

# Business Model and Wearables: What Convergence and Collaboration in the Area of Connected Objects and Clothing?

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## Abstract

The general context of our study is that of the emergence of an ecosystem of innovation and business in relation to IT in a world market in full restructuring. We studied the case of the fashion industry to determine how actors interact and how companies seize new business opportunities. Our qualitative research is based on an exploratory approach; an abductive method allows us to go back and forth between literature review, data analysis and interpretation. Traditional industries are subject to strong global competition, and we ask ourselves the following question: in the context of the 4th Industrial Revolution, how do the clothing and fashion industries remain competitive? Should they increase strategies for innovation, creativity, and the integration of new digital technologies? In short, our paper shows how firms are adopting new business models in a digital context. We found that the new business model is based on the use of various skills, the establishment of intersectoral cooperation (IT, design, textiles, health, etc.) and the search for innovations. These elements are at the heart of the strategy chosen to penetrate a niche market that of intelligent objects and garments. These processes are reflected in a dynamic of intersectoral convergence, which provides new avenues for innovation on the basis of new digital technologies.

## Keywords

Innovation, Ecosystem, Wearables, ICT, Fashion Industry, Cooperation

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## 1. Introduction

Contemporary capitalism is the herald of ruptures manifesting itself “at the

moments when a type of society, a mode of production, enters into crisis and begins its period of transition” [1] [Our translation: p. 4]. The problem of industrial reorganization, moving from “the old business model based on dominant domestic production” [2] [Our translation: p. 22], is a global phenomenon affecting all industrialized countries. This crisis testifies to the decline of traditional industries, putting western industries facing contemporary problems of renewal of the value chain. The integration of innovation and creativity in new business models seems to be a sine qua non for SME’s competitiveness on a national and international level.

It is against this backdrop of globalization marked by an economy of uncertainty [3] that Quebec’s industries, especially the textile and fashion industry, have lost many jobs, especially in the field of production. These industries thus have to envisage their transition. Moreover, the 4th Industrial Revolution invites us to rethink the industrial structures and business models of companies, and encourages them to adopt new digital technologies. This is why R & D and innovation research activities are increasingly favored. Moreover, to maintain its competitiveness Québec must encourage innovation and the development of new materials and garments with higher added value [4] [Our translation: p. 26]. This changes the usual modes of cooperation [5] and there is a transformation of relationships between key players in different ecosystems (creative sectors: software; fashion; technology and digital industries; clothing and textiles, etc.). These sectors eventually interpenetrate to find new niches and solutions. To accompany these changes, many players intervene: public and private; governmental and municipal actors, intermediate bodies, universities, technology transfer centers, etc. They develop collaborations around common projects, although sometimes these are insufficient. This has an impact on ways of working and supporting innovation in order for industries to strengthen niche markets and distinguish themselves in the global market.

As part of two successive studies on the fashion industry and its transformation based on qualitative data (2009-14: 48 interviews, 2015-16: 30 interviews), we analyzed the process of implementing innovations to face international competition. Following the recommendations of the local business community, some Quebec companies are committed to the development of new niches. In our paper, we explore how a creative and innovative niche, that of the wearables (portable objects or clothing) emerges. With the support of political and economic circles, this market mobilizes various players in the fashion industry, including technologies and textiles, confirming the need to engage in inter-industry exchanges.

Therefore, the wearable object is approached in connection with the environment in which it unfolds. In other words, it develops within an emerging ecosystem of innovation, encompassing other ecosystems, where entrepreneurs develop business models for the production of intelligent clothing amongst others (Public policies and the role of intermediary organizations in supporting businesses was studied in other works [6]).

## 2. Industrial Changes in the Digital Economy

The garment and textile industries have undergone significant changes in North America, notably following the adoption of free trade agreements in 2005. Among the major changes were the elimination of quotas on imports of textiles and clothing, the abolition of quotas, the establishment of a highly developed free trade area with China, imports from so-called low-wage countries and the relocation of manufacturing industry.

As a result, industries must rely on new market strategies to reposition themselves [2] [4]. Given the irreversible delocalisation of production and the growing imports of clothing from low-wage countries, governments advise firms to maintain high value-added design activities and increase the value of their products [4]. For example,

“The new definition of the industry adopted by the CRHIV, as well as those adopted by the Canadian provinces and the industrialized countries, serves to redraw the perimeter of the industry, not only by looking at the places where the factories are located, but also by analyzing the nature of value-added operations or activities carried out in Canada” [2] [Our translation: p. 29].

Creativity and innovation, ensured by the white collar workers of the industry, become major values; they ensure a renewal that allows them to emerge from the crisis and sectoral dead-ends in order to face competition. This is why the apparel industry has become a service industry [2], in which the knowledge-based economy finds its place. It must take into account its integration into a wider field where several industries are intertwined, especially with the rise of the digital economy.

### The Rise of the Digital Economy

In an uncertain global economic environment, the digital economy participates in the advent of the 4th Industrial Revolution [7]. By sketching a technological turn (the Internet of objects, Big Data, etc.), this new economy begins an era of rupture with the paradigms of the past, even an economic and social revolution [8] [9]: “The World Economic Forum describes the fourth industrial revolution as a tsunami of technological advances that will transform our economy” [10]. Indeed, by the speed of change, this revolution is disrupting all Western and emerging countries. The urgency of adaptation to the 4th revolution was also the theme of the 45th Davos Annual Economic Forum, in Switzerland in January 2016 (Davos is an international gathering bringing together a large number of actors (companies, politicians, intellectuals, journalists) :

“After the first revolution (advent of the steam engine), the second (electricity, assembly line), the third (electronics, robotics), comes the fourth revolution, which combines several factors at work, such as the Internet of objects or Megadata (big data) to transform the economy” [9] [Our transla-

