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How the Additive Manufacturing will customize our needs on demand?

Final Year Dissertation submitted by

Jérémy TERRIER DELOGE

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Abstract

Abstract - French

Ce document traite l'ascenscion de la technologie additive dans le monde du commerce. Pour mieux comprendre les apports et opportunités que cette technologie peut apporter, ce document traitera en premier lieu, le lien direct reconnaissable avec le concept de customisation de masse dans un context futuriste appelé Industrie 4.0. Ensuite nous allons s'interroger sur les différentes techniques utilisées par les imprimantes 3D, ses possibilités dans différentes industries, ses opportunités dans la châine d'approvisionement, mais aussi les limites et coûts engendrés par cette machine. Pour finir, nous allons rencontré trois managers d'entreprise travaillant dans l'industrie du dentaire, qui pour eux l'imprimante 3D est une partie intégrante de leur fabrication et un vecteur d'avenir.

Mots clés (5 to 6 keywords)

Customisation de masse, Fabrication Additive, Chaîne d'approvisionnement, Management, Dentaire, Prothèses, Innovation, Technologie

Abstract- English

This paper discusses the rise of the Additive Manufacturing in the business world. In order to better understand the opportunities and benefits of the technology, the paper will discuss in the first hand, the direct link with the Mass Customization paradigm, in a near future context called Industry 4.0. Then, we investigate the technics of the 3D Printer, its possibilities on industries, its challenges towards the supply chain but also the costs and limits of this machine. In last time, we will meet three managers acting in the dental market, who are using in their core business the Additive Manufacturing.

Keywords (en anglais)

Mass Customization, Additive Manufacturing, Supply Chain, Management, Marketing, Dental, Prosthetics, Innovation, Technology

Methodology

In order to realize this study, we use different sources of information. The two first parts are mainly based on authors thought, and also specialized press.

For the Mass Customization part, we gather information from authors, and from academic articles, our main primary data. This subject has been developed over and over and experienced at many different levels. Theories have been made at diverse times, from the 90 to 2010's, this permit to get varied points of view through ages. For example, Mr. Joseph Pine has been a very important searcher recognized for his books and interview towards mass customization.

The second part has been investigated differently. We will also use the Harvard Business review for some article. This part is much more an actuality fact. It was easier to find information on specialized magazines. This will represent our secondary data.

The third part is divided in two. The first chapter is about the overview of the dental market. Due to the lack of information about the dental market, we collect data from abstract of market study made by Consultant Companies. We confront them in order to diversify the analysis.

For the empiric part, the third one, we decided to gather qualitative data from experts through Skype interview. Mrs. Agnès DELOGE, CEO of Dental Cap Ocean, Mr. Pascal BONGERT, owner of Laboratoire Bongert and CEO and founder of 3DRPD, and Mr. Denis THERIAULT, founder, and CEO of 3DRPD, I had the chance to interview these three successful managers. Both of them are directly linked to our field of study, they are working in a customized environment using 3D Printer. Their companies are acting a different level in the dental market. This permits to have different view and information into different angles of the market.

Introduction

> *"I've presented a concrete commercialization thanks to 3DRPD, but what I've seen and what I've heard, Jeremy believe me, are unbelievable (…). I saw so many things that I can't explain to you because they are so much advanced technologically. What I remember from this it's how 3D printing will revolutionize every industry in the world at every level, human, mechanic, production" – Mr. THERIAULT founder of 3DRPD, Interview from the 21/05/16, after assisting a congress in Canada on 3D Printing.*

This is what Mr. Thériault said me after he went to a congress on 3D Printing in Canada. The 3D Printing also called, Additive Manufacturing, is a technic that permits to create an object by superposing thin layer of material over and over. Developed in the 80s, the machine was used at the beginning to Rapid Prototyping, then in the 90s, the two pioneers company 3D Systems and Stratasys start to commercialized the machine. We really began to think and use the Additive Manufacturing in the beginning of 2010, where medical, aeronautic, jewelry and also automotive industries appeared to be fascinated by the technology. Managers introduced the machine in their fabrication chain in order to have better quality product while offering new characteristics, and reducing production time. In the meanwhile, 3D Systems, Stratasys and other revolutionize startups in this market, launched the 3D desktop Printer, the affordable price let consumer access to the technology at home. The 3D Printer market is growing every year, with a 100% growth for the next 5 years and grew to 1 billion dollars in 2015 (printer and services). The democratization of the 3D printer, industrial and personal, will revolution the entire conception of an object, companies will create and sell differently while consumer will achieve unique object on demand at their home.

In our connected world, companies are gathering data from every connected device, in order to understand better their customers. When the idea of mass customization appears, companies didn't have those resources. The data generating by consumers on platforms is changing the industry. The presence of internet everywhere is restructuring our society. It is changing how we create, how we

communicate and how we make business. Companies can now understand faster customers expectations and need to react faster to provide product they are waiting for.

In a context of industrial evolution, and where Internet and manufacturing are the new combination, we could think: How Additive Manufacturing will customize our needs on demand? Our axis to answer to that question will be mainly based on the supply chain. We can suppose that the supply chain could be totally renovated by avoiding delivery steps. The customers would be involved in the manufacturing process, to create their own product and elevate a new competition. Decentralizing their production will attract companies. The following paper will try to show how 3D printer will be integrating to the manufacturing chain while offering many advantages and an indefinite customization. We will not enter in the technical fact on 3D Printing because this area requires high expertise, but we will try to take the big picture of the technic. In the first place, we will investigate the mass customization paradigm. We will define its origin, its benefits, and its attributes by the voice of important authors from the last decades. In a second time, we will focus on the Additive Manufacturing. Firstly we will have an overview of the history, the development and the market of that technology. We will also try to give a clear explanation of the functioning of the machine. Then we evaluate the opportunity of 3D printers and also its compromises that company has to understand. In the last time, we will have the chance to interview three Chef Executive Offices of three companies acting in the dental industry at a different level. Mrs. DELOGE, which is the CEO of Dental Cap Ocean, manages a dental laboratory of 28 technicians in Vendée, France. She is associated with Mr. BONGERT, owner of the biggest Dental Laboratory in France. He is also the Co-Founder of 3DRPD, with Mr. THERIAULT. Both of them are managing 3DRPD, a dental supplier of chrome cobalt denture product. Mr. THERIAULT is managing the USA and Canada branches, while Mr. BONGERT is directing the Europe branches. These three companies are using 3D Printer in their daily tasks in order to provide the perfect product for the client. These three managers will provide us very useful information and facts on the utility of the Additive Manufacturing in their activity and new opportunity of the market thank to the technology.

PART I :

Mass Customization: a factor of success

In this part, we will investigate the Mass Customization paradigm. An old idea still present nowadays. We will see its different approaches and how companies want to be seen as customizers. This evolution of the company leads to a total renovated industry. We will have a look of the Industry 4.0 where our entire society will be restructured.

Picture 1: Customer's Name on its Starbuck Order

I – The Mass customization: the actual business strength

This chapter aims to provide information about the paradigm of mass customization. How the society has changed from a mass production concepts with standardized products to a mass customization idea where every product is different.

I.1 Concepts and Ideas

A – What is it?

Mass customization by definition is "producing goods and services to meet individual customer's needs with near mass production efficiency" (Tseng & Jiao, 2001). This concept appears in response to the paradigm of mass production, in the 1990's. After focusing on mass production and making economies of scale, companies tend to change their view over the market and their customers. They understand that the market is no longer homogenous but it is composed of individuals: customers. In these individual the demand and supply still exist but there are not the same and differs from many variables. Of course, some customers have same views, it is logical to group them, but the best company will respond individually to each of its customers' demand.

From that, we can propose a new definition of the market. In marketing, the market is referring to a homogenous group of customers and/or organizations that are stimulating by a product or a service, which are willing to pay for it. In mass customization, we can change this definition and say that the market is a place where different individuals are grouped and are interested in a product or service but differs from their needs, wants and expectations for it. It means that the population is no longer stable and controllable as before.

We also have to define what are needs and wants from a marketing perspective. Needs is something you have to have, for example, you need food to live. Wants are something you would like to have, for instance, a McDonald meal, you don't need it as a physical needs but you desire to eat something special

B – Be a customizer

Mass Production and Mass Customization are two different ideas; a company who wants to focus on customization needs to make continuous improvements. As we can see the example of Toyota, which was the most efficient car's manufacturer, they created the lean management, but they didn't implement the customization process instantaneously. According to Joseph Pine II and al. (1993), Mass customization is not just an idea it's a way of doing business.

> *"Mass customization calls for flexibility and quick responsiveness. In an ever-changing environment, people, processes, units, and technology reconfigure to give customers exactly what they want. Managers coordinate independent, capable individuals, and an efficient linkage system is crucial."* (Pine,B.J, and al, 1993)

Mass Customization requires improvements in organizational structures, management, values, systems and customer relationship. The manufacturing process in a customization environment is very dynamic: workers do not argue the basic product that they have to build because they assume it is how customers expected to be, so they adapt themselves and learn to answer to customers' new design. This is the role of managers, and executive leader, to set a vision and implement goals, companies need to be ready to answer what the future will ask them. This vision is facing the future. Continuous improvements are not used only for today tasks but to realize what tomorrow will bring, or what the next customer will want. This vision and goals permit to put the company in the same directions and give motivation.

Mass Customization needs to follow the same low-cost production, but these improvements and product development may make the task harder. In order to put these two different ways of doing together, companies may need the help of technology. Mechanical and Digital Technology will be welcomed in this process. Mechanical Technology, in a customization environment, will help to automate tasks, to reduce failure, in order to make workers and machines operating together.

The advanced technology will be important for productions but also for collecting data from customers and anticipate the demand and expectations of customers.

C – The four approaches of Customization

Companies have understood to always anticipate the next customer expectations through Mass Customization. There are different types of customization. Identifying the best one for an activity will permit to avoid cost and complexity. There are four different approaches of customization: Collaborative, Adaptive, Cosmetic, and Transparent. (Gilmore, J.H, and Pine, B.J, 1997) Managers should examine each type of customization before heading to a new strategy given that customers will see and value those processes.

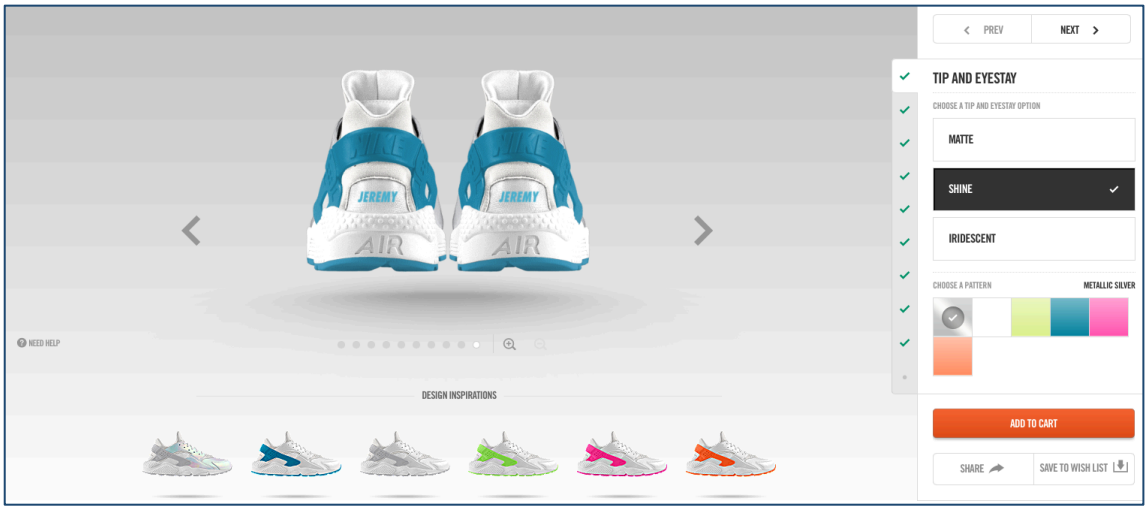
Based on the article of " the Four Faces of Mass Customization" by Gilmore, J.H, and Pine, B.J (1997), we will examine each definition of the four approaches then provide an explanation and an example. The first one will be the collaborative approach.

> *"Collaborative customizers conduct a dialogue with individual customers to help them articulate their needs, to identify the precise offering that fulfills those needs, and to make customized products for them. " (Gilmore, J.H, and Pine, B.J, 1997)*

In other words, collaborative customization, as indicated by his name, the company and customers are working in collaboration to identify the best alternatives and offering the best product that fit the customer. The company will engage contact with its customers to gather information of what they need. In a world where there is a multitude of similar products and alternatives, this approach will help customers who don't really know what they want. Due to the collaboration with the company, customers know exactly what they are expected from a product. The company is trying to understand the needs of the customers and to make it clear to them.

Example: NIKE ID

Nike Inc., have incorporated in their stores and online, a new process of customizable shoes. Since 2012, Nike allows their customer customize their product in a several ways, from colors to texture and even the name. There are so many possibilities, that Nike needs the technology to achieve that, and also the stock. Due to those infinite possibilities, and stock issues, the enterprise as a longer delivery time, almost 4 weeks per customizable pairs.



Picture 2: Nike ID

The Adaptive customization is another approach emitted by Gilmore, J.H, and Pine, BJ (1997):

> *« Adaptive customizers offer one standard, but customizable, product that is designed so that users can alter it themselves. »*

This approach gives the customer the freedom to customize the product according to his or her own choices. This product is a standard product made by the company which can be easily adapt to the customer, by proposing such a service the company implies it has everything in stock, every possibility to answer the customer's unique inquiry. This approach is optimal for the customer who can have different expectations from the utility of the product. The technology is an important resource for this type of customization for creating rapidly the product the customer is looking for.

Example: One slice Pizza

A few years ago, you were obliged to buy an entire pizza. Nowadays, pizza companies, in supermarkets, are able to offers only one slice of pizza. Behind that, the companies adapt themselves to answer to customers: reducing quantities for special demand.

Picture 3: One slice pizza by Sodebo

The third approach is the cosmetic customization, Gilmore, J.H and Pine,B.J (1993) explain this approach let the customers use the product the same way but the only thing which differs is how it is presented. For example, the packaging changes according to the customer, the client's name could appear on the packaging, it makes the product advertised and promoted in a different way according to several kinds of clients. It is much more a merchandising way of doing than a customization of products. We can say the way of offering the product is customized. The merchandising includes atmosphere, music, smell, display, point of sales, taste: the buying experience of a customer.

Example: Coca-Cola, and their bottle names campaign,

Coca-Cola has run in 2014, a marketing campaign that allows customers to put their name on the bottle label. This is an example of cosmetics marketing because the product is still the same but it is advertised and communicated differently.

Picture 4 : "Share a coke" Coca Cola campaign

The last approach is the Transparent Customization as it suggests customers don't see the changes. By definition:

> *« Transparent customizers provide individual customers with unique goods or services without letting them know explicitly that those products and services have been customized for them. » (Gilmore, J.H, and Pine, B.J, 1997)*

With this approach, enterprises want to respond to their customer and surprise them. They want to offer the product they were waiting for without recognizing the effort made. They want the customer to see it, but it has mainly negative impact for them. It will be positive for the company; sometimes they can replace a part or a process to make it cheaper for them but not obligatory cheaper for the customer.

Example: New recipe in food industry

Some food companies have examined their customers and they come to a point that customers are expected something more about the food or the taste. For instance, a company will make a food sweeter, it will give a positive impact for their product but it appears to customers as a negative impact because the price might be more expensive. Consumers continue to like and want the product so they will still buy it.

Picture 5 : New Recipe Lion by Nestlé

I.2 From Mass Production to Mass Customization

From the beginning of time, we make Business. In the past, we were growing our plants and sell it on a marketplace, which remain commodities (see figure). After that, The Industrial Revolution appeared and we were not only growing plants but we started to create goods and to sell it.

After The Second Industrial Revolution, the mass production concept appeared, also called the American System of Production in the 1910s. The after war environment, was favorable to economic growth, dynamism, and demand for products was very high. Americans started to manufacture in mass quantity every kind of product, in order to sell and spread it in huge markets. As we know, Ford was one of the pioneers in this idea; the production of car didn't stop to grow after wars. Workers were settled in assembly lines and reproduced same movements every day. The help of technology permitted to boost the rapidity of manufacturing and to reduce failure. Mass production was offering to the customer a high quantity of standardized products. Consumers didn't care about who make products, they only cared about price. The world was considered as one and only market, companies didn't try to understand customer' expectations. Therefore, goods became commoditized (see figure 1), and we took a step behind from the Industrial Revolution.

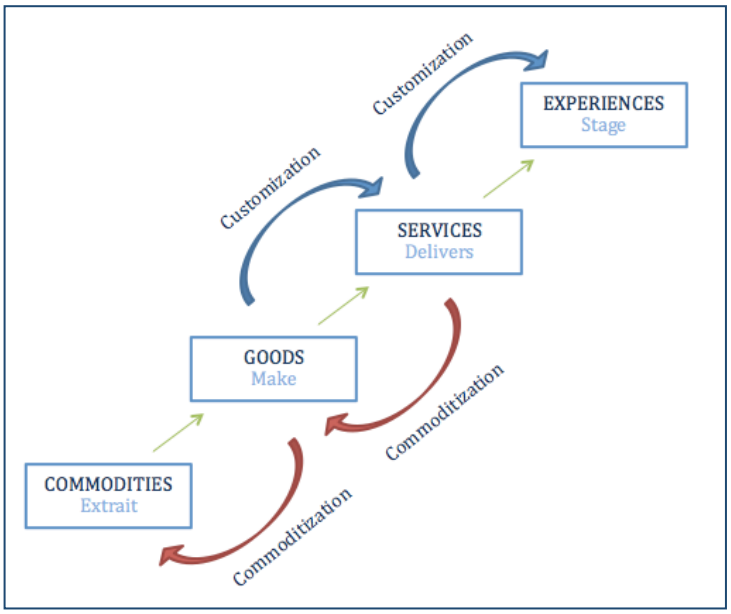


Figure 1 : Adapted from Pine J, from his TED's Conference "What Customer Want"

Manufacturers understood this demand and started to offer diversified products. Industries were focusing on standardized products for a whole same market. They were centralized on stable efficiency and control. The society started to change, we began to express our feelings and we were expecting shifts. In the 60s, the

automobile industry was rising, the population started to express ideas and to make choices, we can speak about the Hippies movement, Woodstock, or about contraception which was decriminalized. It was a changing society. Meaning by that, the world was not stable anymore, companies couldn't be as efficient as the mass production required. Adding to that the usage of new technology and new management methods, companies came up to a new paradigm by creating "variety and customization through flexibility and quick responsiveness" (Pine B.J, 2004).

People wanted to customize a product, to respond to their own and different demand. Companies started to act in a very competitive environment, where customers were waiting for variety. They began to segment the market and to position themselves, in order to promote differentiation to their product, which led to giving a different perceived value from customers. Because companies decided to offer diverse products, we can say they tried to deliver a service on demand to the customer who was waiting for its unique object. This step also found its limit, with the help of technology and different way of leading and doing, the service became obsolete. This evolution had also been commoditized. (See figure)

Another evolution is about experiencing (see figure). Now the client wants to experience when he buys his product. There are experiences everywhere: when you drink a Coke, when you travel, and you go to a fast food, you experience the atmosphere, the taste… Now customization is not only about design, or utility, now we want to feel something when we buy a product or a service. When you buy a plane ticket you expect something about your travel. Customers don't only care about price but by what their new product will bring to them. Companies have understood that by giving more and more value into their product. For instance, consumers are buying VOSS water (see picture), a bottle of water that costs approximately 5€ and not an ordinary tap water. Because customers expected something, they know this water is more expensive, they are expecting a better taste, and they

Picture 6 : Voss Water

also want to show something by drinking this water. Why? Because every customer wants to have a unique feeling, they want to experience what the product is bringing to them, and to distinguish themselves from other people.

