and selling the second generation of an ABS system that integrates digital services, generating data that can be processed with AI engines to improve performance.

Blubrake provides the only “open-platform” ABS system powered by a mechatronic system currently available in the e-bike market. This can be fully integrated inside the bike frame and can drastically increase safety for all types of e-bike. The overall technology is both a hardware and a software system. The hardware includes sensing devices and actuators which allow the wheel to read the road and send a signal to the AI-powered system. The software includes AI that elaborates the signal and sends the controlled

Figure 1: Components of Blubrake's ABS control system



instructions to the braking unit. The actuator modulates the pressure in the front brake in order to guarantee smoother braking and avoid front wheel lock-up, which is a major cause of accidents when riding an e-bike.

The software component – the control system which responds in real time to the bike's behaviour – was developed within a long-standing collaboration with Polimi, regulated by long-term research contracts.

The main components of the integrated system are:

- the speed sensor and the phonic wheel, which are designed to measure the front wheel speed with high precision and in real time
- the main unit, which combines an electronic board that acts as the proprietary system's brain, powered by state-of-the-art AI architecture developed by the research team, with the ABS actuator, designed to continuously and instantly increase or reduce hydraulic pressure in the front brake
- the ABS human-machine interface (HMI) for driver control of the status

In the integrated system, the electronic board and the actuator are embedded within the bike frame. The system can be commercialised both through OEMs (bike manufacturers) and as an aftermarket solution (plug & play) that can be installed on existing bikes. It includes:

- the speed sensor and the phonic wheel
- an external ABS actuator and electronic board
- the ABS HMI

The market

Blubrake collected data using surveys conducted by major consulting companies. The data showed that 58% of accidents involving e-bikes happen while braking and 24% are related to braking. When people fall off their bikes, 39% of cases are caused by the front wheel locking and 25% by a loss of balance. As e-bikes can reach even higher speeds, this makes the braking issue even more serious. There was clearly a need for a market solution in the field of smart mobility. This helped to identify Blubrake's USP and create the business around it.

There is limited market competition in the field of ABS bike brakes. That said, those few competitors are big players. It took longer than expected for the technology to reach the market due to the testing process and the need to make it compatible with existing biking systems. The Bosch ABS, the main market competitor, is a closed solution that is mounted on the bike only in combination with other Bosch components and Magura braking systems. Blubrake offers

an open system and its solution can be adapted and integrated into any other bike system – and not just with a specific bike brand. This means that straight assignment of IP or exclusive licensing to third parties is not practical, as implementing the solution also means adapting the system to the bike's specifications. Therefore, interactions with the OEM are crucial for the technology to be adopted.

The market for e-bikes is booming, not least because of the different concepts of smart mobility triggered following COVID-19. In 2016, 98 000 e-bikes were sold in the European Union. Since then, sales have increased to over four million per year. According to estimates from the European Cyclist Federation, between 2018 and 2030 over 50 million e-bikes will be sold to a variety of different users: urban commuters, bike enthusiasts, families and so on.

Currently, the widespread need for smart mobility systems means that there is an extremely high level of interest in the technology in all global markets. The global e-bike market is valued at an estimated USD 18.2bn, and is expected to grow at an average annual rate of 5% until 2024. The Asia-Pacific area, with a value of some USD 13.5bn and around 33.7 million e-bikes sold, is the biggest market worldwide. However, it is characterised by the slowest growth rate and the lowest average price, with an estimated premium segment that amounts to only 4% of the total. Europe is the second market by size, valued at around USD 4.6bn, with some 2.9 million e-bikes sold. This is characterised by the highest average price and a growth rate above the world average, making it the most important market for Blubrake, with a 46% share of premium e-bikes (price above EUR 1 500). North America is still a relatively small market, but shows the highest growth.