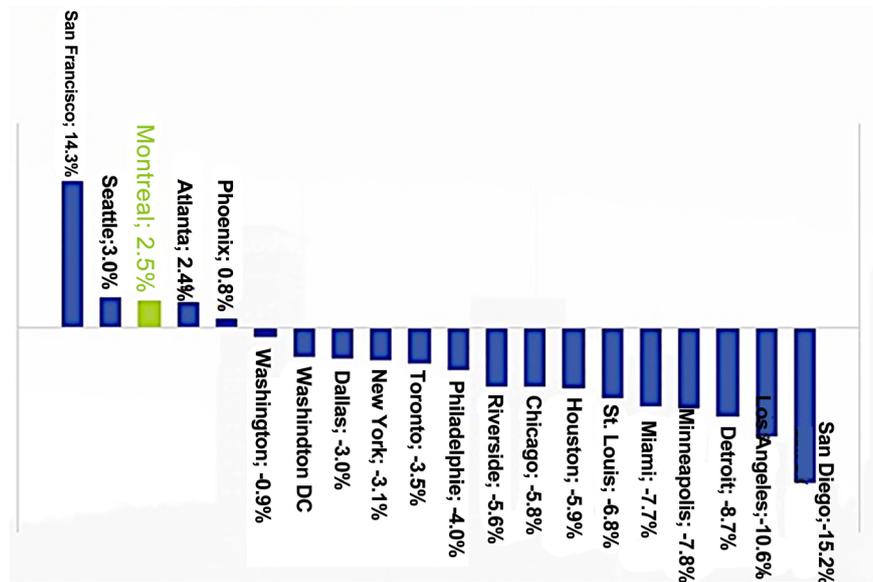
tion].

The challenge lies in the democratization of innovation, but we need to look at the mechanisms of its acceleration in the context of globalization and competition [8]. With the use of new technologies (robotics, 3D printing, the Internet of objects, Big Data, platforms, applications, etc.), new entrepreneurial practices, individual or collective, arise. They highlight two main trends: just-in-time and adaptive technology. First, when the need arises, and the response must be fast, secondly, the trend is that the products can be adapted to the needs of a consumer, a tendency to rapidly prototype, innovate and meet increasingly individualized needs [8].

Unable to ignore these major technological changes, as of 2010, Germany set up the project Industry 4.0 project, which offers an organizational plan called “smart or intelligent factories” which revises production throughout the whole value chain [11]. Other countries are following the trend, and are thinking about the new industrial orientations and strategic organizations to be put in place. This is the case of the SME 2.0 program initiated by the Government of Québec [12].

A global Montreal ecosystem involving nine industrial clusters is proposed by a recent report on the digital creativity industries (2016) as shown in the figure below. “The whole is protean and moving” [13] [Our translation: p.17] and the complex collaborations of multiple actors that result from it vary from one field to another, from one project to another, suggesting that this type of inter-ecosystem cooperation will multiply or be increasingly important. We can see that companies and creators “navigate from one pole to another in this ecosystem, and several subsectors belong to parallel systems” [13] [Our translation: p.17].

The ICT sector generates jobs (92,377 jobs in the metropolis) and Greater Montréal ranks 3rd among the twenty largest cities in North America for growth in ICT employment [14]. The IT services sector is the most represented with a concentration of half the jobs and 75% of the ICT establishments located in the region. It includes software developers, IT services and multimedia [14] (p. 4). The ICT industry has become an important driver of economic growth and over the past decade we have seen growth twice as high as that observed in the economy as a whole [14] (p. 6). In university research, in these fields, Greater Montréal is at the top of the ranking of Canadian metropolitan areas with funds in excess of \$ 6 billion. Large foreign companies are based in Montreal, for example Ubisoft (France, video games), Autodesk (United States, 2D and 3D software); Covidien (USA, ICT manufacturer for the medical sector), etc. The Information and Communications Technologies (ICT) cluster, called Techno-Montréal, has enjoyed a dynamic presence since 2007 and is helping to position the City of Montréal as a global digital capital by bringing together players from various public and private sectors as shown in the **Figure 1**. The following table shows the growth in ICT employment in Montreal, in comparison with other North American cities.



**Figure 1.** Growth in ICT employment (%) [14] (p. 3).

To summarize the general context of our study and that of the fashion sector of wearables in particular are characterized: firstly, by the globalization of markets subjecting traditional industries to strong global competition; secondly, by the advent of the 4th industrial revolution, the digital revolution, with the search for innovation and creativity; and thirdly, by a strong civic, private and public, national and local mobilization, in which various ecosystems composed of industrial, associative, educational/academic and political actors work together. This collaborative work allows us to develop adaptation strategies in order to distinguish ourselves on the markets by innovating and integrating new digital practices.

### 3. Problematics

The Internet of objects will play a major role in the future and the development of new business models is “a global market that will affect all industries and in which investments are estimated at at least six trillion US dollars over the next five years” [15] [Our translation: p. 7]. We are interested in the niche market of wearables, *i.e.* connected objects and intelligent garments. We find that although this market is growing rapidly, it remains an emerging market that mobilizes several industries and actors in the activities of R&D with a strong need for risk financing and support:

“SFIT [Smart Fabrics and Interactive Textile] wearable systems is a fascinating area with great socioeconomic and industrial potential combining, advanced material processing, microelectronics, sensors, nanotechnologies, telecommunication, informatics, biochemistry, and medicine. Innovation in ‘smart textile’ is often considered as already achieved, while in this very traditional sector (textile) the process is just at the beginning” [16] (p. 5272).

While many industries are increasingly affected by these technological changes leading to intersectoral collaborations, the actual boundaries of activities within industries and markets become blurred.

Growth in the sub-sectors of software design and publishing being largely favored in Quebec, these are the same subsectors that we find in the business development of new start-ups, in terms of innovative services or products [17]. There are new business models in the ecosystem of technological innovations, and here innovation is a process in which knowledge transfers, cross-fertilization and collaborations between various sectors are numerous (ICT, textile, garment, health, sport, well-being, etc.). Therefore, the objective of our paper is to show how firms are adopting new business models adapted to the new digital context. We will see that the business model is based on the use of various skills, the establishment of intersectoral cooperation (IT, design, textile, health, etc.) and the constant search for innovations. These elements are at the heart of the strategy chosen to penetrate a niche market, that of intelligent objects and garments, in a dynamic of convergence of sectors.