	Mass Production	Mass Customization	Personalized Production
Production Goal	**Economy of Scale**	Economy of Scale **Economy of Scope**	Economy of Scale Economy of Scope **Value Differentiation**
Desired Product Characteristics	Quality **Cost**	Quality Cost **Variety**	Quality Cost Variety **Efficacy**
Customer Role	**Buy**	**Choose** Buy	**Design** Choose Buy

Table 1: Key differences betwee the paradigms (HU,S.J., and al 2011)

I.3 – What customers want

A) Authenticity

As we said before, clients want to have their own product, which corresponds to them and they also want to experience what and how they get this product or service. As Mr. Pine said in his TED's conference in 2004, customers want to experience but they can't experience product when they don't see authenticity. It is becoming the most important criteria for customers. They want to know who makes the product, from who they are going to buy, and what are they going to buy.

By nature marketing is not an authentic field. Companies are ready to do everything to make profits. But nowadays, new companies are not only motivated by profit. Some of them prefer to create relationships with their customers by being authentic. To be authentic, an enterprise will try to connect to their customers through managing efficient interactions. The field is related to merchandising. An atmosphere, a way of speaking to clients is an important part of the authenticity of a

brand. Also, the emergence of social media lets companies be in a total synergy with their clients at every moment. Social media allow customers to give feedbacks and interact with the companies. In a Mass Customization views, and as we said before, this if very important for those companies which tend to respond to customers' expectations as better as they can.

To offer that, companies need to really define what would be their added value. For example, when you go to a SUBWAYS restaurant, the customer knows that he is going to have fresh and healthy food, made for him on demand. Rather than in a McDonald restaurant where you don't know where the food comes from. In Subways as you clients, you are treated as a unique and different customers, whereas in McDonald you are a customer like the other. In term of atmosphere, McDonald, due to their big recognition, has better infrastructures, but the advantage of Subways is that they are showing ingredients to customers and let them think "this fresh, and green, its better for my body". That is why Subways is the first competitors of McDonald when the yellow M offers a wide variety of sandwiches, Subways offers customizable sandwiches for you, made in front of you.

B) Personalization

In the last figure, we can also see a new paradigm appearing: the personalization. The personalization is the last evolution in Mass Customization. Where Mass production is focusing on Economy of Scale, Mass Customization on Economy of Scope, Personalization tends to focus on Value Differentiation.

With this expansion of Internet, which gathers everyday data to analyze and to evaluate customer's behavior, manufacturing tends to be unresponsive to all the changes that might impact the process. For this purpose, companies pursuit the idea to integrate new technology in their manufacturing process. The edge of the 3D Printing will allow businesses to respond to every demand possible, the most complex design will be on the hand and will assure to create on demand product. As Hu, S.J said:

> *" 3D Printing, present an opportunity for a new paradigm of product realization: the personalization of products tailored to the individual needs and preferences of consumers"* (Hu, S.J., 2013)

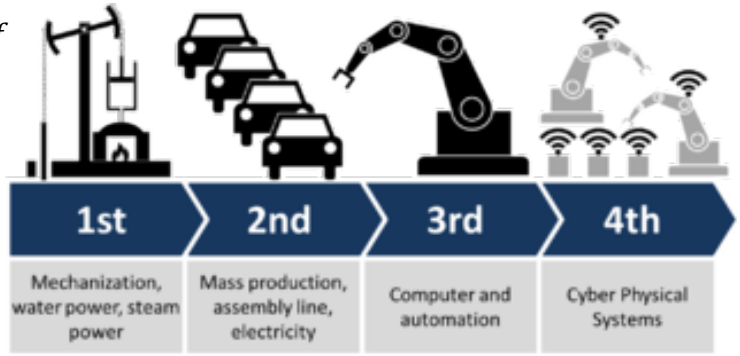
In this personalization idea, the customer wants to get his own product which if may have design himself. Customers nowadays want to be involved in the process of manufacturing. Who doesn't want to have a product that he thought and did himself? The company who can offer that give access to customers, and make them feel to be part of the process this refers to the authenticity fact we were speaking before. Customer will be part of the process and therefore will know what he is going to do and get. The use of technology will lead customers to visualized their product, give freedom in design and let the customer be creative.

II – The Industry 4.0

Before speaking about the Third Revolution, we need to remind about the roots of this one: The First and Second Industrial revolution.

The First Revolution started in the XVIII to finish in the XIX century. In this period, where philosophy had the power to lighten the population, we saw appearing industries.

It is in Great Britain where the first innovation appeared: the steam machine, made by James Watt in 1769, was the precursor of all the following innovations. The textile and metallurgic industry started to be mechanized and gained progress this lead to an accelerated rationalization of the production methods. Thanks to the steam machine permit to put movements in others machines, humans were capable of moving faster, trains appeared, roads have been created. These economic transformations had also an impact on society: the labor class has been created, the urbanization had started and the notion of proletariat came into existence.



Picture 7 : Christopher Rosner on AllAboutLean.com

The Second Revolution have been possible thanks to the invention of electricity, the discovery of patrol and the utilization of gas. These sources of energy started to be

spread around 1880. The first gas motor has been made, steel is more used than iron, and the chemical industry is rising. Then automobiles and plane revolutionize the industry in early XX. In the society, the Revolution made companies more and ore important, people started to care about their money. Big companies, tend to be big factories that lead to the idea of mass production we spoke before. Work has been defined differently thanks to the Taylorism and the Fordism.

II.1. The Third revolution gives way to the Industry 4.0

A – The evolution of the Digital Revolution

The rise of rapid technologies of information and communication, as The Internet allows to, and innovations in the numeric industry are the based on this revolution. Our way of thinking, acting, communicating, working and paying have ben affected by the edge of electronics. Analog technology has been replaced even upgrade by digital technology. Our knowledge has totally changed. The society is different from the bottom until the top. Populations are linked easier and stronger, which permit to better answer to humans. Douglas Engelbart, computer scientist, and inventor have said:

> *"The Numeric Revolution is far more significant than the invention of writing or even of printing"*

As we can see in the timeline, the digital revolution has seen the development of the digital electronic computer, the personal computer and also the microprocessor, have permitted to ameliorate several ranges of product from cameras, phones to music players. The Internet and the World Wide Web radically changed the way companies and individuals communicated. More and more people gained access to everything they want, small companies gained access to huge markets, these are the pillars of the Globalization, which became an important result of this digital revolution. The Internet is a source of date for customer, a platform of sharing information, where companies extract data and facts other their customers

B – The basis of the Industry 4.0

The three past industrial revolutions were driven by technical innovations: the steam-powered machine for the first one, the division of labor at the beginning of the 20th century, and the beginning of automation in manufacturing in the latter 20th century. Experts see the upcoming industrial revolution triggered by the Internet, which permits to create communication between human but also with machines in Cyber Physical System (CPS). The demand for customized product is growing, adding to that the decrease of product life Cycle, forced companies to transform their organizational structure then also the production. This will be the Industry 4.0, in reference to a fourth industrial revolution, where the numeric or digital will be present everywhere as oxygen in our world. This concept appears first in Germany, where the government wants to computerized manufacturing; the biggest example in this country is the automotive industry.

The industry 4.0 focuses on the installation of intelligent product and production processes. In the future, manufacturing needs to be rapid as possible to answer to the need of customers, this involved rapid product development, flexible production in a complex environment. This new industry will be based on four principles that are not common in nowadays:

- Vertical networking of smart production: where machines and humans will communicate and operates together
- Horizontal Integration: the value chain will be totally rethought to be more and more efficient new networks, as smart grid, clouds computerizing and different internets
- The entire value chain will follow a high-tech strategy
- Boosting by “exponential technologies” as said Mr. Das, R (2015)

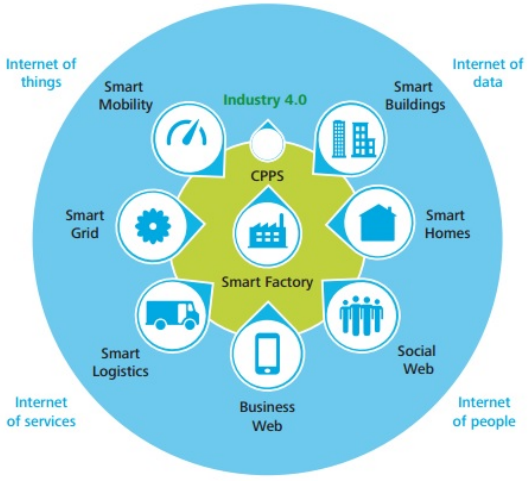
Smart Factory Picture 8, which will be capable of interacting directly with customers or even other machines in order to create the perfect product. Machines will be connected, which will create an intelligent network along the entire value chain that can control each other autonomously. This network while operating will be able to analyze the environment, and customers in order to deliver the best product. Some examples for Industry 4.0 are machines, which can predict failures

and trigger maintenance processes autonomously or self-organized logistics, which react to unexpected changes in production.

In a context of manufacturing, Mass Customization is:

> *"a production strategy that focuses on the production of personalized mass products, mostly through flexible processes, modularized product design and integration between supply chain members along the value chain" (Davis, S.M., 1989).*

The big importance of Mass Customization leads to fundamental shifts in the product and production organization, in order to be flexible and respond to complexity management but also production. Those new manufacturing processes and organization, still motivate companies to differentiate themselves and acquire a better quality product to ensure a strong competitive position. In order to achieve this complexity, Rapid Manufacturing will be a big advantage for companies.



Picture 8 : Smart Factorie by Ranen Das 2015

II.2 The Internets

As we can see Picture 8, there are four internets, which influence the smart factory:

- The Internet of Things also called IoT, is basically all the internet connected devices . "The IoT is a giant network of connected "things" (which also includes people). The relationship will be between people-people, people-things and things to things." (Morgan, J 2014). There si more devices connected than people on earth. This connected devices, as cell phones,

watches, coffee makers, ovens... will predict and anticipate our needs and wants.

- The Internet of Data is also called Big Data. These data are collected by connected devices and are used by companies to better understand customers, and behaviors.
- The Internet of People is more about communication. With the climax of social media, now people are connected continuously and for everything. People are sharing information about relationship, food, and health. This idea gains also power due to all the connected devices that are giving and sharing facts with even without our permission on the internet.
- The Internet of Service: have been also called Web 2.0, it is an "old" concepts where E-productivity and E-commerce start to be accessible on the internet. This idea is a precursor and had pursued the rise of the internet, but now it's a very big business which will never stop growing. B2C eCommerce Sales reach $1.7 trillions of dollars in 2015 and its predicted to gain 12% to hit $1.9 trillions (source: Statista.com)

A lot of experts tends to say that this four Internets are not different they are all part of the Internet of Things IoT. Companies are using these sources of data to offer new services, reshaping experiences and enter into new markets thanks the digital ecosystem

In his conference, Joël de Rosnay spoke about 3 major break-ups, which will alter our society in the future. For Mr de Rosnay, in a near future, his theory is : "the Internet will disappear". It will be fusion in a "numeric ecosystem", as oxygen, water and gas are part of our lives. This ecosystem will link everything and everybody. Production, distribution, service, politics, economy will be around us, will be part of our daily tasks everywhere.

A risk behind this Internet, there is no more privacy. This will be the big challenge in the future or Internet. Our data are collected from everywhere, from everything. We use to say that the first data collector is the ATM, now even a fridge or microwave is giving data.

The energy production will move to be decentralized. Industries will start to make their own source of energy and we offer it to other companies and also to the population. This is used to call the Energy Transition. The distribution of energy will be totally, as Mr de Rosnay said in his conference this energy will be distributed in "a system of peer to peer, thank to a network which will be more important as the internet, as I called Enernet, smart grids interconnected together where the numeric will have an important role". A smart grid is an intelligent distribution network, help by a computer to optimize the production, distribution and consumption of energy.

Thanks to the progress of technology, the pharmaceutics industry, and agro-food industry will be totally disrupted. We will be able to measure by ourselves, what affects and how it affects our body. The Numeric wills fusion with the biology to this ecosystem numeric.

II.3 The Company of tomorrow.

A – The Platform structure

The structure of a company will be totally altered by the dependence of internet. Companies already start to change, new companies are now organizing as platforms. This new business model in centralized on customers. Customers via the internet, IoT and IoP, is sharing information giving information to companies, used by them to better understand customers expectations. Phil Simon has defined the platform as:

" an adaptable ecosystem which includes new product and services rapidly thanks to customers, prosumers, partners, stakeholds, to digital technology and to mutual actors benefits"

For Mr. Simon, a prosumer is a person who either produces and consumes. There are several companies which imaged this definition. For example, Uber is the biggest taxi company in the world, but they have no cars. This is a platform where customers are proposing their cars to produce a service in order to transport people and also consuming the service. It's a Win-Win business model. Uber is just here to put in relation customer and customer. Uber is part of the NATU companies which have the same business model: Netflix, Airbnb, Tesla, and Uber. These companies

are the fastest growing company, for Mr de Rosnay, this enterprise or platform, represents a "thin layer" that going to be graft on distribution industries "where are the cost", and make a connection between several numbers of people "where are the money". This is the Disruption concepts. This is the platform business model that takes advantage, on big industries by avoiding cost but only by settling connections between individuals. This creates a network where services or product are customized and delivers on demand.

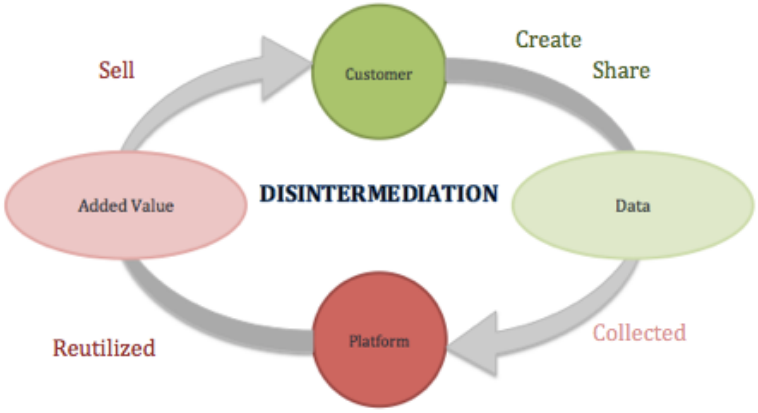


Figure 2 : Disintermediation Process

We can speak about the Disintermediation (See figure 2). It's a new model that nowadays companies are focused on, and which will be the basis of every new enterprise in a close future. This process reduces steps between customer and company by stimulating their participation in the process.

This platform strategy is driven by technology, Bonchek,M and Choudary S.P, defined them as " three transformative technologies: cloud, social, and mobile". The first one, the cloud, facilitates the company production goals where everybody creates data. The Social is powered by social network, which connects people, and Mobile permit to connect them together anytime anywhere. This result in a network of independents, entrepreneur, consumers accessible by everybody, which are able to create businesses, contributes, and purchase goods and services. (Bonchek, M., and Choudary, S.P., 2013). We say contribute due to these new trends of Crowdsourcing. It can be defined as a client have an idea, propose it to other clients, these other customers which are interested about it will invest in it and consume it. Meaning by that, a client doesn't need any more banks, he is creating his own bank with other consumers to achieve a common goal. In the future companies, the clients are in the center of the business model. This will result in a new form of organization: the collaborative industry. Where customers will share everything, as their car, their home, this is an important fact of the Disintermediation.

The risk behind this is the big companies following this business model. The GAFAMA, which is respectively: Google, Facebook, Apple, Amazon and Ali Baba;. This "state company" has so much cash, more than some countries, and such a big power and influence over the population that they can totally take control over an industry or modify it as their own appearances.

B – Millennials: future leaders of the society

Millennials also called this Y generation is the category of people, which have grown in the 2000's, and are much more used to digital technology. This category of people is the independent entrepreneur. They are ready to take risks, and make start up. They knew this system of platforms, the fast growing industry, and society. They don't want to lose time to climb to the top of a company, they want to make decisions with face-to-face meetings. In U.S millennials will represent 75% of the workforce. (Asghar, R, 2014)

C – New form of management

The managers of tomorrow will be, for Mr. de Rosnay "an advanced manager", he or she will have all new tools to be connected to his company. The human and manager will be in symbiosis. Mr. de Rosnay explains this theory, as symbiosis is "the association between two entities which are both alive or numeric". Our everyday object will be symbiotic as the intelligent home; we will be in symbioses with the digital ecosystem, which is the communication, the internet, economies, work, home… Mr de Rosnay defined the term intelligent as a "proactive, interactive in real time", and intelligent home will adapt itself to the environment.

So our manager will be in harmony with his environment thanks to the numeric ecosystem. This may represent a problem between the delimitation of work, home, or hobbies. Managers can now ask anytime to somebody to do a report, even the weekend. Thanks to the high-tech, we can work directly from home, even from everywhere. New workers have to say no, managers even workers have to limits their work activity. We can think that we will lose the human aspect in our company, but Mr. de Rosnay predict that this digital environment will reinforce this

human links because we will manage to fix the limits, and managers will be more concern about the human.

As we say Millenials will be the major part of the population in the next 20 years. This generation is full of entrepreneurs and independents individuals. Managers will be in charge to work in a team that might never be with him physically or even together. These independents, also called slashers, are the example of the disintermediation; they can work in a network, in the future ecosystem. All these entrepreneurs, these independents, will be driven by different motivation, where the managers have to orientate. Our advanced managers, will not be only advanced by technology but also people will advance him. We will have a source of information, the big data, analyzed by different platform, with independents that are the generation of entrepreneurs; the next managers might be a manager of Independent Cooperative. Our manager will need to develop new skills, forgetting about controlling, rewarding or reprehending, but he will be motivating by humans, have a vision, have value and be a listener to others. The new manager will be more motivate by human aspect than by profit. He will be more horizontal, use the millennial culture, and promote innovation at every stage.

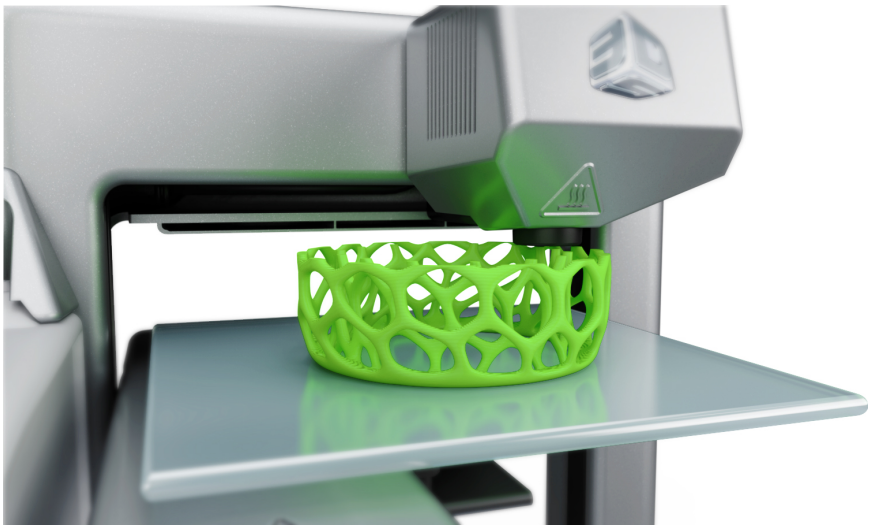
A new category of managers will be created: the Chief Digital Office, CDO. He will be a person, which has the digital culture, as millennials, and his main task will be to transform the company strategy toward a digital and numeric approach. His missions will be to integrate the new tools into the company, not the intranet as today but some new platform that the company will need. As for example Salesforces, which is a start-up specialized in helping company management. He will not be high in the hierarchy as CEO are, he will be in constant exchange with his team, with the entire company, a lateral power. The total idea of work contract is questioned, before you were giving your time to the company, that will pay you if you are doing what the managers ask you, now you are going to work to exchange ideas and achieve your personal objectives following the company goals.

Picture 9 : Illustration of the Numeric Ecosytem

PART II :

Additive Manufacturing: the industrialization of everything

After thinking how the future company will be organized, the 3D printer represents a real tool for them. In this part, we will try to understand the functioning of the machine and also what will be its benefits. We will see how the Additive Manufacturing can have a powerful impact on the supply chain at every level.