Safety is one of the main inhibitors to accelerated market growth. Increasing high speed, the risk of safety systems failing, and low motor vehicle awareness of e-bikes all raise safety concerns. In this context, the strength of an e-bike manufacturer's brand alone does not drive customers' purchasing decisions. In fact, most cyclists are not even familiar with OEM brands. Instead, it is component quality and improved user experience that mostly drive their decision to buy a particular e-bike. Battery performance and brake reliability are the most relevant components. According to a survey by Brose Antriebstechnik of 200 respondents, 42% said that the braking system plays an important role when selecting and purchasing an e-bike.

Blubrake meets the market demand for braking systems by providing a solution that reduces the risk of front wheel lock-up, which causes the bike to roll over the rear wheel lift-off, which in turn causes the bike to skid in the event of sudden braking

The business model

Blubrake sells its ABS control systems to OEMs. At the same time, it is also a technology platform provider, supporting OEMs in adapting its technology solutions to specific needs and bike models.

Its open-ended ABS hardware and software system for e-bikes can be adopted by any OEM and any bike manufacturer. This makes it adaptable for use on any e-bike and renders it highly flexible and scalable in any market segment.

In a market dominated by major players such as Bosch, Brose, Yamaha and Shimano, the strategic value of patents is instrumental for market penetration and recognition for a newcomer such as Blubrake.

TAKEAWAY **IP BUSINESS MODELS**

IP protection is instrumental to many different business models. In the case of commercialisation of open-ended solutions IP allows to keep control of the technology also in the course of collaboration with others.

IP management at Blubrake

Consistent with the original DNA of the company, Blubrake is still very active in innovation and patenting. It is part of the managerial skills of its technical people to understand that the solutions developed can be a source of enormous competitive advantage and that such advantage should remain with the company through adequate forms of protection. “Design, develop and protect” is the formula for Blubrake’s patent management strategy.

As the provider of a braking system that is integrated within a complex object such as an e-bike, Blubrake relies on its patent portfolio to be recognised as a highly skilled and robust technology player and to reinforce its bargaining position in global supply chains with international partners.

TAKEAWAY **PATENT PROTECTION IS NOT JUST A ONE-OFF DECISION**

The alignment of technology development and patent protection is important as a company undergoes technology redesign and market customisation. Patent protection requires continuous management, rather than one-off decisions.

Awareness of the importance of patent protection within the company, its management and its alignment with the technological roadmap, and the support of a network of trusted IP professionals, allowed Blubrake to build a remarkable portfolio of high-quality patents.