#### **4. Conceptual Framework**

For this article, we mobilize the concept of business model and the convergence theory to describe the operation of new firms focusing on technological innovation of products using directly or indirectly internet. As for the business model concept:

“The BM concept refers to the company’s position on the value chain and the nature of the partnerships it develops, but also to the degree of hybridization of business activity, financing methods and their development trajectories” [18] [Our translation: p. 4].

The rise of web 2.0, digital technologies, the emergence of broadband, but also smart phones and applications, IoT, etc., brings about a technological convergence that “leads to the breaking down of traditional barriers between the computer, telecoms and audiovisual industries” [18] [Our translation: p. 5], and also as we see with other manufacturing industries: clothing, textiles, etc. This is why we are witnessing new alliances aimed at creating value, or even a migration of value:

“The transfer of opportunities for growth, profit and value creation for shareholders of a company, sector or industry to other companies, industries or sectors (Slitowski 1996; Hoarau, 2003). The migration of value intervenes when customer priorities change, when there are technological innovations or changes in the rules of the competitive game that businesses have not taken into account by changing their model of development or architecture. The migration of value takes place at different levels: between industries or sectors, between companies in the same industry and within a company, between development models associated with various strategic business segments or areas of activity” [18] [Our translation: p. 6].

This is why, in such a context of technological upheaval, inter-firm, inter-sectoral and inter-industrial collaborations are very important. This is what we have observed by analyzing the development of a business ecosystem of technological and digital innovations in the wearables market. This becomes more and more common: “Today, integrating external partners into the new product or service development process has become almost a routine activity for many organizations” [19] [Our translation: p. 89]. From now on, these collaborations make it possible to create “new opportunities offered by the convergence of technologies, the phenomena of value migration and the development of alliances and partnerships, in a search to reduce costs and risks” [18] [Our translation: p. 8].

The theory of convergence makes it possible to define the business model on which today new firms are developing intelligent products whatever the sector targeted: well-being, leisure, health, etc. “The term convergence refers to the aggregation of intangible services from different sectors within a customer-centric offering” [20] [Our translation: p. 78]. This dynamic is accompanied by a natural movement of sectors such as IT, telecoms and media, converging into same technologies but also developing links with other sectors and industries, as we will see in this article. Indeed, more and more, “the dematerialization of content, Internet, broadband today participate in this evolution” [20] [Our translation: p. 78]. Convergence is based on a paradox that emphasizes the multiple while it is based on uniqueness. Even if the users perform multiple actions for example on the Internet (surfing, watching a video, telephoning), one uses the same device: smartphone, computer, etc.

“Convergence is therefore a current of unification which should make it possible within ten years to have access to any type of content (from the telephone call to the digital film) and services (lotto, bank account...) in an undifferentiated way whatever the terminal (Telephone, TV, refrigerator), the network (ADSL, UMTS complementary to Wi-Fi, etc.) and the nature of the use (at home or in a mobility situation). And it is only when convergence spreads beyond the technology, media and telecom (TMT) sectors that we can speak of success” [20] [Our translation: p. 78].

There are three impacts of convergence, in terms of economic models, boundaries, and management modes which will translate into clear impacts within firms [20].

Chesbrough (2003) observes that today, in such a context of technological upheaval and great competition, companies must develop an open attitude and numerous collaborations (with universities, research centers, private and public partners, organizations, etc.) [21]. In their search for innovation and their R&D activities, IT companies alone cannot have all the knowledge and therefore must either subcontract to access expertise collaborate with other actors to redesign their products. This makes it possible to better respond to market demands and satisfy the needs of target customers; they do this by interacting and distin-

guishing themselves through the provision of new services.

## 5. Methodology

Our research is exploratory because of the novelty of the field and we opted for a qualitative study [22] [23], empirical with abductive method [24] [25] [26]. This makes it possible to go back and forth between fieldwork and theory [27] [28], and to question theory with fieldwork results, and then again to question fieldwork observations with theory.

We began with participatory observations in the IT, garment and textile sectors, which enabled us to clearly identify the key players in the ecosystem under study. We have attended several local events related to our research to get an idea of the collaborations taking place between industries, companies, organizations and other actors, but also to make contacts and clarify our research questions. For example, on October 1st, 2015, we attended the first edition of Wear It Smart, in Montreal, a meeting bringing together speakers to discuss the Wearables market. This event was organized by Vestechpro<sup>1</sup>, the Collegial Center for the Transfer of Clothing Technology (CCTT) in collaboration with the Montreal Fashion Bureau<sup>2</sup> (MFB) and other partners. Along with these observations, we maintained a continuous watch on the internet (different social media, focus groups, press reviews, etc.) and we continued to participate in meaningful local events in October and November 2016 (Wear it Smart, e-health<sup>3</sup>, Mutek: Fashion Tech<sup>4</sup>, etc.).

We created a representative sample of those involved in the market for “wearables” and smart clothes with a sampling technique [29]. We built two interview guides: one for companies and the other for private/public organizations and policy makers. We conducted semi-structured interviews according to the methodology of comprehensive interviewing [27] with 30 representative actors (duration: 1h to 2h) between September 2015 and February 2016. All the interviews were recorded and transcribed. The following **Table 1** shows the distribution and codification of the interviews conducted.

## 6. Results

In the remainder of this article, we present the cases of companies that have combined information technology, wearables (garment or “portable” element with IT) and clothing. Some observations of intermediary actors make it possible to specify the developments observed. A vast ecosystem of digital and technological innovation, including intelligent clothing for different sectors (health,

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<sup>1</sup>Vestechpro is Collegial Center for the Transfer of Apparel Technology (CCTT), affiliated with Cegep Marie-Victorin and its FashionSchool: <https://vestechpro.com/en/>.

<sup>2</sup>Montréal Fashion Bureau (MFB):

[http://ville.montreal.qc.ca/portal/page?\\_pageid=6297,50629558&\\_dad=portal&\\_schema=PORTAL](http://ville.montreal.qc.ca/portal/page?_pageid=6297,50629558&_dad=portal&_schema=PORTAL).