Picture 10 : The Cube: the first Desktop 3D Printer release in 2013, By 3D Systems

I – A Conquering Machine

I.1 – Additive Manufacturing, Rapid Prototyping Rapid Manufacturing, 3D Printing, Layered Manufacturing… What is it?

A – History

We start to speak about 3D Printing in the 80 where the process of stereolithography started to be developed. This process permits to solidify layers of liquid polymer using a laser. The first machine launched on the market was the SLA-1 by 3D Systems. In this era, the technology was developing and was call Rapid Prototyping. This new creation concept was used in order to make a prototype, by printing layer after layer and therefore to get a three-dimensional object. The technology became available to the public and in the 90s people started to speak about 3D Printers. New technologies were developed, which permitted to scan 3D model and replicated in the beginning of the XXIth century. Now, 3D printing is a continuously growing market, where companies start to be interested in its benefits. It is now called: Additive Manufacturing. The desktop computer and the availability of industrial lasers were technologies that enabled the development of this revolutionary machine.

B – What is it?

Additive Manufacturing is the process of joining materials to make objects from three-dimensional (3D) models layer by layer. It is the contrary of subtractive methods, which are to remove, and cut raw material. Additive Manufacturing or 3D printing, both terms can be used, describes the same process of fabricating product. The 3D technology is used to create infinitely different and unique models, patterns, prototypes, components, and parts using a bunch of various materials as plastic, metal, ceramics, glass, and others composites. Now "AM is changing the way organization design and manufacture products." (Wholers Associates, Inc., 2010).

C – Process and technics

1 - Creating the base

We use to think that, we just need to press a button and then the printing start. It is false. To fabricate, the printer needs a 3D file, done by 3D CAD (Computer-Aided Design) using a modeling program. This format file is a STL created by 3D System. This 3D file can also be done using a 3D scanner that is doing a 3D digital copy of an object. Scanners are using different technologies for replicating the 3D model: time-of-flight, structured/modulated light, volumetric scanning and more. A concrete example of 3D scanning is the Kinect developed by Microsoft.

2 – Printing

The file will be converted into thousand of slices that the printer will reproduce. It will print the first slice, then a second one over it, and so on, to get the final product as the 3D file was representing the model. After that, the object can directly be used. The 3D printer is also capable to print articulated object in one process, meaning by that the moving part are printed and assembly while the process is doing.

There are different types of technology in 3D printers. The American Society for Testing and Material (ASTM) had classify them as 7 categories:

- **Vat Photopolymerisation**: this method has a bath filled with a photopolymer resin, which will get harder with an UV light laser. The UV light laser will transform the liquid harder layer by layer.
- **Material Jetting**: this process is like a normal printer. The material will be applied, layer-by-layer to create a 3D object.
- **Binder Jetting**: these is two material in this method: powder and a liquid. Powder is spread then the liquid is applied and will operate as glue to stick the powder. Then the process starts again, a layer of powder is applied over the last layer and liquid stick the new layer.
- **Material Extrusion**: the most commonly used technology here is the Fused Deposition Modeling (FDM). Assisted by a Computer-Aide Manufacturing

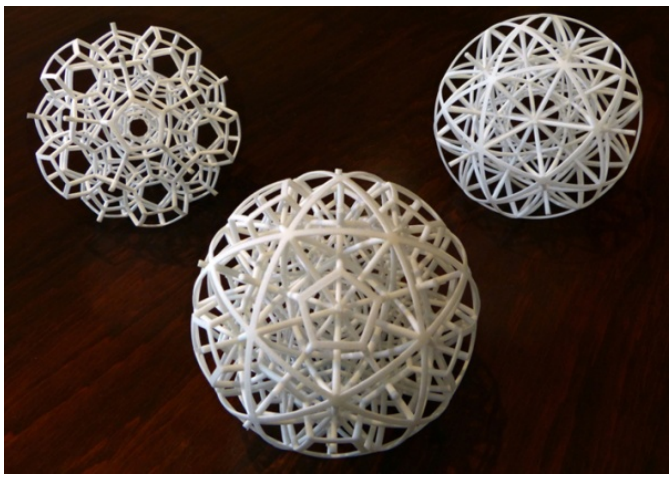
(CAM), two nozzles link to the source of 2 materials, one noozle will for the 3D Structure of this object and there over one will cover it. After the structure is removed, and the other remaining part is the object.

- **Powder Bed Fusion**: the most common technology is the Selective laser Sintering (SLS): this technics use a high power laser to fuse the powder into a mass that has the desired 3D shape. This powder can be plastic ceramic, metal or glass.
- **Sheet Lamination**: This method superposes the material in sheets, which are stick with an external force. For example, paper can be used with this technology; they are cut, stick and superposed in order to have the three-dimensional object.
- **Directed Energy Deposition**: a robot arm with in his nozzle the metallic powder and of source of energy that melted directly the powder and form the object.

D – Purpose of the Additive Manufacturing

3D printing is "*ready to emerge from its niche status and become a viable alternative to conventional manufacturing processes in an increasing number of applications.*" (McKinsey, 2014)

Additive Manufacturing is considerably opening new opportunities for the economy and society. Its flexibility will permit to create infinite customized goods, not only in design but also in utilization to meet every customer's expectations. Thank to its high standards of complexity methods, it will facilitate the production of a new high-tech part and product, which be more resistant, stronger



Picture 11 : Infinite Possibilities of Shapes

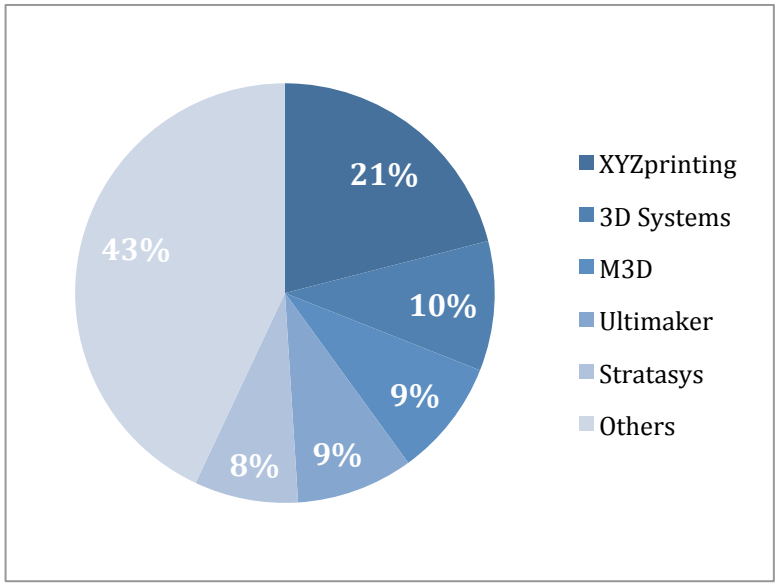
and lightweight for industry such as aerospace, military or automobile. This technology will offer a potential increase in the medical industry, thanks to the development of biotechnology and the utilization of biomaterial by 3D printers. It will improve the human well-being and boost the economy of the country. As Mr. Obama said, "3D Printing has the potential to revolutionize the way we make almost everything."

I.2 The 3D Printing Industry

A - Key Numbers

According to Wohlers Associates, a leading consulting firm on additive market, the market of 3D Printing had grown by $1 billion, for a second year, to a total of $5,165 billion, a growth of 25,9% (CAGR – Corporate Annual Growth Rate). Even though, the growth was used to be 33.8% for previous 3 years, the Additive Manufacturing is a promising market.

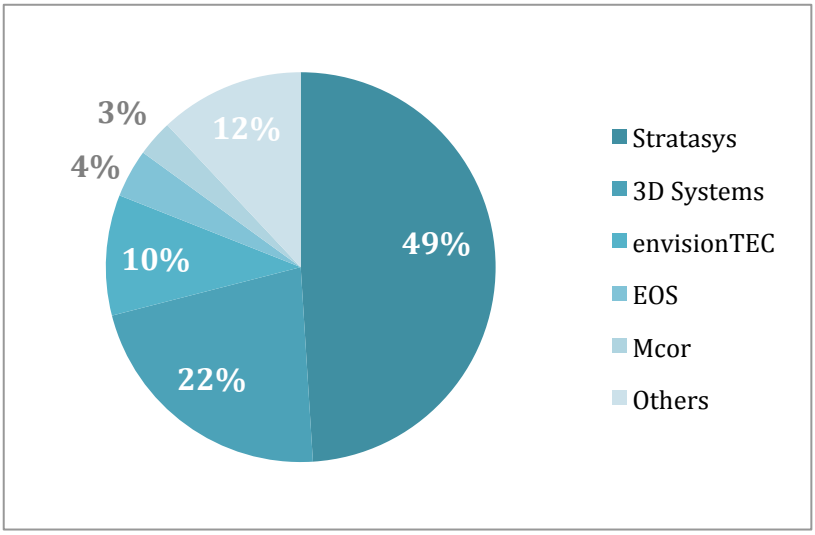
The biggest change between this two years is the sale of Desktop 3D Printers, 278,000 units have been sold, whereas in 2014, around 160,000 desktop printers have been sold. It is called desktop 3D printer because of its minimalist size that allows every customers, or every company to buy one at price under than $5000. In 2016, around 500,000 units are expected to be sold, and to reach in 5.6 millions shipments in 2019, according to Gardner Inc. This can be explained by new low-cost entry range that will be injected in the market.



Graph 1 : Top 5 Vendor of Desktop and Personal 3D Printer in 2015

"Rapid quality and performance innovations across all 3D printer technologies are driving both enterprise and consumer demand, with unit shipment growth rates for 3D printers increasing significantly. The 3D printer market is continuing its transformation from a niche market to broad-based, global market of enterprises and consumers," said Gartner Research vice president Pete Basiliere.

To compare, in 2015, 62 manufacturers sold AM systems whereas in 2014 they were 49 and in 2011, 31 companies. Start-ups are entering in to this competitive market, by pushing their low-cost printer as Ultimaker with their $1,850 Ultimaker 2+, or XYZprinting and their $399.5 da Vinci 1.0.



Graph 2 : Top 5 Vendor of Industrial and Professional 3D Printers

These companies with such a competitive price are shaking the market and boosting the supply for personal printers demand.

B – Two Leaders and a multitude of followers

As we can see in the two last charts, two companies are presented and have a major part of the 3D printer markets: 3D Systems and Stratasys.

These two companies are the two major distributors of 3D printers. As we can see, they are specialized in industrial printers, as they have the biggest market share. 3D


Picture 12 : J750, the last Industrial 3D Printer of Stratasys

Systems and Stratasys both started an acquisition strategy by redeeming many 3D specialized companies in order to have in their possession software, materials, printers, as well as engineers and designers.

In 2015, the acquisition of 3D Systems is split as (source: fabbaloo.com, 2015):

- 58% of their acquisition represent software
- 21% patents
- 18% 3D Printer Manufacturers
- 3% distribution

Whereas Stratasys:

- 82% of their acquisitions represent 3D Printer Manufacturers
- 13% custom part service
- 5% software

We can clearly identify two strategies. 3D System has the technology, as they are the pioneer in the market, by those acquisitions they want to provide a diversification of their offering services. They intent to create a complete ecosystem around their machines. In contrary, Stratasys, in the past, had the technics but not the machines; therefore, they want to provide a strong service available on every different type of machine.

As we can see in the first chart, the Desktop 3D Printers are penetrating the market and supplying a demand for individuals. 3D Systems and Stratasys, as they are specialized in manufacturing expensive professional and industrial printers, the edge of SME and Startup are splitting the market among them. The company as Ultimaker, and also the Taiwanese XYZprinting start up are offering much more affordable price. They are delivering personal printer to the market and strengthen the idea of offering a home factory and creating a micro-factories network inside the population.

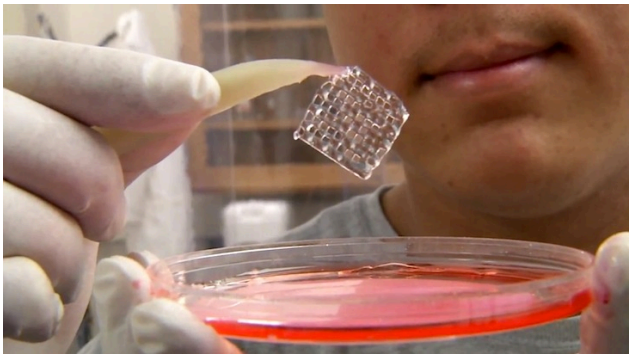
Picture 13 : The Replicator MINI sell by Makerbot

C – Impacted Industries

The manufacturing revolution is brought by the evolution of 3D printing. Several markets are impacted by their new technics and results. We will have a brief overview of these markets.

Picture 14 : The K-1 Prosthetic Hand made by e-Nable and 3D Systems

The first one is the health sector, where 3D printing is showing a real opportunity. For the moment, the main sector using the Additive Manufacturing is the prosthetics market. Thanks to the Additive Manufacturing, the hearing aids manufacturer can produce and offer personalize shape to adapt to every different customer. The dental market is also boosting by the 3D, dental prosthetics laboratory can now reproduce the exact needs of a patient due to the democratization of the 3D scanners used by the dentist, as 3DRPD is offering metal partial denture for a laboratory. Due to the capacity of the technology to reproduce any body shape, prosthetics manufacturers can now produce an infinite range of customized products for their clients. As e-Nable, a specialized company offering 3D printed prosthetics hands. The future for this market is the research made, by companies and universities on the bio-printing. We use to believe that in a few time, companies could be able to print living cells and tissues. According to Keith Murphy CEO of Organovo, "*within 4-6 years the first clinical trials will begin for the 3D printing of partial human lives*."



Picture 15 : A bioprinter tissue compatible with the human body

The Additive Manufacturing also affects the automotive market. Several car manufacturers are adding the technology to their production process. As Ford using the technology to develop prototypes "in a matter hours" that permit researchers to "test and refines new designs". Car manufacturers are also exploiting the flexibility of 3D printers, in order to produce spare parts on demand. In a near future, garage and concession will be able to create "customized" replace a part on demand. (Cassagneau, A., 2016)

The also called rapid manufacturing will change the way Aeronautics and aerospace manufacture their parts. This evolution is more concerned by the Metal 3D printing technology. The machine is able to make complex designs. This will permit to create some part in only one entire process, without welding or bolt. The machine will allow obtaining stronger, lightweight metal part, thanks to the new structures possibilities, and the production cost will slightly be reduced for the aeronautic industry.

Picture 16 : An aeronautic part made for AIrbus

Then, the space industry is able to transport this technology, to create on demand part, with new resistances as chemical, force, and other aspects that space could reserve. The NASA, knowing that this technology will facilitate their life in the space, also thinks about adding a 3D printer in the space in order to print food.

> *"3D printing is just one of the many transformation technologies that NASA is investing in to create the new knowledge and capabilities needed to enable future space missions while benefiting life here on Earth."* (NASA, 2013)

The food industry as well as the Architecture, and Art/Design or Jewelry sectors are representing opportunities for new 3D technology application.

I.3 – Literature reviews of the Mass Customization boost by the Additive Manufacturing

As we explained before, nowadays, the consumer wants to have unique product responding to their needs in a limited delay. The Additive Manufacturing can offer this demand. The democratization of the 3D desktop, will allow the consumer to print or create his or her own product and produce it at home. This give to companies a competitive advantage that other companies, which are using an old manufacturing process, can't deliver (Stavitz,E., 2012). The standardized and mass produced product is aimed to disappear, replaced by constant and indefinite customizable offers.

For the one, which are not enough, qualify to create 3D file, the expansion of platform network will permit to makers to download and print any type of object. These platforms created by innovated start up, are feed with .stl format by designers or even consumers, and permit to create link 3D printer users together. The best example for the moment is 3DHUBS that creates a network of 30,000 thousands in the world and allows customers to buy and print an object from their website.

The flexibility is a strong criteria that the Additive Manufacturing can offer while customizing products. Joseph Pine has understood years ago that Mass Customization is based on product but also on time:

> *"Remember that mass customizing doesn't mean being everything for everybody; rather, it is doing only and exactly what each customer wants, when he wants it."* (Pine, B.J. and Gilmore, J.H, 1999)

As Mr Pine explained in another book, "*The Experience economy*" (1999), experiencing is a new way of engaging customer. Let him experience, let the customer make the product; this is what the 3D printing technology can now offer to consumers. He can now interact with the object directly and create it the way he wants to. The consumer is free to produce, a simple part, or a whole product. This idea of engaging the customer by giving him the opportunity to create himself the product has been denite as Open Customization. It is a derivate paradigm "that motivate[s] people to create, to learn, to acquire, and to recover" a good or service in

order to answer to their needs, referring to manufacturing produces and not only product itself. (Tseng,M.M., Hu, S.J and Wang,Y, 2014).

Mass customization is based on customer expectations; the company needs to understand their needs. Thanks to Internet and new technologies, this is not an issue anymore. Engaging the customer by letting him experience the product or the service, is the new way of getting customer.

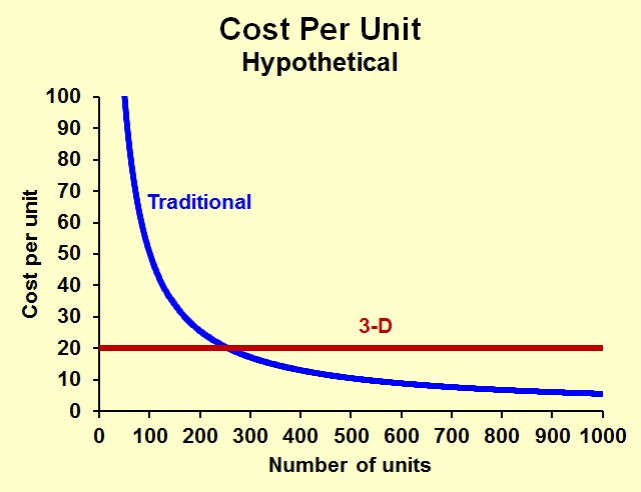
II. How the Additive Manufacturing will continue its rise

II.1 First Limits & Cost to understand

We can clearly identify 3 major limits to the Additive Manufacturing. First of all, this technology represents a cost, such in material and technics than in labor. The legal aspect is also an area, which needs to be defined as well as the relevancy of using the new technics of manufacturing.

Additive Manufacturing as its name suggests is a technic added to a process. A company cannot base all its production on using only a 3D Printer. The machine will be part of the process of manufacturing. As we explained before, 3D Printing has an important role to play in the Mass Customization area. 3D printing is useful for companies where customization is the key of there activity (Holweg,M., 2015). For example, a hearing implant 3D printed will fit perfectly with a higher precision every customer demand. That was not possible before. So when the customization is not important, 3D printing is not competitive. If a company is more centralized on mass produced goods, the 3D printing is still not competitive. 3D printing requires time to print: when other molding injection can print a product 10 times in a minute, a 3D printer will need one hour. Therefore, 3D printing is cost effectiveness when it requires small production (Berman, 2012) and customization is an important concept.

There are three major costs behind the technology: the machine costs, the labor costs, and material costs. We will investigate these costs with the analysis made by Hopkinson, Neil and Dickens in 2003. Not every SME Company can access to a 3D printers. An industrial 3D printer can cost $10,000 as it can reach $500,000. For Hopkinson and Dickens (2003), the machine cost can reach 70% of the production cost of a product, depending on the printing technology utilized and the material. This last factor is also an important factor to take into account. While we can hear everyday, that a new material applied to 3D printing is discovered, the price of this material is a major cost in the production. According to Hopkinson and Dickens (2003), which analyzed and breakout the costs of the technology, the cost of material can reach 70%. The cost of the material for a Laser Sintering process represents 70% of the final product cost, in contrary the STereoLithography (STL) will create product where the major cost will be the machine 70% and the material will represent 25%. The labor does not represent a cost in the conception but it can be important in the pre and post process. The object has to be scanned and transformed into a 3D file, which is not an automatic process. Scanners will permit to model the project, but it still needs some adjustments before printing. Then, after the production, the product needs to be enhanced, meaning by that, last interactions could be done as sanding, cleaning and/or washing. Only one person can do all those steps, this is why the labor cost is not a considerable amount compared to production. However, this person requires high qualifications. (Holweig, 2015). Hopkinson and Dickens (2003), in their analysis compared the Additive Manufacturing to injection molding, and came to these results. In the graph, we can see that the Additive Manufacturing as the linear cost doesn't matter the quantity of production, than an old



Graph 3 : Comparison between Conventional and 3D Printing profuction

manufacturing process will be cheaper when big quantity will be produced. They also defined the cost of building a product with a 3D printing as: $C=P_{Material} * M + P_{Indirect} * T$

Where $P_{Material}$ is the material use for the product measured in Euro by Kilogram, multiplied by the mass of the object in kilogram M. The indirect cost are calculated as the indirect rate $PI_{indirect}$, for example electricity, multiplied y the build time T. In this equation, the two main variables are the time and the mass of the product, this two variables influence the final cost of building. Yet, there is only one we can control: the mass of the product. This could represent the next opportunity for 3D printers: reducing time in order to reduce the overall manufacturing cost.