Figure 2: Technology transfer timeline

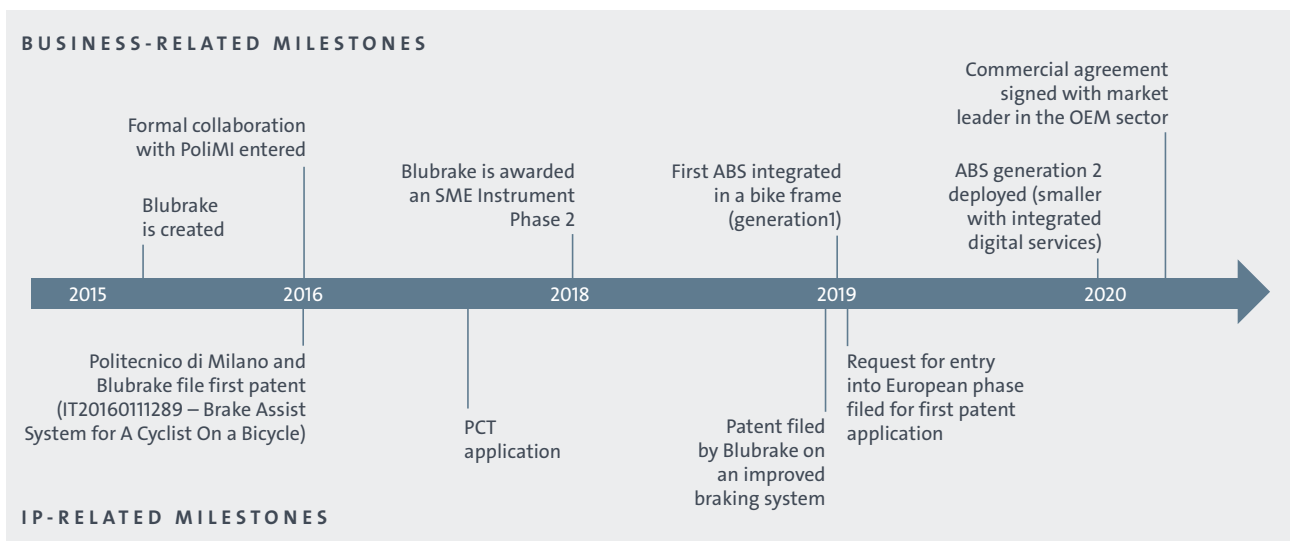


Table 1: Blubrake's patent portfolio

Patent number	Title	Priority date	Applicant
EP3310628B1	Brake assist system for a cyclist on a bicycle by a haptic feedback	19.6.2015	Blubrake
EP3380847B1	Device for determining the angular speed of a bicycle wheel and the pedalling cadence applied to the pedals of said bicycle	24.11.2015	Blubrake
EP3535169A1	Brake assist system for a cyclist on a bicycle	4.11.2016	Blubrake, Politecnico di Milano
EP3411285B1	System for assisting in driving a bicycle by sending a haptic feedback to a cyclist	4.2.2016	Blubrake
EP3717318A1	Adaptive brake assist system for a cyclist on a bicycle by an aptic feedback	27.11.2017	Blubrake

Some of the EP applications listed are still pending and no decision to grant has been taken. Granted patents may also undergo an opposition or appeal procedure, in accordance with the procedures laid down in the European Patent Convention, which could limit the scope of protection of the patent. All legal events are published in the European Patent Register and can be accessed via www.espacenet.com.

MAIN PLAYERS INVOLVED	SOURCE OF IP	TECH TRANSFER CATALYSTS	IP COMMERCIALISATION
	<p>Sergio Matteo Savaresi</p> <ul style="list-style-type: none"> > full professor of control systems at Polimi > co-founder of e-Novia > the team's principal investigator and now a company shareholder > worked for the spin-off company during its technology transfer transition stage while still retaining a full time position at the university <p>Politecnico di Milano (Polimi)</p> <ul style="list-style-type: none"> > an Italian public university which already had fundamental controlling technology before the creation of the spin-off. Here, the technology continued to be researched and adapted for the market after meeting e-Novia <p>Fabio Todeschini</p> <ul style="list-style-type: none"> > former PhD at Polimi, co-founder and now General Manager of Blubrake and board member 	<p>e-Novia</p> <ul style="list-style-type: none"> > founded in 2015 > a company builder and incubator made up of engineers and managers who scale up technologies by identifying untapped potential fields > identified a team from Savaresi's group within Polimi (end 2015) > identified the need in the market and the corresponding technology and created Blubrake > provided first financial aid <p>Polimi TTO</p> <ul style="list-style-type: none"> > the first contact for inventors > responsible for managing the IP procedures and the IP portfolio of the initial patent family 	<p>Blubrake spin-off</p> <ul style="list-style-type: none"> > founded in 2015 as a spin-off from Polimi within the e-Novia group to which identified technology was assigned > formed before the first patent application was filed > the co-owner and licensee of the ABS technology > provides "open-platform" ABS system currently available on the e-bike market > Awards and prizes: <ul style="list-style-type: none"> – Eurobike Winner in Bicycle Component category (2019) – Bicycle Brand Contest Winner (2019) – SME instrument phase 2 (2018) – Intesa San Paolo Innovation Center Award (2018) – Gaetano Marzotto Award (2017) > staff: 20 (mostly engineers) > turnover EUR 1 675 171 (2019) > key products/services: integrated ABS system for e-bikes > customers: Crescent, Bulls, Stromer (other non-disclosed OEMs)

Further technology transfer case studies can be found at epo.org/case-studies

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