<sup>3</sup>The future of health, 7 Oct. 2016:

<http://www.technomontreal.com/en/news-center/events/the-future-of-health-impact-of-revolution-30>.

<sup>4</sup>Fashion Tech, Mutek 9 Nov. 2016:

<http://www.mutek.org/en/archives/events/2016/1265-tech-a-porter-art-industrie-la-fashion-tech>.

**Table 1.** Breakdown of interviews and codification.

<b>1. Universities/College</b> (5 interviews/+ 2 interviews distributed in companies and universities)			
Education (5)	Interview 1.1 (Professor/Research Center)	Interview 1.2.1 (Professor, Researcher, Consultant)	Interview 1.3.1 (Researcher, Consultant)
	Interview 1.6 (Professor/Research Chair)	Interview 1.7 (Professor, Researcher, Consultant)	
Secondary School (2)	Interview 1.4 (Clothing Technology Research Center)	Interview 1.5 (Succession Support, Fashion)	
<b>2. Companies</b> (8 interviews)			
Québec	Interview 2.1 (Startup, 3D)	Interview 2.5 (Garment Production)	Interview 2.3.1 (Consultation on Wearables)
	Interview 2.4 (Technical Clothing)	Interview 2.7 [E1] (Intelligent Clothing)	Interview 2.2.1 [E2] (Intelligent Clothing)
Europe	Interview 2.6 (Technical Clothing, Spain/Switzerland)	Interview 2.9 [E3.1; E3.2] (Communicating Objects, France)	
<b>3. Organizations</b> (7 interviews)			
OBNL	Interview 3.1 (Fashion Sector)	Interview 3.2 (Digital Industry)	Interview 3.3 (Business Monitoring)
Transfer Center	Interview 3.4 (Textile)	Interview 3.5 (Digital)	Interview 3.6 (Clothing)
Other	Interview 3.7 (Games, IT)		
<b>4. Public administrations</b> (4 Interviews)			
Municipal	Interview 4.1 (Fashion Promotion)		
Government	Interview 4.2 (Sector: Clothing)	Interview 4.3 (Sector: Textile)	Interview 4.4 (Sector: Digital)
<b>5. Network of open innovation</b> (5 interviews, 3 structures: Companies, network, NPO)			
3 Respondents	Interview 5.1.1	Interview 5.2	Interview 5.5 (Exchange of E-mails for Complementary Information)
	Interview 5.1.2	Interview 5.3	
	Interview 5.1.3 (Audio)	Interview 5.4 (Videos)	
<b>6. Media</b> (1)			
	Interview 6.1 (Network on Wearables, France)		

surveillance, gerontology, sport, etc.), encourages several actors to co-operate (clothing/IT, public/private, etc.). In the era of Web 2.0 and the rise of new technologies, firms must adapt their business model to structural transformations just as they must anticipate market trends to develop.

Leveraging niche products and product innovation, the innovative company must mobilize different types of expertise as we will see in the analysis. Let us begin by introducing the context of the ecosystem as it is presented by the actors we interviewed.

## 6.1. Business Context

Montréal, renowned for the influence of these creative industries, its digital creativity, contributes to the positioning of new business models.

*“So Quebec was actually an amazing place for (our) shirts to happen because that expertise is there. But textile expertise, all of the new interests in electronic textiles and biometric textiles, as well as a focus on the cultural industries in terms of new technology. You know, obviously companies like Ubisoft etc. are amazing examples. And there is this climate of design. Montreal is one of the UNESCO cities of design. There is a long tradition of interest in cultural industries.”* [Interview 2.2.1]

There are also sectoral issues relating to the intelligent biometric textile niche that would allow the textile industry in Quebec to be renewed.

*“So France, Finland, just like Quebec has a long history of textile industry, and a lot of the governments in those three countries specifically see the benefit of using that expertise, that historical expertise, to reorient the industry to work with more technical textiles and technical garment production. So, both at the university, at Concordia University and at OMSignal, you know, we’ve benefit it from very interesting government programs that want to reinvigorate the textile and garment industry in Quebec, by giving grants and other kinds of subsidies in this sector.”* [Interview 2.2.1]

- **Innovation and market niches**

Technological innovation in clothing is compared by one interviewee with other innovations which, in the history of fashion, seemed revolutionary. This person mentions the example of the zipper:

*“In the 1920s a zipper had to cost 2 dollars, a lot of money at the time, when today it costs only a few cents and you don’t think about it any more... It was a revolution because before the zipper, how could you close a garment?”* [Interview 2.7]

As a general rule, innovation

*“[It] is to make new advances in science and technology and then turn them into products that meet new market needs... There are many ways to innovate, we can innovate in technology or lower prices but also with a new business model... innovation is also finding new ways to bring products, competitive services to the market”* [Interview 2.7].

Creativity is linked to innovation, as is explained by the Montreal Company [E1].

*“Innovation happens on a daily basis, and every person who works in research and development or design is trying very hard to encourage people to imagine new solutions, to be creative in these solutions and then not necessarily only to make innovations but to make creations. I believe that*

*most people who work in the companies here have creative jobs... Someone has to write software, there are a million ways to write software that meets a need, it is sm extremely job” [Interview 2.7].*

An actor working in R & D activities related his vision of innovation: *“Innovation usually comes with a capacity to go beyond the initial performance of a technology, a machinery etc. It is when you exceed this... So it’s in the know how” [Interview 3.4].*

A Montreal-based manufacturer of smart clothes explains how new technologies have allowed it to consider this.