For the moment, as we saw with the figure, 3D printing is a niche market ready to explode. Nowadays consumers do not intent to buy a personal printer because they don't know what to do with it. In future years, maybe months, when people will understand all possibilities offered by the printer, a question will be asked: How far we can go? The legal aspect is a controversial question in the head of manufacturers and pro Additive Manufacturing. For the moment, they want to push their product and to prove the capabilities of their machine. Knowing that, we can print almost everything, even guns, and politics need to fix limits to the infinite creativity.

The Intellectual Property is threatened. As the movie and music industries have experienced this phenomenon, the object is not physically distributed anymore but streamed on The Internet, also call the Digitalization (Widmer, M., and Vikram, R. 2016). Due to the possibilities of 3D scanner, which can recreate a model of an object and then transform it into a file: files could be shared, reproduced and distributed without any rights. Anyone who needs a part or an object just has to download the file and print it. This infringes the patent, copyright and other trademark of the object. (Depoorter, B., 2014) Whoever wants to be a designer, can now pretend to be one, by copying with a scanner an object. The CAD file infringes the patent rights. The 3D printer will allow everyone to copy and produce other goods: people just need to print the object without the logo or trademark and they don't risk anything. If this object is distributed and submitted to profit, this would alter the trademark of the original object. 3D printing can also challenge copyrights law by reproducing counterfeit of a product. The holders of the copyright design can

attack the reproducer, and claims his right. Another aspect is the security of the final product. You can download a 3D file, print it but nobody guarantees that this object complies with the safety requirements. The position of the manufacturer and the operational risk need to be clarified. (Widmer, M., and Vikram, R. 2016). For the moment, the law behind copyright and trademark needs to be reevaluated, in order to lead the future market of 3D print. There is also a challenge of regulating the gun printing activity, which is an important subject in the US, where you can find blueprints on the internet, and can be printed legally. (Palmer.R, 2013)

> "*The whole idea of regulating 3-D printing is enormously difficult to conceptualize*" Darren S. Cahr

II.2 – How the Additive Manufacturing will challenge the supply chain

The Additive Manufacturing, a revolutionized process is commonly compared to computers, cell phones and Internet. These new products, innovations are called a Disruptive Technology and all had the same impact on the market.

A – A Disruptive Manufacturing

By definition, a disruptive innovation is a technology that penetrates industries or can create new industries through new products or services, which offer new characteristics. These technologies can totally change the workforce by offering a revolutionary approach to actual processes and operations, and creating a new competitive technic in the industry. It can be a combination of technologies in order to answer to new commercialization challenges. (Kostoff, R.N., and al, 2003)

The Additive Manufacturing aim to provide a rapid answer to the market needs: which are Mass Customization in a fast consumption society. 3D printer provides to industries and customers new ways of producing, distributing, and purchasing. That is why we can say that the Additive Manufacturing is a disruptive innovation. It could be as disruptive as the computer was, by the strong digitization of product allows sharing and distributing design. It will reduce the manufacturing barriers

into customer activity, and permit anybody to be an entrepreneur. (Campbell and al, A., 2012)

B – The breakout of Supply Chain

Apart from the fact that 3D Printers will affect manufacturing and customer habits, these new technologies would give an opportunity to the entire supply chain management. The entire value chain proposition will be revisited, from the conceptualization, production, to the distribution of the product. The supply chain will be also affected where companies would not interact anymore with the product itself. By adopting the technology, companies need to know what will be the objectives: improving supply chain performance or changing the way they produce and deliver? The entire business models of these enterprises could be redefined.

The supply chain involved purchasing, operations, distribution and integration. Purchasing is about finding the product by the suppliers. Then, operations plan the demand for a product supplied, and the inventory. The distribution will allocate products within different channels, and then integration will coordinate the entire supply chain. In order to reduce cost between these steps, companies try to cut the link between them.

The Additive Manufacturing represents the needs for companies who want to cut those links. The two main costs that 3D print can cut are inventory and transportation cost. This inventory represents a high proportion of the supply chain cost. Traditionally, a product needs a certain amount of different part to be done and this represents a multitude of manufacturing, inventories, and transportations costs before the assembling of the final goods. It also requires a place to store and this physical space is expensive: rent, insurance, cost and taxes. Furthermore, the transportation costs are directly linked to that; parts are shipped to facilities to make the final goods, and then shipped to different distribution channels.

This technology can redesign the supply chain. The Additive Manufacturing system allows companies to produce multitude part on demand, in one building, in

order to create the final product on demand. This approach will recentralize the production in order to be close to the consumer.

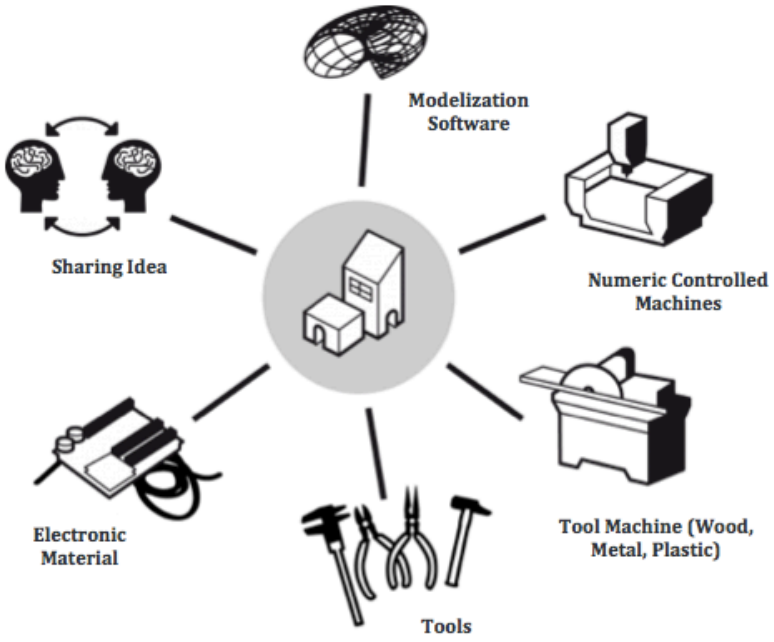
The supply chain flexibility is the ability to react to changing requirements. Additive Manufacturing can better react to the customers needs, and requirements, meaning that the 3D System have the capacity to do fast product developments. Time is an important variable in the supply chain and involved transportation. The shipped time and cost aspire to reduce even disappear due to the decentralization of production that 3D printer can provide. The production will converge into the customer proximity in order to avoid every distribution cost. Consumers can buy a 3D printer and produce products by themselves. A retailer can use a 3D printer to create the product for a customer on demand, in order to have no inventory. (Neef and al, 2005) This idea of decentralized production would be organized around consumers' requirements and demands.

The decentralization of the production will take place into customer's home or at the retailer next door. The object will be fabricated near the point of use in order to reduce the inventory, lead-time, and dependency on forecast accuracy (Marchese, Crane and Haley, 2015). So, those new factories will produce less, but better. This disruption in supply chain, where steps are avoided, results in more localized impacts than global. The production will be distributed among customers and places able to produce. It will create a network among the population, where the inventories will be stocked in the clouds as data or files, organized by platform and 3D Printer farms also called FabLab will do the production.

C – Fablab

A FabLab, Fabrication Laboratory, is a place where a community is interested in creating themselves their own product. It is a space to share ideas, experiences, on open sources machine and software in order to co-develop ideas and products. It is a workspace and also local meetings point, a gateway to the worldwide network. These FabLab have the opportunity to share innovations. (Kulkarmi, Y.R., 2014). This Fab-lab allows everyone from customer to SME, to get knowledge about new technologies. This will permit to lower the barriers of innovation and digital

production, by sharing ideas and technics among the network. This represents a decentralized place for companies and customers. In France, the number of FabLab grew from 3 in 2010 to 27 in 2014. The members of this FabLab grew by 754% between 2012 and 2013 (390 to 3334). You can find a FabLab in cities, companies or even schools. These members are called Makers. (Source: 20minutes) As we can see this growing community is willing to learn about new technology. This strengthens the idea of creativity in customer minds. Some FabLabs give access to 3D printers and all its possibilities.



Picture 17 : FabLal Availaible Ressources

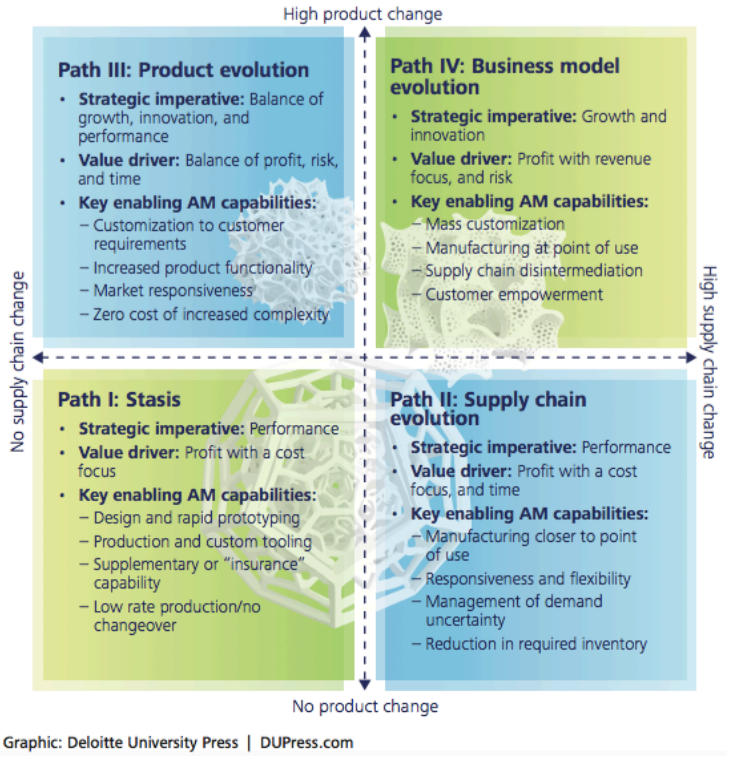
II.3 The adoption strategy

McKinsey, a consulting company, specialized in technologies, spoke about 5 advantages that could be exploited by companies into their strategy.
The Additive Manufacturing:

- Accelerated product development cycles: reducing time in production was the key to the technology. Creation of prototype, of specific tools, permit to avoid considerous time.

- New manufacturing strategies and footprints: 3D printer can build a more complex part that results in reducing the labor cost and material cost.
- Shifting Sources of Profit: Additive Manufacturing could alter the way companies add value to their products and services.
- New capabilities: New design, new structure, new possibilities.
- Disruptive competitors: 3D printing can lower the cost of market entry. The technology would allow everybody to be an entrepreneur by doing every kind of product or tools in order to customize and collaborative design that can meet demand.

Deloitte University has released a collection on Additive Manufacturing and its opportunities. They explained how companies who want to adopt the Additive Manufacturing have to act. They provide 4 Strategic Path to follow, driven by three imperatives: Performance, Innovation, and Growth. By using Additive Manufacturing, companies want to deliver another business value, they use to follow to driver: Profit, Risk, and Time.



Picture 18 : Framework for Understanding AM path and value

Path I: Stasis

This path is driven by Performance. Companies don't want to change the supply or the product, they just identify what new performance and cost saving came bring them 3D printing. Also called Rapid manufacturing, 3D printer offers performance in the production design by proposing prototype, complex structure model or also tooling. This leads to improve product quality and reduced cost. The adoption of the technology following this path does not represent a big risk, it will accelerate the business cycle while reducing cost.

Path II: Supply Chain evolution

In this path, the integration of additive technology requires supply chain transformation. As we explained before, 3D printers aim to provide a new opportunity for the operations, as reducing inventory and transport. According to Cotteleer and Joyce, these changes can "deliver performance " in all the "three drives of value: Profit, Risk, and Time". This permit to answer directly to customers needs on demand without inventory cost. In order to deliver, faster, cheaper, and competitively, companies can now focus more on a local market, by using a local retailer to produce goods on demand.

Path III: Product Evolution

This evolution is related to the possibilities offered by a 3D printer. Help with scanner, and CAD, the machine can deliver an entire product in one build, which was not possible before. It can create a complex model with empty and full part in one process. The product development is a strong characteristic offered by 3D machine. It can reduce R&D cost if you don't include the price of the machine, wasting cost, by producing with the right amount of material, and reducing time by the one-process build. It can offer to old product new competencies like lightweight, strength and precision that companies want to deliver in their value proposition. This path is related to the Mass Customization paradigm we referred to before and is driven by product performance and product development in order to meet customer's

expectations and industry requirements. The medical sectors are pursuing this path in order to provide much more complex products to meet individuals obligations.

Path IV: Business model evolution

This path aims to combine both the transformation of supply chain and the evolution of the product. The operational advantages and the product development define new levels of competitions and aim to create new business models. This permits companies to deliver their value in a way that such competitions can't attempt. This is the ultimate way of meeting the demand of the market, customization, and deliver on demand, by disrupting traditional distribution and over competitors thanks to supply chain innovation.

This innovative technology will redefine the structure of companies and industry. Indeed, this technology has the potential of reducing the economy of scale while expanding the scope economies, thanks to its flexibility. We can compare those 4 paths to the Three-Dimensional strategy enounced by Richard D'Aveni.

Where Cotteleer and Joyce see economy of scop, D'Aveni sees "Offerings, redesigned". In his opinion, companies need to anticipate what they will sell. If customers can be better served by using the technology themselves, companies need solutions to find out what they will offer and how they will market it. With the decreasing of product life cycle, due to Mass Customization, 3D printers can now print an upgrade of a product for a small period of time. This new design can be stored in cloud, big data, and with the use of CAD, or CPS, the printer can automatically adapt itself to create the waiting product in Internet-connected Industry.

As the 4 Path, and our explanation of supply chain, the Operation will be Optimized. Thanks to the flexibility of the machine, parts, and final product will be print on demand in a distributed production center. This new distribution channel will be spread into customer houses, or supermarkets and other retailers in order to avoid transportation costs. Then, customers will have the choice of infinite design, new use, color, or materials. For example, if you have to replace a part of your car, your concession could print your piece on demand. The car manufacturer reduces

his inventory cost, reduces in “on demand” manufacturing cost, it’s a win-win situation either for the enterprise than for the customer, who doesn’t need to wait excessive time.

Then, due to all the possibilities offered by this new manufacturing process, companies need to really identify what they are doing. If a company has many printers, it can answer to many demands, the risk is high because a company can differentiate itself too much. It produces a toy one day, and a glass another day. They need to keep their values and visions, to evaluate their capabilities and assets and to stay competitive to other companies’ capabilities. (D’Aveni, 2015)

As we said before, nowadays, platforms are the trend of our society, as Uber or Airbnb are. In the future, as we say in the industry 4.0, these platforms will be more and more present. This represents an opportunity for the Additive Manufacturing. The biggest actors of the technology, Stratasys or 3D Systems, or even eBay, are willing to develop platforms. It will allow other companies to share and sell design, to a network composed of consumers or makers, in order to be produced in customer’s home or in printer farms, as FabLab could be like a retailer or any enterprise. Blueprints will be stored, and printers’ capacity will be trade all over the world. This will create a competitive ecosystem, where printers owner will compete with design sharer, to deal with the customer and product flow.(D’Aveni, 2015)

PART III:

The Dental industry: a technological advanced environment

After explaining, the concept of Mass Customization and the advantages of the Additive Manufacturing, we will try illustrating that with an example. The dental industry is the perfect case. The Dental market is offering a personalized product according to a patient. In order to achieve that the industry has been digitalized through the last decades, and now is starting to integrate more and more 3D printers in their manufacturing process. We will have the opportunity to see the vision of three successful managers making business at a different level in the market.

Picture 19 : A Removable Partial Denture made By 3DRPD

I. The Dental industry

This first chapter aim to provide a concrete understanding of the dental markets, regarding products, activities, and competition.

I.1 Overview of the market

The dental industry gathers different activities and participants as the dentist, the Dental laboratory, and the Dental Suppliers. The prosthetics dentistry is about analysis, treatment, and support of the oral function. In order to response to patient's needs, dentists provide crowns or bridges, denture, and abutments made by dental laboratories. These products offer comfort, made clinical surgery due to missing teeth or damaged teeth made with biocompatible materials. The aim of these products is to offers health and aesthetics option for patients.

This market has shown an interesting growth for the past few years. Due to the aging of the baby boomer class, where we find more incidences of dental caries, tooth loss, and other periodontal conditions, we found out that they are the one who drive the market worldwide. This population is more touched by the edentulism, the fact of having fewer teeth at some different level. The focus made by companies and dentists to provide efficient dental care, better quality and the global rising income and the disposition to spend more to have the better product are also factors that help the growth of the market.

However, the economic slowdown and limited reimbursement and insurances coverage did by government inhibit the growth of the market to a certain extent.

I.2– Global Market drivers

As we said, the expanding aging population is a market driver as there are more subject to edentulism and more vulnerate to teeth loss. In the same time, it will increase oral diseases and raise the number of dental procedures. The advancement of Dental technology represents a factor that will permit to reduce the time for manufacturing, improving the quality of the product and reducing the

manufacturing cost but not automatically the product price according to Mr. Bongert. With the new technologies, new materials will be accessible as biomaterials represent an opportunity. Consumers will be attracting by the cosmetics and aesthetics that dentistry can offer, this trend will be found in developing countries, where incomes are higher. The industry will tend to focus on dental aesthetics and consumer. Globally we will be the rising awareness about dental care.

I.3 – Product

A dental prosthetic is a personalized product, ordered by dentists for their patient. There is an infinity of variations in design, material, and utility in products made by dental labs. We can speak about Removable Partial Denture, bridges, crowns, implants, and orthodontist apparel, all of these products are unique to perfectly fit into the patient mouth or treat special incidences.

The main segment in this industry is crowns and bridges. This segment can also be divided into material families. The main ones are Porcelain-Fused Metal, ceramic, and others metal. The titanium was the most used material, in 2014, due to its better biocompatible characteristics, and its lower cost than the Zirconium.

I.4 – In number

The dental market valued $2,861.2 million in 2013, and $7,365.7 million in 2015. Market Analysts evaluated growth around CAGR 7% during next years, in order to reach in 2020, around $10,300 million according to different market studies.

The crowns & bridges segment represents 97% of the total market activity. The different material families we spoke about before, represent 58% for the Porcelain-Fused Metal, and 31% for the ceramics prosthetics of the total dental market. This segment is expecting to grow with a CAGR of 8.3% and reach $1 billion in 2018.

I.5 – Geography perspectives

In term of localization, the dental industry is spread into two majors areas: Europe and North America. In these areas, we can find a bigger percentage of the elderly population and it is where the insurance and coverage procedure are present for a long time. Europe used to represent the largest market. France, Germany, and Switzerland are the main drivers for this market, where we can find the biggest dental material suppliers as Ivoclar Vivadent AG (Lichtenstein), Nobel Biocare and Straumann (Switzerland). But for Mr. THERIAULT, the biggest market is the US "when we think about the market, America is always 40%!". We can also speak about a new trend that starts to gain power nowadays: the medical tourism. In Europe, Italy, Spain Romani or Hungarian has attracted many consumers for their lower prices. This tourism will also affect two others big regions of the world as Asia Pacific and Latin America. These regions will show, in the next years, the fastest growth in the market, because of their low cost of treatment and low prices in dental products. The dental awareness will rise in those regions as better-trained dentists and other healthcare infrastructures are attracting dental tourists. We can localize Brazil, Mexico, India, China and South Korea as the main prospectus markets. The US and European top companies already evaluate those markets, and try to penetrate it by doing acquisitions and launching products.

I.6 – The dental lab crisis

In France, there were 5,259 dental laboratories and 21,250 professionals in 2002. Ten years after, a decrease happened and 3,800 dental lab and 17,900 professionals were remaining. This represents a decrease of 27% between 2002 and 2013. In comparison 5000 of 13000 dental labs have closed in the last few years. This is due to the increasing of imported product, especially from Asia. The Asian Dumping delivers products at lower cost made with low labor cost. In France, 30% of the dental prosthetics come from importation. The work is sent overseas, because the labor cost in dental labs, in developed countries is high. In contrary, in China, it is easy to find 1,500 dental technicians in laboratories. Even if it is an actual fact which

you can find in every industry, Chinese imported goods usually don't follow regulations, as FDA for example in the US. Like Mr. THERIAULT explained, the FDA homologation is primordial to enter the US market, and even that his company needed the downstream of Santé Canada, the equivalent of FDA, to offer its product and by consequent enter the US market.

Ten years ago, it was normal to see small dental labs or basement labs, but with the difficulties of finding employees, who have rare and high certification and so cost more, and the prices of new technologies, these small labs tend to disappear.

They try to associate with other bigger laboratories, which had a bigger workforce and bigger resources to invest in sophisticated equipment. Having larger amounts of employees doesn't mean working as an assembly line. The final product is a patient's personalized goods handcrafted. There are different technicians who work the product before delivering, but it's required precision and time to perfectly fit in the patient's mouth. The qualified labor represents a very big cost for laboratories.

This explains the reason of the digitalization this profession. CAD/CAM look like the rescue for the dental sectors. For instance, Mr. Pascal Bongert (owner of Laboratoire Bongert) told me, that he started to invest in the CAD/CAM years ago, before continuously investing in new technology and acquiring their first 3D Printer in 2007. In France, 45% of laboratories are equipped with CAD/CAM, during 2014, one-quarter of investment was on new technology.

II – The Dental laboratories is facing the numeric age

In this chapter, the interviews of Mrs. DELOGE, and Mr. BONGERT will help us understand how the 3D printer became a very important tool in their laboratory. Through their words, we will see the different steps and benefits of the integration of 3D Printers.

II.1– The technology rescue

The arrival of CAD and CAM technology has excessively reduced the treatment time. Crowns designed by CAD/CAM are always seen as a better product as a traditional product and are available at the same price.

For laboratories, the technology reduces drastically the manufacturing time. These factors will drive the ceramic market across the world. The demand for CAD/CAM ceramic is increasing rapidly, because of their superior aesthetic and improved fitting. About 20% of all prosthesis elements have been made with this technology in 2012. CAD/CAM permit to lower the production cost for labs. Though the majority of prosthetic elements are still made manually, the use of CAD/CAM prosthetic elements continues to increase due to the advantages of the technology over conventional technologies. Therefore, this is an exciting market for dental players to invest in. This will lead to the development of new material with high compatibility with the human body, and it will also improve the workflow.

However due to the cost of machines, small labs cannot compete with bigger one. It's another reason why small lab tends to disappear. In order to stay competitive, small labs need to get the technology, but they don't have the financial resource to afford that. The solution is to associate with other laboratories.

II.2 – An industry digitalized

Due to the progress and the importance of the technology in this sector, the entire industry started to be redefining. The whole workflow is getting digitalized. The Dentist now started to take impressions with 3D Scanner, which permits to create a file, and a 3D impression faster than the traditional way using alginate. Mr.

BONGERT explains that this step of sending a file and not a physical impression anymore is an important point in the dental laboratory activity. Furthermore, Mr. THERIAULT enhances this advantage by explaining that this file "stayed in his computer for all (his) life", which permit to recreate or modify it when needed. In any case, the dental laboratory has to rework both. If it's the conventional way, the impression is in negative the technician needs it in positive. He will use a 3D scanner, and print the module in resin, or used plaster on the dentist's impression to have the module ready to work. After examining it, and depending on the treatment needed, implants, abutments, or RPD, the dental could refer to a supplier for a special part.

II.3 – The future will be with 3D Printer

Mr. Bongert and M. Deloge will help us to understand how they adopted 3D printing in their laboratory and what are their benefits from this technology.

The Laboratoire Bongert, established in 1970, is the pioneer in the dental lab sector in France. 120 employees make 75,000 prostheses each year.

Dental Cap Ocean, is a dental laboratory own by Mrs DELOGE for 10 years, working in collabaoration with the Laboratoire Bongert. The company has a turnover of 2 millions Euros and employed 28 peoples

The Additive Manufacturing was for him an obligation to compete for the low-cost product from China.

A – The discovery

Mrs. Deloge explained me, that she discovered the company by participating in some international conferences, mainly in Germany. There, she met innovative companies and other dental suppliers.

I had the opportunity to interview Pascal BONGERT, he explained to me how he managed his company and his employees to adopt new technologies. Since the beginning of the 2000s, Mr. Bongert has been interested in the CAD/CAM technology. After using mainly CAM process, he "discovered three-dimensional printing, with a printer from 3D Systems, which was printing wax". It was for him

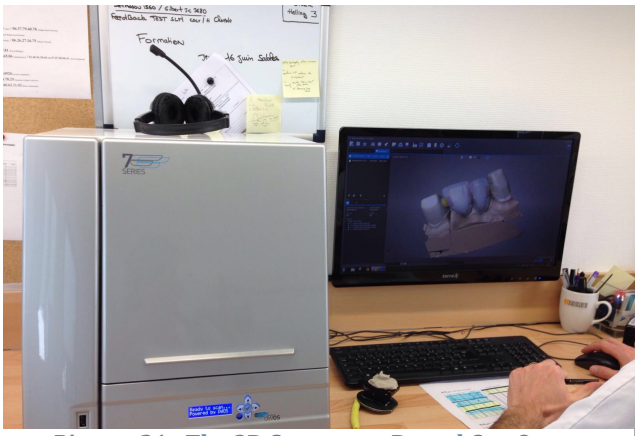
the first 3D printer he bought in 2007, now he owns 4 printers. He explains to me, he didn't "really understand what could achieve with 3D printing", this idea can be associated to the bent we can actually find in the market nowadays. The consumer doesn't really know what they can do, they can also be afraid, this can explain why machines are interested only the early adopters. For him, 3D printer was assimilated to rapid prototyping, as he explains to me this reveal the exact activity of industry, we make and try prototype which can fit in the patient's mouth.

B – The Implementation

With the evolution from plastic to wax printers to metal printing, Mr. Bongert integrates the machine into his fabrication process. For him, the 3d printer is not the core of his manufacturing process but much more a tool that will help to have the final product. He took the example of a house construction: "the process of building a house starts (…) by the ground studies and the architect's design. For us the 3D Printer is simply the masonry, it enters only when we had decided all we need upstream, and only at this moment we will start the house." The 3D printer is at the beginning of the process, but only act to fabricate, in order to have the final product, which Pascal admit that the product coming from the machine always need some post adjustment.

Picture 20 : The Creation of the STL File at Dental Cap Ocean

In contrary, Mrs. Deloge told me that it's impossible for her laboratory to own a machine. She prefers working with other laboratories, which has a 3D printer to create products or parts, the laboratory needs. She uses subcontract to manufacture their



Picture 21 : The 3D Scanner at Dental Cap Ocean

product, these laboratories are a new form of suppliers. So Mrs. Deloge bought a 3D Scanner in order to create the STL file they will be sent to a 3D printer, located in big supplier or big laboratory.

She has the obligation to work with 3D printers because the market is expecting this quality of product, so she needs to follow the “the industrialization of her profession"

C – The Final Product

With the 3D printing gives to the product a better quality. The machine draws the “intrinsic quality of the material” and procures a better precision. The machine permits to avoid 10 to 20% of step, according to Mr. Bongert, than the conventional process. Avoiding theses step result in better quality, high precision in his “intrinsic element of usage” in order to give something better adapted to the mouth. Mr. Bongert admits that the machine leads the company to be more efficient because it can work by night, producing more and easier.

One negative point could be the cost of the final product. In general, Pascal Bongert explains: ” we are near 50 to 60% of superior” cost. This is compensated by the gain in productivity, labor cost, and the finalization of the product.

D – Advantage of the technic

For Mr. Bongert, the 3D Printer, give many opportunities and advantages. For him, there is a gain of time, as we said the machine could work alone by night for example. There is a gain of productivity, where he can do “ 2 or 2.2 instead of 1” product at the same time. We saw in the theoretical part that the labor cost of the machine can be a limit, but for Pascal Bongert, there is a gain in labor cost. This higher productivity and reduction of manufacturing gain result in gain labor cost, which permits him to “increase his activity and his turnover”. These gain permits to give a product, which the final cost are higher, to the same price at the other conventional product on the market. The most important for the manager is to sell the added value offer by the machine.

Mrs. Deloge manages to offers such a better product that fit perfectly to the patient, and which the dentist loved to work with. In another way, she manages to increase the loyalty of their dentist.

E – The Added Value

When I asked the question " you have to sell the added value, that you offer to client", Mr. Bongert admits that it's something he didn't manage to sell. So he is offering a better product at every level but at the same price because the higher cost should not have an effect on the final product. As he explained: "when consumers see digital or numeric, the price has to decrease, and my objective is to say no". The final cost should be higher but Mr. Bongert to stay competitive, he aligns his price to the competition. That's why he has to sell the added value of its product. For him, the added value of his product is the innovation. The innovation he is using to produce, permit to obtain qualitative and technics results. The technics value permit to better position the product on the market. For him, the principal threat comes from China, where the labor cost is low. If Chinese laboratories start to use 3D printing, the Laboratoire Bongert and the Chinese one will have "the same weapon" same machine, same material. The labor cost will not be important anymore, so they will not compete anymore on the final price but on the amortization. So producing the same denture product in France has more interest than important in China: product twill be the same but there will be a differentiation in the service.

III – The vision of a worldwide denture supplier: 3DRPD

This section is feed by the interview of Mr. THERIAULT, the CEO and Founder of 3DRPD, and Mr. Bongert the CEO of 3DRPD Europe. I had the chance to have a conversation with each one of them, to speak about the company and the 3D Printing in general.

III.1 – Presentation of the company

3DRPD, 3 Dimensional Removable Partial Denture, is a manufacturer of dental prosthesis removable, specialized in the conception of metallic chassis. The company manages the production of the metallic chassis and it can also adapt itself by doing only the fabrication. The metallic chassis is made as a measurement, and therefore every product is unique.

The main objective of the company is to be a Removale Partial Denture, quick, viable, with a large range of product that can be adapted for everybody. In order to achieve this goal, the company's strategy is aiming the manufacturing, the globalization, the innovation, and alliances, which are made with 3DRPD.

3DRPD is the first and only one, company in the world that are manufacturing with a 3D printer, chrome cobalt Removable partial denture in the world. Since 2012, 3DRPD have sold about 50,000 of dental prosthesis in the entire world. Now the company has four 3D printers, in Europe and North America, with a maximum productivity of 60 chassis by day.

The main difficulty for 3DRPD is to furnish themselves in 3D printers. Indeed, there are only 2 companies based in France and Germany, which can manage to create this equipment.

Before this technique came, metallic chassis were made by hand. Dental lab created themselves or order it to a denture supplier. Now with 3D printers, 3DRPD can ensure a new kind of conceptualization: more industrial, precise, fast and rigorous.

A. Customer

3DRPD reaches a certain type of customers: the dental prosthesis labs. The company is developing more and more alliances with their main clients to increase their volume of order, by giving them products with high added value at low cost.

Because 3DRPD want to keep this high and quality savoir-faire, the company is investing a large amount of his turnovers in new technologies and research and development. Very implicated in the technologies of designing and manufacturing, 3DRPR manages to collaborate with diverse contributors in the CAD, Computer-aided Design, and CAM, Computer-Aided Manufacturing in order to be efficient is the type of production. Therefore, the company can stay proactive toward the evolution and the rapid growth of new technics link to CAD/CAM.

B. Product

The main product made by 3DRPD is a Removable Partial Denture doing by CAD/CAM. It's the base of an implant or a dental prosthetics.

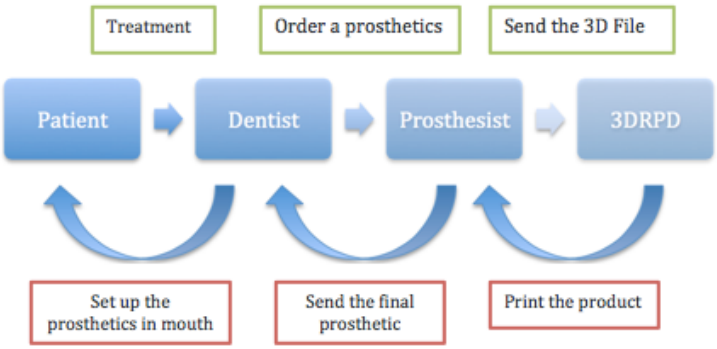
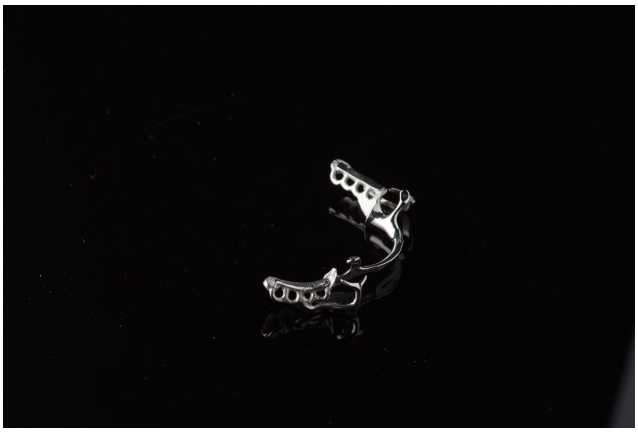


Figure 3 : 3DRPD Workflow

For instance, a patient will consult his dentist for a treatment. Then, the dentist will order the prosthetics to his prosthesis. The prosthesis according to the treatment, will order a specific base with his 3D scanner. 3DRPD will receive the file, put the data inside the machine then the result will be printed and sent back to the prosthesis. He will then finish the work before giving back to the dentist. At the end of the process, the dentist will introduce the product in the mouth of the patient. So the 3DRPD product is reworked by prosthesis: it is not directly sold to the patient.



Picture 22 : Final Product sent to laboratories

III. 2 A 3D Printer, not a simple tools

A. The Origine of the Idea

Mr. THERIAULT as Mr. Bongert as quite the same profile: they both have a dental laboratory playing among the top companies in this sector in their respective countries. Mr. THERIAULT own 2 laboratories called Dentachrome, leaders in Québec. They both have their respective company from the 90s, and as Mr. Bongert said they did quite at the same time their MBA for Denis THERIAULT and a management license for Pascal Bongert. The idea of 3DRPD comes from Mr. THERIAULT and a meeting with the CEO of Dental Wings. This last company was trying to develop dental scanners. The Dental Wings CEO asks Denis to help him because of his experiences and his expertise in the denture industry. After developing the scanner, which creates STL files, Mr. THERIAULT wonders who can produce this, and they come to the point that nobody in the world can print this file. That's why, in 2011, Mr. THERIAULT create 3DRPD. After the homologation from medical institutions, they started the production in 2012. Now 3DRPD is producing Removable Partial Denture in Chrome Cobalt, and distribute it in 3 majors region: North America (USA & Canada) which Mr. Théirault is responsible, Europe lead by Mr. Bongert and in Australia.

B. A company drives by value

As Mr. THERIAULT explains to me "it's a replacement product we have to be careful, it's not a new product and we replace an existing one". In order to compete, they have to offer value. As Pascal Bongert said, their added value is the quality of the product and the innovation added. Mr. THERIAULT stands for the same value, he also had the reduced time of production, that for Mr. Bongert reduce the labor cost and the fact that the product is recorded on the computer for a very long time. It will permit to produce it again if the patient needs some changes, the customization is infinite and possible thanks to the 3D printer. But Mr. THERIAULT is emphasis on one important value for him: Human. Denis wants to offer a product that is better for the patient, more comfortable, healthier, which improve their everyday life. This is very important for him. The 3D printing can achieve that because it is delivering

better quality, the product is much more convenient for the patient. Technically the product is the same, there are some clasps on the RPD which clip the natural tooth and its permit to stay at the right place in the mouth. With the conventional fabrication this clasp after 6000 open and close, the RPD will lose the "80 % of memory" meaning by that it will not fit perfectly anymore. With the 3D Printer, after 6000 open and close the claps will lose only 95% of the memory. For Mr. THERIAULT, this advanced product will make patient's life easier, and for him, it is the main goal of his company.

C. A scale up company.

3DRPD is using the Stereo Lithography technics, to produce its product. As we saw before, many theories said that 3D Printing is not the best tool to fabricate in big quantity. As the two founders said to me, producing with a 3D printer results in having a product with higher cost. Mr. THERIAULT said the contradictory of this theory : "if you want to make money with this production, you should go on the quantity production". He also explained that all the costs of the production, force him to produce more, that's why its main goal was to reach 100 RPD in one day. 3DRPD is not a supplier but a production center, they receive a file, produce it and send it back to the laboratory: "If we can design it, and if you need the product in cobalt chrome, 3DRPD can print it." This production process requires big financial resource, 3DRPD own 10 machines and each machine cost around 400,000€. That's why Mr. Bongert told us, the entry barriers are difficult to cross. New companies need the financial resources but also the savoir-faire. Concerning the savoir-faire, Mr. Théirault explains that it was a long development procedure that they establish before going to the market, and before reaching high production quantity you

Picture 23 : The Production Center in Europe of 3DRPD is composed of two 3D Printers

need to know your product. He takes the example of the Big Mac to illustrate: before going to the market the Big mac was tested, maybe for several months, and then when they knew what to do, they have to try the production, and when they can produce 1 million, they can produce 2 or 3. He assimilated it to his company: as soon as I will be able to print one hundred a day, it's easy for me to print 2 times one hundred 3 times one hundred of, 4 times one hundred, doesn't matter for me"

Mr. THERIAULT describes this company as a "scale up" company. Meaning by that, they need to produce a lot to educe good revenue, due to the fact that their product already exists. They both agree that it's difficult for a laboratory to switch to their product. Dental technicians are used to working with the conventional product and are dependent from their dentist. In order to obtain more dental lab, 3DRPD needs to really well market their value.

D. Competition and Opportunities

3DRPD is the only company which is doing cobalt chrome RPD with Additive Manufacturing. When I spoke to him about the competition he argued that he has no competitors. They are the only one to deliver such an innovated product with a very high level of quality. Nobody manages to produce. As Mr. BONGERT explains, they know that some companies try to do as 3DRPD but they can't manage to offer the same product.

To Resume

The three companies have some very interesting opportunities in front of them. Mrs DELOGE is fidelizing her clients and wants to grow her market thanks to the quality of the product she is offering. Mr BONGERT exploit every possibility of his machines in order to reduce the cost, avoid some steps while obtaining such a better product that can compete every imported goods. Then Mr THERIAULT and Mr BONGERT, together has a prosperous company called 3DRPD, that is offering a product that have never been done and when at this time nobody in the market is able to reproduce it.

Furthermore, with this interview I met three passionate managers. They both love what they are doing, and exciting about the future of their profession. This is an important fact that all managagers need to have to reach the success: be passionnate, and maybe " a bit crazy" as Mr THERIAULT said.