*“We consider that the origin of the product is the Smartphone and the appearance of the App-store (or Play-Store in Android) in 2008. Before 2008, it was complicated to write software for cell phones. Before the App-store, to deploy a software solution on the phone, you had to have agreements with each of the service providers. Let’s say if we wrote a game for phones, we had to go to. Bell Canada then sign a contract, then they we were not available at Rogers, we were not with Videotron... You had to go one by one throughout the world! With the App-store suddenly it was a way to distribute mobile software internationally in 80 countries and it was not possible to do that before [...]. Our garment has been designed to work with smartphones; our clothing, it is a network, it is connected to the internet through the gateway as smartphone and then it uses the smart-phone as a software interface for personal clothing. The person wears a garment, the clothing is talking on the phone [...]. It is compatible with the Smart Watch, Apple Watch, etc., but still via telephone, these watches-there are phone accessories [...]. We can see our clothing as an accessory...”[Interview 2.7]*

New technologies, Web 2.0, the new smart objects, part of the growth of the market of wearable technologies, and other innovations are related to other objects such as clothing, for example. Moreover, *“it is believed that the clothes in the future will increasingly be connected. It will happen in a certain order and not everyone will adopt this overnight” [Interview 2.7].* Consumers will finally think: *“no need to connect a device to charge batteries, eventually they will think that it is part of the garment” [Interview 2.7].*

Future markets for technological innovations applied to clothing or textiles, or other media, will focus on innovations in Biotechnology, in intelligent sensors, etc., offering health solutions, gerontology products, etc. For example, the biotextiles are now a *“Material of the Future” [Interview 2.3.1], “health will be a huge sector... People will become increasingly older and we do not really have resources to accompany them at all times so we will have to develop interfaces, intelligent systems to solve this issue” [Interview 2.3.1].* Furthermore, the automobile industry will also be affected by these transformations.

*“Automobiles and aircraft of the future will be made with the integrated circuits in textiles adapted to different modes of transportation because it is*

*lighter, it's flexible, it can last longer, it can autoprogrammed, one could program different materials to transform themselves*" [2.3.1 Interview].

- **Collaboration**

This changing and complex ecosystem requires working through projects, thus subjecting participants to uncertainty, and this requires constant adaptation of professionals and entrepreneurs, encouraging collaboration in order to reduce uncertainty.

*"We as entrepreneurs we do not develop a product, we create an organization that generates products, it is far more complex. It is always changing, changing all the time and we are never the same organization six months later [...]. We must constantly evolve, and that influences the development of staff, we want people to become people that will still be needed in six months, in twelve months... We would like to promote it internally and then keep that special expertise that we developed and cohesion in the team"* [Interview 2.7].

Furthermore, collaboration between key players and groups concerned is not always easy, weaknesses are recorded in strengthening the ecosystem in Québec. An actor speaks of his experiences as he tries to develop relations with a group working in the fields of garment, IT and smart textiles [M.1].

*"We met with [M.1, they came to us, they took pictures of our equipment and they purchased the same equipment [...]. They took all the numbers of machines and bought the same! There is unfortunately no cooperation [collaborative failure]! I do not know if they know how to use ... In addition, if they had asked us, we would have proposed other machines because it would have been complementary, because we know what we don't have... They wanted to make it more mechanized than manual, and this is correct, but for we could have cooperated better"* [Interview 3.4].

A French speaker at the Wear It Smart event (2016), a head of a textile R & D center, emphasized the need to develop cooperation to strengthen the textile and clothing industry, despite the fact that people tend to work in silos.

*"Individuals are working in silos, whereas if we want to produce innovation, we need all these skills to come together! We need chemists working with designers, electricians, engineers, computer scientists, textile manufacturers... The ideal profile does not exist. [To] get to have an innovative curriculum: [there is an] issue of training, learning to work together in putting on the table the skills of each person, a multidisciplinary and multicultural approach"* [Wear It Smart, 2016<sup>5</sup>].

A development partner supporting innovation in several companies and sectors talked about team collaboration, which requires sustained work and must follow several steps.

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<sup>5</sup>Wear it smart 2016, Montréal: <https://www.wearitsmartconf.com/single-post/2016/07/11/wis2016>.

*“If companies come to us, it is because they want our help. When working alone in our laboratory, we can not do this. We need to know the realities of the business to manage these transfers and we need to take into account the realities... and business needs evolve in a two year project. If we said at the beginning: These are the expectations, but two years later we say what are the expectations? In general, they are the same... But there was a process of innovation that brought information, developments that brought changes and we do not always achieve the result we wanted, but we reach an outcome, that’s for sure!” [Interview 3.4].*

## 6.2. New Business Models: IT, New Technologies and Wearables

Several start-ups in Montreal develop business plans using new technologies, the internet, but also services using 3D technology (online ordering of customized shoes and clothes). Some are still in their infancy, so not strong enough in the market but at least two of them enjoy an international reputation in the niche of smartclothing. We present these two cases here.

### • *Company No 1*

The first company [EI] is an “innovative company with integrated development” [Interview 2.7], which was created in 2006 by two engineers (*biomedical engineering, signal processing...*). They developed a smart garment with embedded sensors, providing a new experience to consumers: a “*biometric sweater*” dealing with “*personal health information*”, “*a product for human health [which] will interact with a real human body*” [Interview 2.7]. This garment allows management of health and well-being (sleep recovery measure, heart rate, breathing, step counter, calories burned, physical activity monitoring, etc.). Its innovation is based on its business model: “*an innovation has been created, driven by a vision of what health management should be*” [Interview 2.7].

However, the company believes that this remains “*a first generation product*” [Interview 2.7] which is brought to improve. This is why the company has plans to incorporate the technology into different types of clothing “*[without] adding a lot of production cost for clothes*” [Interview 2.7]. Moreover, it is important to take into account “*the technology ecosystem in which it operates: telephones, internet, computer, social networks, e-mails, etc.*” [Interview 2.7]. The ready-to-wear technology meets

*“[A] growing need for new tools to measure health, real life [...], to allow people to remain functional but also to continue to be measured at home, at work, in environments that are not traditional clinical settings... So we can know how a person is active in the day, does his training, his recovery, [...] we can have information on how you sleep at night, on the effectiveness of your sleep [...]. It’s working with people with special health conditions that need to manage [...] chronic diseases” [Interview 2.7].*

In its early days the company developed many R & D activities in cooperation with many partners and for various products.

*“We did a lot of research in medical engineering, and made a lot of R & D at all levels, clothing, electronics, etc. Working with universities, private companies doing research... In fact, it is an extremely complex network that includes thousands of agents who are mostly very technologically advanced and in R & D [...]. We work with companies that develop software for health, for sports, sports teams, management of athletes for example, and working with hundreds of people doing health research in fifteen countries” [Interview 2.7].*

R & D activities benefit from several industrial aids and supports (in aerospace, security, etc.) and also support from government programs.

*“We had to deal with so many actors [...]. With government departments, local financing centers, etc. For example, we received NRC research grants (the National Research Council); Economic Development Canada; Central Canada Development; several Centres of Technology Transfer; several universities... In general, the Natural Sciences and Engineering Research Council (NSERC) of Canada supported such partnerships; tax credits for research and development; Investissement Québec... Contests, grants, scholarships [...]. In some cases it is grants, in other cases loans, or it is people who helped us make updates in relation to other companies, researchers... We have several types of relationship and activities... We had to go seek support from many organizations to develop the project but I think we had a beautiful project, that’s why we had so much support” [Interview 2.7].*

Due to the complexity of the product, the company collaborates with experts from different sectors and set up a multidisciplinary team to have “*expertise in electronics, software, biomedical, textile, clothing and financial skills, marketing, marketing innovation, e-commerce*” [Interview 2.7]. This diversity of expertise requires sustained management of the various professionals working on the same project: “*people are asked to have it all in their heads every time they work on the product*” [Interview 2.7].

*“It straddles several areas. We make a garment, but that is a digital technology, so electronics, computer, and then connected to health. So it straddles the software, clothing and the health sector... We work with people in cardiology, heart disease, respiratory disease, sleep disorder...” [Interview 2.7]*

Various actors are mobilized for the development and commercialization of the product (industrial, professional, and public...)

*“We looked for people who had experience in traditional clothing, we have in-house people. Designers were hired to make prototypes, we worked with Vestechpro who made a very important contribution in the product in terms of expertise to move from prototyping to the stage of commercial production... We looked for people who had experience in sportswear. Same for the factories, we make clothes that are close to the body; what is comparable to that today is the sportswear, you know the spandex, the un-*

*derwear, lingerie, swimwear, this field of expertise... So we need all the expertise” [Interview 2.7].*

Finding the local people with these skills, the company developed long term relationships with subcontractors although initially it was necessary to train them for these new products and improve production methods. This now ensures its production line and sub-contracting. Moreover, entrepreneurs have to “*constantly invent new manufacturing methods*”, if “*the plant was 12 time zones away, it would be extremely expensive to maintain the innovation cycle*”. This is why the company prefers to “*have higher unit costs but keep the production lines within driving distance from Montreal*” [Interview 2.7].

*“There is no factory in the world besides ours that masters all the manufacturing steps because we had to develop it in partnership with our factories. So it took a lot of investment to develop. And it’s the same problem for all start-ups. They need to start production with manufacturers who want to do smart clothing but who have never done this and most of the time they have zero experience in intelligent clothing. We visited several factories, we did tests in several plants, and then finally, we made decisions” [Interview 2.7].*

Once the prototype is finalized, these companies rapidly move to an international distribution, thanks to the tools offered by Web 2.0 (media and marketing). Company [EI] is developing partnerships with retailers and representatives from different countries.

*“We have more than 80% of our sales outside of Canada. We are distributed in Asia, Australia, but it is the United States and Europe mainly [...]. Two years ago we developed in North America first and then [we developed] internationally... especially we made sales on our website, we are at Best Buy Canada, Amazon in the US, Amazon-premium... We have a few retailers in Australia, the Middle East, France, no physical retailers in Quebec! Here, we mainly do online sales and direct sales. Then we have a network of representatives and salespeople in Europe, Asia, the Middle East [...]. We have a commercial presence in 10 - 15 cities in the world” [Interview 2.7].*

When a market is geographically remote, regardless of the company, the client support is done online: “*if anyone has any problems, they can call us and we can, with permission, see their information and support them. So we have visibility*” [Interview 2.7].

Because these new products offer an unprecedented digital experience, they’re new, fun and creative, they need to be publicized (newspapers and specialized sites, blogs, social networks...), which encourages companies to be proactive on Web 2.0, social media, with e-marketing, e-commerce and sometimes the design or maintenance of the website. As noted by the company No 1:

*“We have a good presence in social media. This is information, education, customer relations, there’s something happening almost every day, around*

*the world. We try to list the events that are happen, with people who do extraordinary things in our social media which facilitates access to information for the people who are interested... When we have new customers coming we try to identify their sources, where they come from, if they are from Twitter, Facebook or Lindkedin? All social media work for us but it depends on the sector: Facebook will be rather for consumers, Lindkedin, more professional, YouTube is more to put our videos; Twitter, it is the influencers that are there, journalists, speakers, communications people” [Interview 2.7].*

- **Company No 2**

The second Montreal firm [E2] is associated with a designer, scholar and researcher for the development of an intelligent garment, with biometric chip, which uses sensors in knitted textiles (for mobile health, welfare and sport).

*“The first shirt that we’ve develop is a male sports shirt, so it’s target specifically at fitness, performance for a male athlete and it integrate sensors [...]. The shirt is knitted, so it’s basically like a compression shirt, so it has a lot of benefits as well in terms of helping with your posture, helping you pay attention to how you are holding your body and your breathing. It’s also antibacterial, etc. But basically through sensing your biometric signals, so your full heart signal and your breathing as well as your movements, etc.” [Interview 2.2.1]*

The company also works with a multidisciplinary team and stresses the importance of the textile expertise:

*“Our first products are really focused on the engineering of the textile and the development of new types of textiles. We do not position ourselves as a fashion company; it is why we partnered with fashion companies [...] Ralph Lauren is our first partnership and they have the vision of fashion, design” [Interview 2.2.1].*

Cooperation with Ralph Lauren for enterprise visibility leads to the creation of a Tech Polo. The designer has been involved for four years in textile design and R & D.