Conclusion

Before our investigation, we thought that the 3D Printer will be accessible to everybody, and will allow everybody and companies to create objects rapidly. In order to achieve that, the society and industries need to continue their evolution. We can easily predict that the industry 4.0 expressed by Mr. De Rosnay, is on its way. The Internet will be present everywhere and companies will be organized differently. Platforms will continue to appear, in order to put in relation consumers and creators. By this, organization will understand customer expectations and will deliver the perfect product. Thanks to the tremendous quantity of data, companies can develop a product that fits everybody. Here, the 3D Printer enters in the game. The company will manage to offer the customized product expected by the consumer.

When we thought customers would be able to create their own product, this trend will still need some development. Not everybody can create a product with the Additive Manufacturing technology. That's why the platform will share source of data that is called crowdsourcing. Of course, customers will express their desire, but they will not be all able to create by themselves, they will need the help of companies. Companies will see that as an advantage to create their product directly in customer's home. This links to another hypothesis we made. We think that 3D printer will restructure the supply chain management. We learned that 3D Printer permits to avoid costs. The inventories and transportation costs will be affected. Companies will not be anymore obliged to stock large quantities of product. First, because they will create a product in one build, and not by assembling different components. Secondly, they will be able to produce in the right quantity at the right time depending on the market demand. These reduced steps will decrease the transportation. Enterprise will be able to relocate their production center. There will be one mother company, designing the STL file, sending it to production centers. All the transportation costs could be avoided by the technology. This production centers would be found in convenience stores, supermarkets, in every kind of retail stores, even in customers' houses.

As we supposed, this technology has some limits. There are three limits we developed in our study. In the first place, as we said the 3D Printer and the

technology behind are not accessible to everybody. They are so much advanced, that to understand the functioning you need to have a certain level of expertise. Creating the STL file requires also different tools and practices that nobody can have access easily. These complicated tasks affected the second limit, which is time. Before the study, I personally thought that you just needed to press a button and then you have your product in the minute. As explain Mr. BONGERT, the machine it's not plug and play. You require time to set up your machine, create the STL file, and then enter your data. Furthermore, there is a time of production that could reach hours even days of production. The idea of "on demand" delivery we emitted, is not really possible now, but there are strong Research and Develoment project made by companies to break the limitations. Some small parts could take few minutes or few hours, but an entire company needs more time to produce in big quantity. So our idea "on demand" is more "in response to the market". The company will be able to specify the amount of product at the same time, compared to the traditional manufacturing where you need to produce big quantity to reduce your production cost. With the 3D printer, the production cost is linear. The last limit would be obvious because it is the cost of the technology. The machine has a big cost, as Mr. Thériault told me, his machine cost 400,000€. In addition, the materials used by the machine have high characteristics and by consequent are expensive. On the other hand, the machine does not do wastage, it put the right amount of material at the right place. There are also important fixed costs. The machine is consuming more power because it's working longer. The maintenance costs are also high and unpredictable as Mr. Bognert explained. All this overall cost let companies afraid about buying and integrating the machine into their process.

So we thought that the competition will increase due to the democratization of 3D printer and I was wrong. The cost, the time and the technical aspects represent a threat to anyone who wants to acquire a 3D Printer. Companies who want to acquire Additive Manufacturing systems need financial resources and qualify labor for that achievement. As Mr. BONGERT and Mr. THERIAULT said, the entry barriers for new companies are still high. For instance Mrs DELOGE, is in a good place to illustrate this, she can't afford to buy a 3D Printer, because it represents a financial risk for her company, she preferes working with others big companies which can produce her orders at a lower cost. If we take their example of 3DRPD, nobody and

even bigger company are able to recreate a product similar to their RPD. When I spoke to them about the exponential penetration of 3D Desktop printer, and the possibility that consumers will create a new competition, they both argue that this is believable, but it will require time and recognition for the bunch of possibilities that offer a 3D printer. In other words, individuals will not be able to create the intra-competition I was thinking. However due to the decreasing price of desktop 3D printer, and with the communication rising around the technology, the machine is ready to make the buzz. When I think about Apple and the iPhone, I come to the idea if a company could offer a revolutionary machine at a relatively affordable price with a strong marketing strategy this will be the same success. In term of customization, the Additive Manufacturing offers wide possibilities. This new tool can adapt to any disposition, to any design and can offer new characteristics. The benefits of the 3D printer are recognized in some indsutries. For example, in the aeronautic industry, the 3D printer can create stronger parts and lightweight that can decrease by consequence the fuel consumption. In the medical industry, the 3D printer represents an important opportunity to create tailored prosthetics, specialized and unique tools adapted to any bodies in order to achieve a chirurgical operation.

That's why interviews of majors dental companies have cleared our vision toward this machine. For them, the Additive Manufacturing offers possibilities that their clients, dentists, are waiting to better treat their patient. They can create on demand a product that will fit perfectly in the mouth. Another advantage these managers told me because it's a computerized technology they can record the file (STL), as long as they want and can modify it when they need to. Both of them are driven by their passion and the desire to offer a better, high quality and most comfortable possible product for their patient.

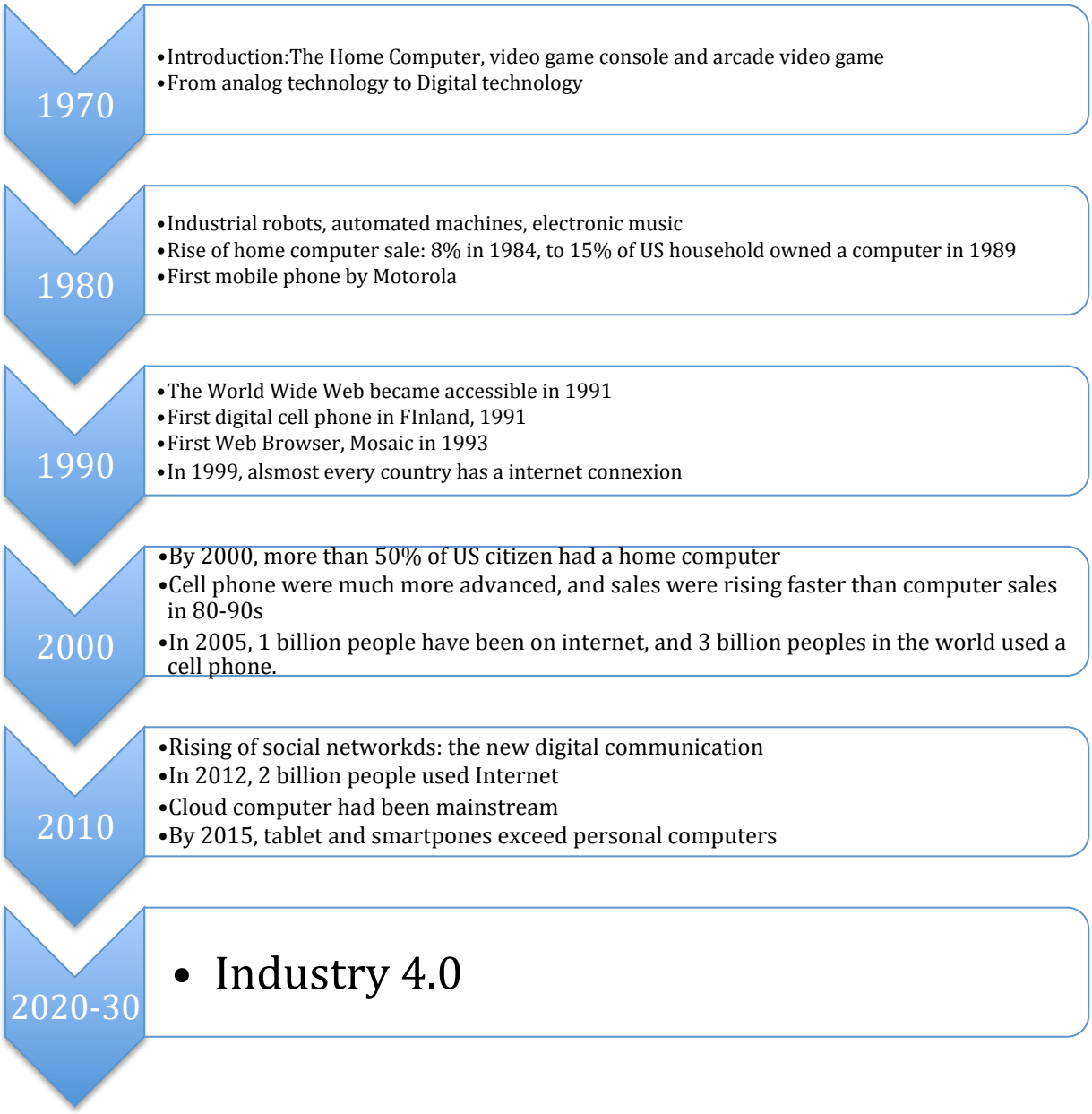
Our last words will be to explain how the 3D Printer will revolutionize our industrial world and day-to-day life. In our multi-connected world, we are giving data to system that will better understand us. Companies are exploiting it to offer the perfect product. We are living in a society, where everybody wants to be unique and have his or her own product. The Mass Customization is present in every new services and product delivered by companies. The Additive Manufacturing will offer this personalized product. The way companies are distributing a product and

delivering it, will change. The notion of time in business could be redefined. The proximity with enterprises will be reducing. We could find our future product next-door, or even in our home.

Nevertheless, there is an interface that we didn't take into account. Nowadays when companies are producing goods, they used transportation courier to deliver them to a point of sale. We couldn't have the view from this couriers company, how they see the arrival of the 3D printer in the business world. This could represent a threat for this transporter if manufacturing company equipped themselves with 3D Printer, they will not send physical product anymore, but file to their printers located in strategic place.

Appendices

Appendice 1 : Timeline of The Thrid Revolution



Appendice 2 : Interview of Denis THERIAULT, CEO & Founder of 3DRPD

24/05/2016

Mr. Theriault spoke about a congress he went and made a conference
In my case, in this meeting, where in major part all the presentation were about R&D, I've presented a concrete commercialization thanks to 3DRPD, but what I've seen and what I've heard, Jeremy believe me, are unbelievable. For example, I saw a small square such thin that they will put under the skin of a patient, in order to treat diabetics people. I saw so many things that I can't explain to you because they are so much advanced technologically. What I remember from this it's how 3D printing will revolutionize every industry in the world at every level, human, mechanic, production, and it was for me not a revelation but I suspected this but now I had such evidence, and it was very very interesting. We close the bracket.

So I decided to interview you, Denis, to have a worldwide vision of the 3D production, Mr. BONGERT for the National perspective but also European with 3DRPD Europe, and Mme Deloge for the regional side. I divided the interview into 3 parts: You and you company, the opportunities and the 3D printer itself.
But first, I want to know who are you, and how did you become a 3D printer addict, if I can say?

Ok, so I'm dental prosthetics since 1983, I always been in love with the production of Dental Stelite, we were fabricated in a traditional way, before the laboratory itself was manufactured its stellit, fix structure like Mme Deloge is doing in her laboratory. I have always been one of the rare student that love product stelitte. So I opened my first laboratory in Quebec in 1983, and then I opened a second laboratory in Montreal in 1995, and now my laboratory called Dentachrome are the market leader in Quebec with around 60 employees, we are presented in the universities, hospitals almost everywhere, so this me

You before 3DRPD?

Yes before 3DRPD, I am the CEO and founder of it (Dentachrome), after I run into, in 2011, the CEO of Dental Wings who produce dental scanners, in order to model the dental impression. So I met the company based in Montreal, the CEO asked me if I could help him to develop, yes to develop, a software of stelit production. "Us(Dental Wings) we have the ingredient, but we don't have any dental prosthetist, may be with you experience could you gave some advice and validate the process we are doing in a software for website. " so I said yes with pleasure, so I met his team few times, then and I had one question which was, finally THE question, I said " your company will create a software to draw dental stellite, but now when you will create your file, an STL file, who will permit be able to print it?" He looked at me and he said " I have no idea, it was n part of my core business, I don't know" I said to him in "your production room, you give the software, and the STL file, but there are nobody after to create it? " he argues "No". I said to him I don't believe you, I'm sure there is somebody in the world who is able to print it… And we did our strategic analysis, and everything, we come to the point finally that there is nobody, no laboratories, no production center, who is able to receive the STL file. And so the company 3DRPD has been created with a very small machine, a small plastic printer. So we started the R6D and tests, the first printer lend kindly by delta wings, and then we started to print STL file in plastic. We realize that the plastic was not, strong enough, we were casting the alloy, and we were losing all characteristics expected. By that, we bought and import the first printer from the Fedex enterprise, from France, based in Clermont Ferrand. The company has developed a certain expertise in the dental sector, who printed sometimes before some dental part. We acquired

the machine from them and the powder from Santé Canada, the equivalent of FDA, the Food and Drug institution in the US. SO when we receive the homologation from santé Canada, to know that the powder was accepted in Canada, then we start the clinic test in mouth (in patient mouth)

So, in fact, you start to establish contact with Dental Wings in which year?

Dental Wings in 2011,
And so the first time, you put in the mouth a product it was in?

I said probably in 2012,

So it took one year of experimentation and every test

And at this beginning, we printed in plastic, and he could go in a mouth,

So, it's not as we said, you want to print something, you do it and then you commercialize right now, no you need a lot of tests and submit to government and law

Yes for sure when you work with the human body, you need some homologation. But of course if you want to print some cufflink, you don't need anything, you take a table and you sell it in a commercial fair.
One of our first rules, in our company, it's not a rule but a necessity, obligation, is to find where you were, you have to certify that you did your tests with a university. You have to find the recognition for the university, what we've done from the beginning, you did the test clinic everything in order to know if our stellit, will fabricated, we printed, was a good quality. We discovered the fact that they had a better quality than the one did traditionally. It was at this moment a big risk for the company, because if the studies and the conclusion was that the stellit was the same even a bit less efficient that the traditional process, the entire project was done for nothing. We wished to have an element of differentiation important between the traditional stelit and our. But we suspect that the printed product was better that the conventional process, and it was the case.

So 3DRPD, it's a company which print … what is it exactly?

RPD, Removable Partial Denture.
This why our company is named 3DRPD, 3D for three-dimensional, and RPD for Removable Partial Denture, we choose this name because our main market is in the United state of America, and without Quebec, in Canada and united state everybody speak English so this why we decide to go with 3DRPD, this name is an easy for everybody to understand. When they see 3DRPD they see exactly what we are.

So this removable partial denture is when you want to have a fake tooth, its based, it's the metallic part?

No, it is the frame, in cobalt chrome, this frame will support the prosthetic teeth. So this is only the base with some clasper. They will clip the other teeth, and of course, if you have a RPD, it's because you need some teeth. So the first part it's the cobalt chrome, they fit and has some clasp to clip the teeth. Then the laboratory can process, can set up the fake teeth, the pink acrylic.

So your product is the base of the prosthetic laboratory activity? So the dentist will take an impression, with the 3D scanner for you, the file will go the laboratory or directly to you?

Yeah ok, I'll explain to you the workflow.
For example, you need to have a RPD for you. What you will do, you will go the dentist, the dentist will take an impression of your mouth, and then they will do the model in plaster. They will have a model in negative of you mouth. With this model, the dentist will send the model to a dental laboratory. Most of them, don't produce RPD, they can't do it. So they will send the model to a laboratory which ar doing RPDs or if have a scanner, you will put the model into the scanner and then the scanner will scan and create an STL file of the product. So your laboratory will send to 3DRPD the scan of the model, and then we will be able to design direct on the screen and then create an STL file, and then send the file to the printer, a cobalt chrome printer, and then we will produce the RPD direct from the STL file, received from the laboratory and then he will receive the final model printed. Do you understand the workflow it's not easy.

Yes, I understand, so the dental laboratory scans the model, it will be an STL model, he will send to 3DRPD, which will design it, it will create another STL model? Layer-by-Layer? Ah, so another STL model in positive because the other one was negative?

Got it!

So the technology of the machine is laser sintering?

Stl file…

STereo Lithography technics?

Exactly

So then the dental laboratory will do its work on the product from 3DRPD, and they send to the dentist who will put it in mouth

Exactly got it!

If the dental laboratory doesn't have a scanner, and can't work with you he will go to another company who will make the frame, the same product as you traditionally?

So now you have to option you send the model or the STL file to a laboratory and they will produce this, in a traditional way, or send this file to 3DRPD and we will print it with a laser sinter printer.

Ok, so the advantage of your company is the value. Well, what is the added value you give to your product?

We have 3 mains value, yeah more than 3 but we target 3 values:
- The turnover to produce is three days
- The STL file record is on my computer for the rest of my life, so we can repair, instantly when the laboratory need.
- The most important value in this process, I will try to explain to you ok. Imagine if you have a clasp, which goes around your teeth to fix the product in your mouth and it will stay at the right place if you don't have any clasp the RPD will move. If you cast the metal in a

traditional way, the metal won't keep the memory for a long time. After 6 thousand cycles, to open and close the clasp. The clasp loses 80% of the memory, it means after time the RPD will not fit as the beginning. It means your clasp will be loosed, it will move in your mouth. Then if you print with laser sintering after 6 thousand cycles the clasp will keep 95% of the memory. It means for the patient he won't have to go the dentist so often, to adjust the clasp, because the clasp will keep the memory after 6000 open and close. So this the dig added value for the patient compared to the traditional way.
It is very important to understand, Jeremy I will explain to you. Most of the company doesn't matter about the patient, the production the medical, most of the time use the technology to make their product cheaper, to produce more and more, most of the time at the end of the process it not common that they help the patient. Most of the system, where we bought since the last 20 years, help the company the dental lab to make profit to have more and more volume, to increase the benefits. Most of the time the patient can't see the added value. So for the first time, with laser sintering, at the end of the process, the patient will see a difference, and this is for me very very important, to see that the new technology will give to the patient a better product than the traditional way.

I saw this in my research, before company where driven by profit by money, but now companies tend to be driven by human, by what we gave to the end customer and not by profit, by the economy of scale or scope, but more by what the customer needs. This is what 3D printing can afford can give to consumers now. With traditional way if you want to reduce your cost you have to produce a lot, but now 3D will allow doing few production but better production.

That's it! And now you can see the difference. But, the dark side of that is to, if you want to make money with this production, you should go on the quantity production. You can't make money if you have only one printer or two. At least you make money if you produce 60 – 70 a day, so because of the cost of the equipment and all of the structure you need around the machine: the air the electricity lot of things, it costs a lot of money. That's why 3DRPD is a production center, not a dental laboratory. This is important to understand 3DRPD is a production center. We receive files, so we can produce any kind of product, any kind of prosthesis. If we can design it, and if you need the product in cobalt chrome, 3DRPD can print it. We print now RPD but we also print, implant, or surgical stand. We print also some orthodontist apparel; we are able to print it by using cobalt chrome.
It means that if you can design it, we can print it. If you need it in cobalt chrome, 3DRPD is able to do it.
Does it make sense to you?

Yeah for sure. So if somebody doesn't want a dental product, but he wants something in cobalt chrome, he can ask you and say "Denis I want to print this, in cobalt chrome? You can do it. " it's not a risk if you have the opportunity to produce anything you want, some manager can say " ok today who do dental prosthetics, tomorrow we print toys and we will sell it on the market!" Don't you think?

Well yes, this is a good question, honestly, we concentrate our production in the dental market, and so any kind of product we are producing came from dental fields, so we didn't print anything else. But honestly it's true, between you and me we have a Canadian optician here; he is doing his own glasses and he wanted a small logo in cobalt chrome on the branches, he send to us the design of the logo.
It's a small piece you have to insert here in the branch and we print I think like 1 hundred or 2 or 3 hundred like small parts to insert in the branch of the glasses so we've done that one time. We will not take money on that. That was just funny. It's funny to do that. We have done that part and we also did another part so it's just for fun we don't make money on that.

We charge like 3 dollars each one. But 3DRPD goals are we are dedicated to print exclusively dental parts in Cobalt Chrome that's our vision and the mission of 3DRPD for now.

And in terms of number what is it? Employees, turnover, growth?

Of course, when we started, we start from scratch I can tell you that last week for the first time since we start 3DRPD we print more than 1 hundred a day in 3DRPD USA so it was honestly my first goal when I started 3DRPD. In my mind, I said Denis, as soon as you will be able to print and finish one hundred a day you can say that now you have a success in your hands, but I like to compare RPDs with the Big Mac from McDonalds. How long it takes do you think to create the Big Mac? Before the big mac was on the market at the headquarter MacDonalds maybe it takes a year, maybe it takes a year and a half to decide what is, what we will have here in the big mac what kind of, what will be the bread, what kind of sauce you need and taste it and then come back. So as soon as they said this is the big mac then we will introduce the big mac in the market, so as soon as you've done one million big mac it's not a big deal to do 2 millions 3 4 5 because all the work you've done before it's pretty the same with 3DRPD we know how to build, how to design and how to print RPDs but in my mind my first goal was as soon as I will be able to print one hundred a day, it's easy for me to print 2 times one hundred 3 times one hundred of, 4 times one hundred, doesn't' matter for me. If you can print one hundred a day it's because your workflow is perfect cause you know how to print and you know from scratch if you can receive hundred files a day, you are able to print hundred files a day, you are able to finish hundred files a day. So for me it's the first big step for me and its was my first goal in my mind when I started 3DRPD to have one hundred a day cause you can't print 2 hundred a day if you can't print 1 hundred a day. Yes, you have to walk before to run. You can't run if you don't know how to walk.

How many 3D printers do you have?

We have 5 printers

With a capacity of 20 per printer more or less ?

Yeah, figure-to-figure 22 per machine per day so with 5 means that we have 110 capacity. We have 3 printers in Montreal, and Mr. BONGERT has 2. So together we were very close a week ago we were very close to print 2 hundred we were at 180 a day with Europe Canada and the USA. So this is a good step.

So there are 3 in Montréal 2 in France

Yes and 5 in the USA. Yes, we have 10 machines.

And how much is it one machine?

It's 375 000 US dollars

So it was a big investment?

375,000 yes it's closed to 400 000 euros. Mr. BONGERT bought a machine a year ago, you just have to ask Pascal what was the retail price, and he knows it.

And in terms of turnover?

It depends, it's a scale up process if you start with only one machine you loose money, 2 machines you don't make money a lot, 3 machines borderline and 4 5 6 7. I will tell you something and then you will understand. If you can produce 3 hundred RPDs a day your net benefits are 20%,

So there is a lot of fix costs behind like electricity, labor costs ?

Yes, the marge I think I'm sorry we're talking about EBITDA you know what is EBITDA? Earnings before Interest, Taxes, Depreciation, and Amortization you just have to check and I don't know exactly what is it, So it is a term in finance in which you measure benefices in function of amortization

Is it depreciation?

No depreciation is the rate you take on the machine each year, in English is benefits before interest and depreciation

How many employee do you have in 3DRPD ?

Overall with France? France and Canada? And the USA ? or Canada and the USA?

USA and Canada? *laugh*

USA Canada is a, in the USA we have 5 employees in the USA and in Canada we have more than that because we (counting) do you count the executive? Yes we are working *laugh* We are 8 employees in Canada

It's not that much. And you can produce maybe 100 product per day and you are only 8 + 5 USA so 13

Yes but now we have 5 employees in the USA we can produce up to 100 and we are probably able to produce 120.
In Canada we are 8 we have 3 machines but if I had two more machines and I can go to 100 a day also in Canada. I don't need more employees. So this is the minimum employees you should have to start a business but if you grow up your production daily weekly go to more than 100a day, you don't need to have more employee so this is why now you can understand why explained to you that this is a scale up run, company and if you have only 2 or 3 machines you don't make money but if you have 5 machines if you can produce 100 a day with the same numbers of employee then you make money.
I have ten more minutes for you. I have another meeting starting.

Ok well, what is the opportunity for 3DRPD now?

It's worldwide. We are discussing now to add a new production center in Europe probably in Belgium
And we are discussing with a partner to … maybe it's a possibility to transfer to 3DRPD France from Mr. BONGERT to have a new production center more centralized in Europe probably in Brussels and then to have 3DRPD huge production center in Brussels, and produce for all the countries around in Europe. It's probably Germany France Belgium UK Italy Spain and all these major countries and our target, our goal is to duplicate 3DRPD USA and doing the same in Europe to be able to produce 500 a day in USA and 500 a day in Europe. It's our goal.

These are the future market?

Yeah. So with the production center, then we will have an exclusive license. That's what we have now in Australia, New Zealand, and Switzerland. So what we will do is to give some exclusivity to countries to companies and then they will represent 3DRPD. They will have exclusivity of 3DRPD but they will not produce anything. It will send files to our production center. This is our business plan. Our business plan is to have three production center. One in Canada One in USA One is Europe and have exclusivity license.

The one in Australia is in Melbourne ?

Yes, and I was in New York yesterday and we receive 20 files from them yesterday. It was the first time that we receive 20 files in one day from Australia. It's good yeah. They are working hard. They have good marketing. They have a good marketing there.

Is this market going to prosper in Australia?

If they can send me 20 a day, 100 a week and 500 a month, I will be very happy.

Can't they produce it in Melbourne? You produce it in Canada and then you send it back?

Yes but now when we start 3DRPD when we start with the Australian guys, the production was only in Canada but then we transfer the production in the USA. So now we are producing in the USA it's more efficient to send, to ship from the USA than from Canada. It's faster from the USA instead of Canada so you save one day so that's the reason why we transferred from Canada to the USA.

And in terms of competition, is there some competitors? Except the traditional manufacturing?

I don't know. *laugh*

You don't know for the moment?

We don't have any. Honestly, they have few laboratories in France only. They start to produce RPD but in a very low production quantity per day but yeah so since we start years ago we know that some huge company tries to produce RPDs but they are not able to produce. So we are today may 24th thanks go we are the only one to have production center dedicated to RPDs. We are the only one worldwide.

About the 3D Printing, my question was that I saw in my researches, that 3D printing is not good for mass production, you the example of contrary, because you can produce 100 a day. I saw 3D printing is more for customization so how did you manage to exploit all capacities of 3D Printing in order take all the advantage in a mass production system. I read a lot of things that it is not dedicated for this, because the product is more expensive. How did you have you and Mr. BONGERT this idea to set all you production on the 3D printing technology? Was it risky?

Yes, sure. The numbers said the contrary! if you want to make a little production the price of the product would but too expensive than the traditional product. We could get through the

market, but if you go with a mass production 60, 80, par jour and if you are able to have a competitive price. Meaning by that the selling price of the RPD of traditional that RPD made by laser is the same price, you can't even try to enter in the market. Now we will be competitive because it's a replacement product, we have to be careful, it's not a new product, and we replace an existing product. And when you replace an existing product, people are not ready to pay. Because it's already available for 50 or 60 years, it works well so the question is : Why do we (dental laboratory) have to use 3DRPD ? if the question was : Why paying more with 3DRPD ? For the same product as the traditional one, if it was this we were bankrupt. One of the first goal I had very clear in my mind, the price had to be lower as possible, and ideally at the same level of the traditional one. If the selling price would have been more the traditional one, we would be bankrupt.

Is it the dental laboratory that will pay the product or the patient at the end of the chain that will pay?

No, it's the laboratory.

So, if I understand well its a B to B to B to C?

Mr. BONGERT and Mme DELOGE, their dental laboratory are B to C. 3DRPD is over that; 3DPRD is working for Mr. BONGERT or for the laboratory of Mme Deloge, without having direct link with their clients. So our goals are to convince laboratories to work with us, send their files to us. So the competitive advantage is the metal will keep the memory up to 95%, the dental laboratory will say « oh yes perfect I will speak about this to my dentist, which will say oh wow ! » so this is our main competitive advantage. Then the first question we still had is: is it the prices of your product is it higher or the same or lower than the traditional one? If you said its higher you're dead if you say pretty the same, why it the main reason I will switch for your product instead of the traditional, and we will argue because it's from the memory of the metal, the new advantage bring by the technology to the product. Your patient won't have to come back 3, 4 or 5 times to adjust the clasp of your RPD, THIS IS A HUGE ADVANTAGE!

Yeah, but the laboratory is not happy because it's client will not come back as much so, the laboratory loose some sales?

In my mind, I though I twill be easier than that, but honestly it's not easy to convert laboratories to switch from traditional to laser sintering.

So what is the next innovation project, with the 3D printer? The opportunities and development axis?

The main opportunity for us is to open a major production center in Europe and be able to become the worldwide leaders, and produce RPDs around the world. So we can imagine having a production in Europe and the USA we can reach a capacity of production of 1000 a day. With that, we will be the number 1 worldwide to produce RPD

Because Europe it's the biggest market right now?

No, the US market is the biggest one. The USA is 40% worldwide market. As soon as you speak about US market is always 40% of everything. All the Europe is probably Less 35% of the market but we all the countries.

Asia can develop the technology, can't they develop the concept as you? Have they this production idea?

People in North America are little bit afraid with China and India they don't like it so much, this is the reason why 3DRPD in the USA, in United States god bless America so the company it's called 3DRPDUSA.com. They are very very proud they protect their country; it would be impossible to produce from Canada to the USA.

Ok I think it's enough and last question,
Do you like what are you doing?

I love, if you go in my bedroom you will see RPDs under my pillow and this is Jeremy the number one thing I have a son who turn 20 years and he spent the last 2 years in business school to become an engineer and I was so proud and I said to my son do what you like to do because if you don't like it your life will be pain in the ass. So if you don't like what you are doing I can't imagine the life you will have so the passion is number one I love what I'm doing and I have friends around the world this is an amazing story, this is awesome what we've done, we are more than passionate, and you should be a little bit crazy to do what we are doing.

Appendice 3: Interview of Mr Pascal BONGERT, CEO of Laboratoire Bongert, and CEO & Founder of 3DRPD

29/05/2016

Bonjour Pascal, j'ai eu la chance de m'entretenir avec Mr Denis Thériault, il m'a évoqué la création de 3DRPD et m'a beaucoup parler de tout ce qui était production au sein de son entreprise. J'ai interviewé Denis pour avoir la vision mondial d'une entreprise qui utilise l'imprimante 3D, et je souhaite avoir ton témoignage, qui serait plus tourné vers un marché national grâce a ton laboratoire, et comment l'imprimante 3D t'a aidé, besoin ou pour rester compétitif. Mais je serais également intéressé par la stratégie de 3DRPD Europe qui tu as établie avec Denis.
Donc je vais te poser la même première question que j'ai posée à Denis :
Quel est ton parcours ? Comment est tu devenu dirigeant du Laboratoire Bongert et de 3DRPD Europe ?

*Alors, la direction du laboratoire Bogner s'est fais assez naturellement du fait que je porte le nom de l'entreprise, et du fait que mes parents possédait l'entreprise, j'ai intégré l'entreprise et presque naturellement, ce qui n'est pas bien car on ne devrait pas forcément. J'ai quitté l'entreprise pour recréer un autre laboratoire pour savoir si j'avais les épaules et les compétences pour diriger le laboratoire. Mais naturellement j'ai hérité de la boite. J'ai préféré validé que je pouvais en hériter, et le parcours fait que je suis reparti à l'école après, que j'estime que j'ai un niveau BAC -3 *rire* avec la prothèse en elle même. J'ai donc repris une école de question, un peu comme Denis Thériault qui avait fait un MBA, moi j'ai préféré faire un maitrise en gestion en 1997 exactement. On s'est aperçu que le Bac -3 n'était pas utile pour gérer une boite, il valait quand même mieux avoir des bases, et après en 99 j'ai repris l'entité de mes parents, et j'ai reprise la tète et j'ai continué à la développé.*
L'imprimante 3D est ce qui m'a emmené chez 3DRPD, c'est tout simplement la découverte et la rencontre avec des personnes. Ça c'est que je peux aussi vous attirer vous tous les jeunes, je l'ai encore fait hier avec un apprenti, la chance ça n'existe pas, comme le dis Philippe Gabilliet, tu dois être en Australie, un peu comme toi tu es en Australie tu fais des rencontres, des gens peuvent dire : « Jérémy il a de la chance il est en Australie ! » Je réponds « Non il n'a pas de chance il a créer l'opportunité et la saisi pour y aller » J'ai fais la même chose avec 3DRPD. C'est à dire que je me suis intéressé aux châssis métallique en prothèse dentaire et avec ça Jai souhaiter créer un nouveau cheminement, voir si on pouvait travailler d'une autre manière, voir si avec la prise d'empreintes optique, et puis avec un nouveau système de fabrication qui est la CFAO. De là j'ai eu cette rencontre avec Mr Thériault, que tu as interviewé et on s'est aperçu que on avait des parcours assez semblables, aussi bien côté privé humain mais aussi surtout sur le côté professionnel. En plus nous étions dans la même direction, dans la même voie. D'où in fine la mise en commun de nos connaissances, on a trouvé qu'il y avait comme toute association un intérêt à se grouper, et chacun de son coté à pouvoir regarder son marché. Nous avons donc créé 3DRPD USA et mais aussi 3DRPD Europe, naturellement il assure la direction du marché américain et canadien et moi j'ai pris l'Europe à charge. Voilà comment je suis devenu le gérant de 3DRPD Europe grâce a la notoriété du laboratoire Bongert et tous les acquis qu'il y avait avant, à la perspective et l'exploration des nouveaux territoires de l'innovation mais aussi des possibilités qu'il y avait et, après être dans les réseaux, et comme je dis toujours être une opportunité soi même pour être regardé et choisi, donc à ce moment là tu avances.

Concernant ton laboratoire avant d'être associé avec 3DRPD, utilisais tu déjà l'imprimante 3D, pour les besoins de ton entreprise et la fabrication des prothèses dentaire ?

Oui, nous avons commencé par l'utilisation de la FAO (Fabrication Assisté par Ordinateur) et CAO (Conception Assisté par Ordinateur). La FAO était uniquement de l'usinage Nous avons découvert l'imprimerie trois dimensionnelle, par une imprimante de chez 3D Sytems, qui imprimait de la cire, de la Wax Pro, c'était pour nous la première imprimante 3D en 2007. On a vraiment commencé par ça, et sincèrement je n'avais pas encore vraiment compris ce que pouvais faire l'imprimerie 3D.
*Tu sais je dis souvent à mes interlocuteurs, je suis monté dans l'imprimerie 3D, ce jour la j'aurais marché dans une merde, ça aurait été pareil *rire**

Un peu comme aujourd'hui, les consommateurs ne savent pas vraiment ce qu'est l'imprimante 3D, c'est peut être un peu pour ça que le marché de l'imprimante 3D personnel n'est pas encore vraiment lancé

Non…

J'ai lu que environ 400,000 imprimantes 3D personnel on était vendu et il prévoit des ventes atteignant les 5 millions dans 3 ans ?

Oui, je pense que le marché de l'imprimante 3D n'est pas comment dire… Tu sais on a envie de compliquer ou d'ampouler les choses. Moi je pense que je suis plutôt un porteur de l'information inversée, puisque que je dirais au contraire il faut démystifier, rendre simple les choses, l'imprimante 3D c'est avant tout une imprimante. Si tu as une imprimante 2D, comme tout le monde a chez sois, ça sous entends que en amont tu n'as pas une imprimante pour avoir une imprimante. C'est à dire que non seulement il faut que tu l'alimentes, en énergie, en papier, en encre mais il faut surtout que tu lui donnes quelque chose à imprimer. Mais pour le faire il faut encore avoir un ordinateur, mais dans cet ordinateur, faut il avoir un élément, car si tu fais que des jeux sur ton ordinateur à quoi te sert l'imprimante. Donc ça sous-entend quand même que ca réponde d'abord à un besoin, c'est par exemple le courrier, des tableaux, un dessin, voile tous ces éléments que l'on possède à travers le papier. Il faut bien comprendre qu'une imprimante 3D chez un particulier ou même en général aura un intérêt à partir du moment ou la personne est équipée en amont de tous les éléments nécessaires, c'est à dire informatique mais aussi et surtout des logiciels qui vont lui permettre de faire quelque chose, si tu as un logiciel qui te fait juste des prothèses tu vas me dire : « ok pascal c'est super mais je ne peux rien faire avec, ça ne m'intéresse pas ! » donc il faut bien comprendre où est l'utilité, d'où est l'intérêt chez les professionnels, et surtout l'imprimante 3D, j'y reviendrais après. Je ne m'étais aperçu, c'est après coup Jeremy, simplement que dans notre métier tout ce que nous fabriquons dans la prothèse dentaire, des dispositifs médicaux sur mesure sont en fin de compte des prototypes, puisque en fin de compte par définition chaque prothèse dentaire est différente d'un individu à l'autre ça veut donc dire que chaque prothèse est un prototype mais en même temps un projet final et ça où l'imprimante 3D fait une parfait collusion avec notre métier car l'intérêt de la 3D est de faire des prototypes. Si tu veux faire des prototypes de lunettes, de surf de tout un tas d'éléments et de pouvoir tester, l'imprimante 3D est là. Pour l'instant dans le mass market je pense que ce sera plus long mais si à mon avis ils commencent à s'y intéresser, non pas parce que c'est un prototype, un produit unique mais parce que la qualité du produit qui est créée est supérieure à ce qu'on pouvait faire par usinage ou fonderie. Par exemple les tubes de Pitôt, ce sont ceux qu'il y a sur les avions pour mesurer la vitesse. Tu en as plusieurs à l'extérieur de l'avion pour mesurer la vitesse réelle de l'avion. Souviens-toi il y a eu un crash, Rio-Paris, ces tubes de Pitôt ont été défaillants et maintenant je crois qu'il sont fait entièrement en imprimerie 3D, on sait les faire en usinage ou en fonderie mais en imprimerie 3D, on a atteint une qualité supérieure et pourtant ce n'est pas un prototype.

J'ai lu dans l'histoire de l'imprimante 3D, que au début cette technologie était appelée « rapid Prototyping » …

Ouais !

C'est ce qui permettait un petit peu à toutes les entreprises, avant de lancer un produit, de créer un prototype à moindres coûts, pour évaluer les budgets et comment développer ce produit. Avant c'était plus on essaye avec l'imprimante 3D, après on verra, mais maintenant, on commence peut être à se dire on sait comment se marche, on design et on imprime directement, Non ?

*C'est exactement cela ! Par exemple les premières coques d'iPhone, si tu n'avais pas d'imprimante 3D il fallait d'abord en faire une, regarder, la tester, en faire un moule, l'injecter et puis voir si c'était bien, assez fort et épais. Là en prototypage, et avec un imprimante 3D, tu l'édite, tu l'as fait et tu peux directement la corriger. C'était vraiment effectivement du prototyping, pour répondre à la question de coût et de rapidité. Maintenant ce qu'ils font, c'est que toujours avec la coque d'iPhone, maintenant tu peux donc la caractériser, la customiser à volonté et donc tu obtiens d'un produit grand public que tu peux diffuser à grande masse, *c'est la que ton mémoire est intéressant sur l'imprimante 3D* on faisait un produit de coque d'iPhone injecté, découpé à 100,000 exemplaires de couleur blanches et bah maintenant je peux la faire tu imagines avec des initiales un design, avec bref un élément customisé, personnalisé pour chaque iPhone et la l'imprimerie 3D réponds à ça.*
Il est certain que l'imprimerie 3D, à d'abord du sens pour tout ce qui est prototypage, du sens pour les éléments uniques entre autre les prothèses dentaires, correspondent parfaitement à ça. Mais il y aura du sens avec des éléments de plus relations avec la customisation.
Pour revenir sur le parcours, on est monté dans l'imprimerie 3D, sans trop savoir que ça correspondait parfaitement au prototypage, comme ce que la prothèse représente parfaitement. Au fur et à mesure qu'on a réfléchi avec ce qu'on pouvait faire avec mais que en même temps, les imprimantes ont évolué pour passer de la cire au plastique et même du plastique au métal, alors on a compris que l'on pouvait directement faire de la conception en évitant des étapes intermédiaires et faire un produit directement en métal.

Donc l'imprimante 3D dans ton laboratoire, aujourd'hui fait partie de ton processus de fabrication, ou c'est la base de ta fabrication ?