*“I’ve been involved since the beginning so almost four years now in developing the core technologies for integrating the sensing and also the connectivity in the shirts themselves by knitting specifically with different kinds of fibers, so we integrate functional fibers, silver coated fibers together with nylon, polyester etc., to put the sensors and the whole circuitry, everything directly in the shirts themselves” [Interview 2.2.1].*

In this case, the explosion of new technologies and communication facilities, connectivity (WiFi, Bluetooth, applications, broadband Internet, etc.), and smart phones have all participated in the development of the business model:

*“We can help athletes improve their performance, train better, understand*

*how to push themselves without exhaustion to like really improve their physical condition. So you wear the shirt, but also there is an app, you know, it is functional on iPhone, so the shirt has all the sensors knitted in the textile itself, but then you connect a transmitter box basically, which also has a few sensors in it, it's snapped directly to the side, and through bluetooth it communicates all of the raw data to your phone, and there we have many different applications, many different sort of ways, that you can track yourself in real time, you can analyse yourself overtime, your performance, your biometrics, you can also train with virtual trainers based on your real time biometrics, so it's a very personal experience for training that gives you deep insights into your body, your performance, the kind of insight that was never possible before, because having these sensors directly on your body gives you much more complex signals than just getting your heart rate from the wrist"* [Interview 2.2.1].

The second product development stage was to the female market in sports and well-being.

*"The second step [...]. We are developing a women's product right now, which is also in the sports sector [...]. So the first step is really sports performance, understanding insights into the body training, the second step is to actually have much more predictive metrics"* [Interview 2.2.1].

Then a third market is targeted, that of the health sector, the future market, which requires certifications that are to obtain: *"It's not what we are focusing on right now for several reasons, one is that to get FDA approval for products, it's a very long process"* [Interview 2.2.1].

*"The last step, is what we called CARE, and that is a range of products that we foresee that we will have in the next five years, that will help you to predict, not just stress and performance and when you are most productive, but also perhaps some medical conditions that we should be aware of. [...] It can become this amazing source of knowledge for long term predictive care"* [Interview 2.2.1].

The company cooperates with specialized international consultants in electronic textiles: *"so we have experts who are trained in Finland, who are trained in France, who actually have already that knowledge in electronic textiles. So it's a high bread field of knowledge that already exists in several universities internationally"* [Interview 2.2.1]. This electronic expertise is important in the design and use of the product (processing and interpreting biometric signals from textile sensors). However, it is necessary that experts understand the world of textiles and apparel, knowledge and skills they acquire over the collaborations with partners.

*"They had to design their hardware in a very different way, in a very innovative way, because the textile sensors change overtime, as you move, as you*

*breathe, there are different constraints on the textile sensors compared with the traditional sensors that are just in plastic on your wrist” [Interview 2.2.1].*

Such cross-fertilization between disciplines of IT, textile, electronics, design, etc., to develop a specialized market, the smart clothes market, are new ventures and they can sometimes be difficult: *“I think because this is such a new field, electronic textiles and biometrics clothes that a lot of our collaborators in the company and also outside the company underestimate how difficult the textile aspect is” [Interview 2.2.1].*

*“We have to develop a lot of good communication to actually explain the intricacies and the level of details that is necessary to knit these wearable circuits boards in the most efficient way... We were doing presentations for each other, testing things, everybody in the company was testing the shirts, everybody was wearing them. So this kind of hands-on, tacit knowledge is crucial to really communicate some of this information” [Interview 2.2.1].*

The government supports the firms with various aids and partnerships are also important for R & D activities, as our interviewees mentioned.

- **Other cases**

Two other companies [E3.1, E3.2], were developed by the same contractor in France. They offer a hundred products at low price, representing an expanding and competitive business model in France. Communicating and connected products, associating an object *“of digital content such as a small private video” [Interview 2.9]: accessories, small bracelets, door-keys, necklace, locket for animals, etc. The contractor integrates into his objects the QR codes or NFC chips that he orders in China (silicone bracelets, metal, smart cards, etc.). These portable objects are used to store information that is to be communicated:*

*“Behind every code there is something, so that’s my computer platform... The first time you flash the QR-code you get to an activation page that allows you to say what you want to put on. And after you receive an email with a link that lets you change the content as many times as you want, you can put photos, videos, etc... With total control over what you share... (telephone numbers, status, hobbies, YouTube video, etc.” [Interview 2.9]*

In the NFC chip, for example *“you approach your phone to the chip and the information on the animal will appear on your phone” [Interview 2.9]. Manufactured in China, they are cheap products that are sold primarily on the internet or in collaboration with retailers from different sectors (Wines, Sephora, etc.). This French entrepreneur admits not having moved much physically but he benefits from technologies and resources found on the Internet.*

*“In China I went once, so it works well on the internet, by email, Skype sometimes... Why China? Because in terms of costs it is a ratio of 1 to 10 relative to the French cost, so it’s huge. How did I find them? On Ali-Baba,*

*I made inquiries, I selected a dozen vendors, I requested samples, I sorted them out because there are suppliers who are not very reliable, and then at some point, I went to meet physically with two or three suppliers, to make sure... Alibaba.com is a marketplace that lists all vendors, all Chinese manufacturers. This is one of the largest companies in the world” [Interview 2.9].*

To communicate these objects need to go through a connection to applications from a smart cell phone or a computer. They are different from the connected objects themselves, which require continual capture of information which is then sent on the web:

*“For example, there are bracelets that are connected to constantly analyze your pulse, pressure, etc., and they send these informations permanently to a smart phone. This can be very sharp. Me, it is not what I do! That’s very expensive and it is very complex. I am working with passive objects, which are communicating information [...] if we approach the phone at that time it’s going to talk to you and it’ll say things but only if we approach the phone. That’s why it is communicating but it is not connected” [Interview 2.9].*

Selling online is a common practice in the dissemination of connected objects, as we have seen also for company No 1. The challenges facing this other entrepreneur, which has hired a business school graduate, is a lack of expertise in viral marketing. The interviewee said he must develop his products in collaboration with designers. *“The expertise that I lack is not so much on products but on marketing, to push viral marketing on social networks... This is an expertise that I don’t necessarily have and that I hire from time to time”*. *“Also, I always need to aesthetically improve the product so I can always hire designers” [Interview 2.9].*

These objects making use of technology in a different way from those making smart clothes are much less expensive. The internet sales channels are numerous and entrepreneurs in this market rely on e-marketing to make themselves visible.

*“I also sold with sales platforms online, there’s one called fiverr [...] I have sold very well in Canada and the United States ... My products sell easily online. So today, [...] I threw an ad on Facebook and on Facebook it is quite easy to buy all over and marketers from different countries [...] at least for my products. [Then] I can easily sell them around the world without physically being established there. For my second product, I’d like to meet local businesses because they are somewhat larger contracts and this may require that there be a physical presence” [Interview 2.9].*

However requires the firm to renew its skills and be constantly on the lookout for new ways of doing things. From this point of view, the French entrepreneur mentions his difficulty to access all the knowledge required to organize his evisi-

bility.

The firm uses several sub-contractors, especially for the development of his presence on the internet.

*“The design, I subcontracted. For example, I have subcontracted to a society that does the website, I sometimes subcontract for video creation, I subcontract for social marketing on social networks [...]. I work a lot with advertising agencies and they sometimes recommend me”* [Interview 2.9.2].

## 7. Discussion

With the rise of the Internet of Things (IoT), the expected effects of the convergence of technologies and organizations producing intelligent products are observed in terms of the three following dimensions:

1) The ongoing adaptation of services depending on the technology available which requires a redesign of the value chain of the ICT industries [30] and management of knowledge oriented towards the development of specific market niches;

2) Outsourcing or access to specific skills increasingly needed in order to develop technological innovation and new offers on a competitive market;

3) Finally, the legitimacy of companies, industries or sectors has to be established as these firms that produce smart clothes also position themselves in software and services. Companies in the field of wearables see themselves as foremost software companies [E1, E2], or “communicating objects” companies [E3.1, E3.2], etc. In this context the internet marketing activities become increasingly important as we saw above.

The convergence in the ecosystem of the digital economy rests partly on intersectoral collaborations, but also on the importance of IT in these ecosystems. According to Chesbrough (2003), companies need to be more open and to develop more collaborations, differentiating themselves from the closed operation of traditional businesses [21]. This will make it possible for them to better meet the needs of new customers in the market, with the online service offerings (eg. tracking, synchronizing, analyzing biometric data online to accompany the client).

Today’s firms or start-ups can start by offering an innovative technology or product and then they can move from one ecosystem to another. In our study, companies are in an ecosystem which is that of mobile and smart phones because of the possible connection anywhere. They are also related to the Internet of Things, because some produce an object to wear: connected, communicating and/or intelligent. These ecosystems also have relations with more traditional industries for the manufacturing of clothing or objects (watches, bracelets, shoes, etc.). The integration of technologies into these objects allows for the process of cross-fertilization between, for example, the work of engineers and the manufacturers or designer (object, clothing, etc.). However all these ecosystems converge in IT and the digital economy, leading to the system of smart objects. This

dynamic is complemented by the contribution of technology connections and data processing (software, applications, etc.).

The value chain is redesigned in this context and it is dependent on convergence which “here implies a particular configuration of the concentration of players and a mixed positioning around the intelligence of services offered at the chain end” [20] [Our translation: p. 81]. This dynamic is based on numerous collaborations, for example in the sale of their products on Amazon or Best Buy for company [E1].

Businesses need to constantly rethink their business models, including the offers and the quality of services towards a target client or via interaction on a platform [19]. Companies thus try to better meet the needs of socialization, health, well-being, and fashion in the digital era. To confront Internet giants such as Google, Amazon, etc., and successfully gain a share of the market, emerging firms must increasingly be proactive, but also strive for excellence in innovation and business models.

## 8. Conclusions

Let us recall that our conclusions are based on the full research that is participant observation, observation of the web, our 30 interviews, which were followed by thematic analysis and an abductive method which made us go back from theory to fieldwork results. We went back and forth from fieldwork results to theory, and questioned theory with results, and results with theory. This led us to the above discussion and present conclusion.

As we observed, some companies we met are rather specialized in technical clothing and realize important innovations (textile which can breathe, is fire resistant, cold resistant, etc.). These companies use the internet and their website in their business development, but also contacts with international markets. Other start-ups are using technology including Web 2.0 (3D scanner, analysis and transmission of data via a website) for measurement services related to the body and to order products (suits, shoes...). Here the technology is mainly used to sell a final product. These companies have spontaneously used e-commerce and digital marketing.

We observed in our cases that collaboration is a challenge for these companies, as was observed by Tcheng *et al.* (2005) also: “The main challenge for the coming years is [...] the ability of professionals from different backgrounds (different economic sectors, university) to work together on common projects while their objectives, methods even their agendas may differ” [20] [Our translation: p. 82]. Convergence clearly therefore calls for collaboration, negotiation and knowledge sharing between sectors [31]. The areas of software, the IoT, creativity and innovation are mobilized in the deployment of business models based on collaboration between various experts: IT specialist, textile, design, etc.

Communicating garments also call for this cross-fertilization and our research and interviews show that these cooperations are at the beginning of their development. Integrating sensors, software, intelligent fiber design, the garment be-

comes a receptacle for these new technologies converging to connect to a server via a mobile application to track data (heart rate, sleep, etc.).

Also, to conclude, this is what is planned in the future in the industry: “The next step, truly convergent, is to introduce not only wires and equipment in classic clothes but to introduce electronics in the material itself” [20] [Our translation: p. 82]. This also represents an important challenge and will require all the more collaboration and cross-fertilization.

Among the limitations of this research we need to mention the small number of companies that we analyzed as case studies; this can be explained by the fact that these new business models based on the niche of smart clothing or wearables, are only emerging. That is why we presented an exploratory study of the cases presented to document the process of collaboration and convergence, which leads to innovation in these new markets.

In the continuation of our research, we plan to look into the success factors for collaborations by analyzing other cases of businesses, particularly abroad, since there are relatively few cases in each country. We also will try to determine if these companies nevertheless cooperate, even if there is intense competition between them, and we will try to see what the best level of cooperation is, *i.e.* local, regional, national or international, or if this may be different according to the specific “wearable” product.

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