Alors elle rentre dans le processus de fabrication, elle n'est pas à la base, mais tout dépend si tu estimes que ta base c'est la conception du produit. Si on part du principe, par exemple une maison si tu me dis le process de la construction d'une maison commence, non pas par l'achat du terrain mais pratiquement par l'étude du sol et par le dessin de l'architecte. Pour nous l'imprimante 3D est simplement la partie maçonnerie, elle ne rentre qu'à partir du moment ou on aura décider de tout ce qui est besoin en amont, et à ce moment la on va démarrer la maison, elle fait partie du début du processus mais uniquement au niveau de la fabrication, de la construction.

C'est juste une partie intégrante à ta fabrication, c'est plus un outil et non une nécessité dans l'utilisation de l'imprimante 3D pour avoir le produit final ?

Oui c'est à dire, c'est ça ! on passe par l'imprimante 3D pour avoir le final, et qui est souvent même pas fini, pas tout le temps, des fois il sort prêt à l'emploi on va dire, mais d'autre fois il y a un post process, ou il faut travailler derrière. Il faut continuer à les reprendre à les façonner.

C'est pas comme ce que les consommateurs pensent de nos jours, ou tu appuis sur un bouton et tu as ton produit final prêt à l'emploi dans l'heure qui suit ?

Ça peut exister dans certains cas, mais il y a encore, dans beaucoup d'imprimante, je ne les connais pas toutes, mais on retrouve souvent ces post process. Quand le produit sort de l'imprimante il n'est pas fini, il faut continuer à nettoyer, vernir, découper… Il y a encore des post process derrières.

L'imprimante 3D qu'est ce qu'elle apporte a tes produits au final ? En positif mais aussi en négatif.

Alors la première chose, en positif, on parle toujours du positif en premier bien sûr. C'est surtout en fin de compte une, comment dire, une qualité, c'est la qualité intrinsèque dans les matériaux, mais surtout dans la précision fournie par cette technologie. Pourquoi ? parce qu'on a évité de nombreuses étapes, parfois jusqu'à 10 voir 20% d'étapes par rapport à de la fonderie conventionnelle et donc en enlevant toutes ces étapes on a gagné en qualité, de précision du produit, dans sa finalité dans son élément intrinsèque d'usage, pour au contraire fournir quelque chose mieux adapté après à la bouche. C'est vraiment ça, mais on a aussi gagner en efficacité, et même j'ai envie de dire en efficience puisqu'on peut produire, peut être plus facilement, elle produit la nuit alors que mes employés manuellement tu dois attendre la journée. Donc voilà, c'est ce coté et ça permet d'être sur un nouveau territoire d'innovation.
L'imprimante 3D permet aussi quelque chose qui est souvent oublié, c'est tout simplement en amont dans la chaine de production ce qu'on appelle le workflow, les praticiens ont eux aussi changé leurs méthodes, et aujourd'hui je ne reçois plus une empreinte conventionnelle physique mais je reçois un fichier numérique et donc je peux directement le traduire et faire de la conception et après l'envoyer dans un imprimante 3D.

Pour le coté négatif, il y a un coût. Cout de la machine, amortissement, couts des matériaux, de la matière…

La main d'œuvre ?
Non, la main d'œuvre n'est plus au contraire, c'est plutôt un gain main d'œuvre. Mais ça reste des machines à un certain niveau qui sont sensibles, par exemple aujourd'hui j'en ai encore une en panne, la tête de laser, il y a quand même un agglomérat de beaucoup d'éléments, beaucoup de techniques et de points qui font que derrière la machine n'est pas « Plug and Play » c'est pas une machine je la branche et ça marche tout de suite. C'est aussi une des raisons pour laquelle ça ne fonctionne pas très bien chez les particuliers car ce n'est pas si facile que ça.

Donc ça représente bien un coût pour l'entreprise, est il répercuté sur votre produit final ?

Oui, il y a un coût supérieur par rapport, on n'est pas loin de 50 à 60 % supérieurs. C'est assez énorme, le surcoût en coût direct est 50% on va pas exagérer, c'est ce que j'estime. Il est compensé par en fin de compte :

- *Un : le gain, il n'y pas de travaux refait ils sortent en phase finale directe*
- *Deux : on augmenté la productivité grâce au numérique je peux faire 2 voir 2,2 à la place d'un. Donc je dois compenser ma perte en cout direct par une augmentation de productivité, et donc ça me donne soit du gain en masse salariale, soit ça me permet d'augmenter mon activité et mon chiffre d'affaire. En augmentant mon activité, ma mass market si je puis dire, ça me permet en fin de compte de prendre une place sur le marché avec un produit qui est plutôt innovant.*

Donc c'est une économie pour ton entreprise, et en ce qui concerne le client, le dentiste, est ce qu'il perçoit ce coût supérieur, n'est il pas rétissant ? Même si ton produit est besoin médical, le client tant le dentiste peut dire je vais aller voir un autre laboratoire un autre dentiste qui me fait la même chose à un prix inférieur.

Exactement !

C'est pour ca que tu vas vendre ta valeur ajoutée de ta qualité, et de ce que tu peux fournir

Malheureusement non. C'est ce qu'on a pas su faire et ce qu'on ne sait pas faire dans notre métier, et surtout en France, on ne sait pas vendre notre valeur ajoutée supérieur et on donc ne peut pas répercuter, cette surcharge sur le produit. Ce qui fait en fin de compte on a un produit de meilleur qualité, à tous les niveaux mais au même prix et au même cout que celui que l'on a de manière conventionnel. Il faut bien le vendre, bien marketer, et bien faire comprendre que le coût est le même, alors que pour beaucoup de gens quand on parle de numérique et digitale, le coût doit baisser, et mon objectif est de dire non ! Non seulement il ne baisse pas, il devrait être supérieur, mais ce que je fais c'est que je les maintiens.

En fin de compte pour rester compétitif sur le marché français tu as eu besoin d'acquérir une imprimante 3D ?

Alors pour rester, il faut que j'ajoute de la valeur et rester innovant. Et d'ajouter une valeur produit supérieure qui est l'innovation et qui donne des résultats qualitatifs et techniques qu'on a déjà vu ensemble, et qui permettent de mieux se situer sur le marché. Surtout cette innovation, aujourd'hui mes concurrents sont en Chine, dans des pays avec une main d'œuvre à bas coûts, si mes concurrents s'équipent de la même technologie de nouveau on joue à armes égales, car ce n'est plus le coût de la main d'ouvre qui est prioritaire, c'est l'amortissement de la machine. L'imprimante et les matériaux sont identiques en Chine ou en France, dans son prix et dans sa rapidité cela donne un rééquilibrage, pour dire : pour ce même produit il y a tout intérêt de le faire en France parce que le prix ne sera pas différencié et au contraire on aura une différenciation sur les services.

C'était pour la partie de ton laboratoire. Je reviens à 3DRPD, qui a une vision un peu plus globale du marché. J'ai découvert que le marché de l'imprimante 3D a augmenté de 1 milliard de dollars l'année dernière, et qu'il prévoit de vendre plus de 5 millions d'imprimantes personnelles dans les années à venir, est ce que ça ne représente pas un risque pour les entreprises, voir même pour 3DRPD. Imagine que quelqu'un sache faire un stellite en fichier STL et qu'il l'imprime, il n'aura plus besoin de passer par 3DRPD par exemple.

C'est ce qu'on appelle la concurrence !

Tout le monde pourrait créer ce qu'il veut quand il veut

C'est pas faux mais comme je te dis ce n'est pas « Plug en Play », c'est pas parce que tu as une imprimante que tu sais, comme une imprimante 2D taper à la machine, et c'est pour autant que tu as le logiciel Word tu sais taper à la machine et tu as un imprimante, mais le courrier, si c'est un courrier d'avocat tu n'es pas forcément avocat pour le rédiger. Donc il y a un ensemble d'élément, oui je veux éditer quelque chose mais en amont j'ai quoi. Ensuite, imaginons que tu as le courrier de l'avocat, tu as tout ce qu'il faut et tu dis moi maintenant ou je vais imprimer mon courrier, tout va dépendre de la qualité de ton courrier et de ce que tu veux faire, si c'est simple et banal tu le fais sur un papier A4, tout le monde peut le faire. Mais si tu veux un papier

spécifique avec une encre spéciale, la il va falloir une imprimante différente, comme l'imprimerie en générale. En l'occurrence nous, dans notre technologie, la différentiation se fait aussi par le fait que dans l'imprimerie tu as plusieurs familles et surtout l'imprimerie métal est une famille à part entière. L'imprimerie métal est déjà dans l'imprimerie une famille, dans le 3D c'est une famille extrêmement difficile et les barrières sont assez difficiles à franchir comme les barrières de financement, de développent et de réalisation, parce que derrière il faut de l'azote par exemple et un tas d'éléments. Donc on va retomber sur des coûts, que on ne peut pas acheter une imprimante métal facilement, première chose. Deuxièmement c'est la qualité, comme je t'ai dit si j'ai des documents à faire du certaine manière il faut mieux que je passe par un imprimerie que par une imprimante chez toi. Et enfin rien que pour avoir l'accès à la technologie, toujours pour le métal, est assez difficile car juste pour une tête de laser dont je te parlais ça vaut facile 50,000 – 80,000 €.

Alors les imprimantes personnelles sont utiles pour faire du plastique, des petites choses, à part certaines personnes qui savent très bien comment exploiter les possibilités, ils peuvent créer un produit et les vendre

C'est pour ça que en fin de compte, les matériaux les imprimantes vont se développer, et métal bien sûr. Mais la barrière d'entrée pour franchir le premier gap est quand même assez haute, assez élevée et ne sera pas on va dire grand public. Pas pour le moment, ni dans les années qui viennent.
Et donc on (3DRPD) a une forme de protection qui est donnée de part la technologie, de part la complexité de la mise en œuvre des machines, de l'ensemble du process et après du produit dans son résultat. On s'aperçoit que beaucoup de nos concurrents n'y arrivent pas alors que pourtant ils ont les produits les machines, et ils n'y arrivent pas pour autant.

Ont-ils les ressources financières pour y arriver ? Car il en faut pour intégrer la technologie du 3D dans sont entreprise. C'est une limite aussi.

Effectivement, le gars de chez Xerox, ou celui de HP, il te vend un imprimante, et tu lui dis « moi je voudrais qu'elle sache me faire un courrier d'avocat ? » le vendeur va te dire : « moi je fabrique une imprimante, mais c'est pas moi qui vais produire ce que vous allez en faire » il va également conseiller d'utiliser les papiers et l'encre de sa société, car ça nourrit les consommables, mais bien souvent les gens mais un papier moins cher et une encre qu'il achète en grand surface ou sur internet. Donc les imprimeurs eux ont a charge de mettre en valeur l'outil de production, les vendeurs ont a charge de vendre l'imprimante qui correspond à ce que tu veux faire avec. Toute l'adéquation, est difficile, parce on peut acheter une imprimante mais sans savoir ou elle va mais ils n'ont pas les moyens de développent et de se dire qu'est ce que je peux faire avec cette imprimante. Après en plus il faut savoir que si tu es avocat, c'est quand même beaucoup plus facile de dire dans ces cas la, j'achète une imprimante et je sais ce que je vais faire avec, et ça va m'aider à travailler et je vais faire quelque chose. Mais si tu es boulanger c'est pas pour autant que tu achètes une imprimante et que le logiciel que tu vas devenir avocat et faire un beau courrier.
Donc il faut bien garder à l'esprit que les barrières d'entrée, même si les gens peuvent accéder à la machine, elles sont quand même assez élevées y compris par les produits, les machines mais aussi par l'esprit même de la conception.

A partir de mes hypothèses et mes recherches, j'ai vu que l'imprimante 3D était un produit de disruption, elle permet de sauter des étapes, est ce que tu crois que tu ne pourras pas créer un laboratoire Bongert Bis à Lyon en y mettant un imprimante 3D, tu envoies tes fichiers là-bas, tu les imprimes et ça te permet un gain de temps et de transport, tu économise le prix du transport entre La Roche sur Yon et Lyon ? Est ce

que tu penses que c'est quelque chose que de futures entreprises vont tenter de faire, de décentraliser la production, et même produire chez les consommateurs ?

Tout à fait je résume souvent cette chaine par ACF. A pour Acquisition, C pour Conception et F pour Fabrication. L'acquisition peut venir maintenant de n'importe où, je viens de récupérer un client à Dakar par exemple, la conception se fait ici. Au jour d'aujourd'hui, la fabrication se fait ici, car en terme de coût on la vu tout à l'heure, les machines, l'amortissement et l'ensemble des savoir faire sont réuni sur ce site là. Mais tu as raison de dire, demain rien ne m'empêche d'avoir l'acquisition au Dakar, de faire la conception ici, et parce que le volume le permettra, parce qu'il y aura un gap de service, qu'on aura une imprimante à Dakar et à la limite tu imprimes directement à Dakar après. Tu n'as pas tort en disant que cette une voie de développent, pour l'instant elle ne sera pas développée tout simplement parce que le coût engendré est beaucoup trop lourd, ou alors il faut tout de suite monter sur des volumes importants. Je t'en fais preuve tout simplement. Nous avons 3 sites de production chez 3DRPD, Montréal, Etat de New York et France en Vendée, et pourquoi on en crée pas un en Australie alors qu'on a un client, 3DRPD Australie qui existe ? Parce qu'il na pas d'intérêt économique, il n'y a pas d'intérêt à installer une ou deux machines en Australie pour l'instant parce que le masse du marché ne le permet pas, enfin deuxième raison il y aurait dans ces cas la aussi un transfert de technologie donc un transfert de l'ensemble des compétences et des données et ça, ça peut être parfois aussi plus gênant, car tu peux avoir une déperdition de ton brevet, de ta licence de tes savoir faires. Donc il vaut mieux concentre pour l'instant dans des produits, dans des masses, mais la question va se poser assez rapidement pour l'Australie, elle va se poser assez rapidement pour l'Amérique de L'ouest et elle se posera probablement un jour en Europe ou il faudra non pas 1 mais 2 centres de production.

Denis m'a évoqué de cas de figure, de déplacer la production vers Bruxelles ?

On y pense, pour un tas d'éléments car on a peut être un partenariat, parce que c'est un center plus facile après pour desservir les produits vers le nord de l'Europe, la réputation est plutôt intéressante et la législation a un côté plus flexible que chez nous. Et donc il y a une réflexion sur ce sujet là.

Je vais te poser la même question que j'ai posé a Denis pour finir l'entretien, Est ce que tu aimes ce que tu fais ?

J'adore ! Et je te dirais, comme je t'ai dis, tu le sais, quoique tu fasse fait le toujours avec plaisir. Si tu le fais avec motivation et ambition, parce que vous y trouvez du plaisir alors vous réussirez. Mr Theriault, Mme Deloge et moi même, je peux dire que nous avons réussis car on aime ce qu'on fait et on prend du plaisir à le faire. Et le jour ou on aime plus il vaut mieux arrêter.

Très bien, merci beaucoup pour ton temps et ton témoignage.

Appendice 4 : Interview of Mrs DELOGE, CEO of Dental Cap Ocean

09/06/2016

Bonjour Madame DELOGE, après avoir interviewé Mr THERIAULT, directeur de 3DRPD et Mr BONGERT, dirigeant du Laboratoire Bongert mais aussi reponsable de 3DRPD Europe, j'aimerais avoir votre témoignage sur votre entreprise et l'imprimante 3D, qui me permettra d'avoir une vision autre, c'est à dire à une échelle plus régionale,
Et donc premiere question comment est vous devenue dirigeante de Dental Cap Ocean ?

Alors après avoir eu mon bac gestion, j'ai passé un CAP en prothèse dentaire. Avec ce diplôme je me suis installée en 1988, en tant que artisan seule dans mon laboratoire, accompagnée de mon père. J'ai travaillé pendant 14 ans à mon compte. Après j'avais envie de rejoindre une grande structure, j'ai eu l'opportunité de travailler dans le deuxième laboratoire de France, anciennement appelé Laboratoire Naulet situé à Saint Gilles Croix de Vie en Vendée. J'étais chef de laboratoire, à ne pas confondre avec dirigeant, je manageais 120 personnes sur la partie artisanale de l'entreprise. Ca m'a permis pendant à peu près 5 années de m'occuper, me former sur l'entreprise à plus grande échelle. A cette époque le numérique commençait déjà à apparaître, dans la prothèse dentaire.
Ensuite le gérant s'est retiré pour partir en retraite, et finalement on a voulu créer une autre entreprise avec la sienne et en s'associant avec d'autres personnes. Malheureusement l'association s'est mal passée. Donc ma collègue de longue date et moi-même, avons eu l'audace de créer une entreprise qui s'appelle Dental Cap Océan, elle a 10 ans aujourd'hui. Nous sommes allés chercher un partenaire, en l'occurrence le premier laboratoire de France, le laboratoire Bongert, situé à La Roche Sur Yon et dirigé par Mr Pascal BONGERT. A ce moment, nous avons réussi à remonter une structure dotée de 28 techniciens dentaires à l'heure d'aujourd'hui. Dans cette association de 3 personnes, Mr BONGERT, ma collègue Christiane, et moi-même, je suis cadre dirigeante et je m'occupe des services de ressources humaines, achat, commercialisation, développent du marché mais aussi industrielle sur la partie informatique autrement appelée CFAO.

C'est intéressant de voir que vous vous êtes associée avec Mr BONGERT. Dans mes recherches j'ai vu que de nos jours un nouveau laboratoire qui veut prospérer à besoin de s'associer du aux coûts et aux barrières d'entrées. Fût-il un besoin pour vous de vous associer, afin d'avoir certaines ressources et grandir?

A l'heure d'aujourd'hui le métier de prothésiste dentaire, est un métier artisanal et aujourd'hui le métier devient industriel. En s'industrialisant automatiquement, comment dire c'est couteux ! L'informatique, les logiciels, les imprimantes sont relativement chers, le services après vente, et les mises à jour de logiciels sont très… c'est énorme ! et si on a pas une structure assez solide et une trésorerie assez « riche », nous n'avons pas « les reins assez solides pour pouvoir continuer ». Certains laboratoires, deviennent des sous traitant, on a une nouvelle clientèle. Ces petits laboratoires, avec qui on sous traite car nous, nous avons les outils les imprimantes pour pouvoir répondre à leurs demandes.

Donc, sans associations, ces nouveaux et petits laboratoires sont voués à disparaître. S'ils veulent continuer à se développer ils doivent acquérir une technologie onéreuse dont ils n'ont pas forcément les budgets ou la stratégie pour l'intégrer. Alors il y aura deux possibilités devant eux : s'associer ou intégrer le numérique dans leur conceptions afin de répondre au marché ?

Il existe en Europe des grosse imprimante 3D, c'est à dire des entreprises de production, comme Simeda au Luxembourg avec qui on travail, qui fait essentiellement des produits en Zircon et aussi de l'implantologie. C'est un fournisseur, a un cout beaucoup plus bas, c'est pour cela qu'ils ont une multitude de clients (laboratoire). Si nous même on avait une imprimante, il y a beaucoup trop d'entretien, dans notre comptabilité on a maintenant une partie « sous-traitance » qui se développe énormément, cela représente 7% de notre part de marché. En même temps, comment dire, cette sous-traitance, il ne faut pas la négliger car elle devrait faire diminuer mes achats. C'est pour cela que les petits laboratoires, ce n'est pas qu'ils ne veulent pas grandir, ils innovent dans juste un logiciel, de conception pour pouvoir garder leur client et répondre à leur demandes et à ce moment là, ils envoient à des gros laboratoire ou fournisseurs, afin de fournir leurs dentistes et les conserver. S'ils ne veulent pas évoluer vers cette dimension informatique, en impression 3D ou conception 3D, à ce moment la ils mettront vite la clé sous la porte.

Et vous, vous travaillez avec une sous-traitance ?

Oui j'en ai plusieurs, je travaille avec, c'est à dire nous n'avons pas d'impressions 3D sauf une machine pour concevoir les models en 3D.

Les fichiers STL ?

Oui voilà, par contre on soustraite tout le reste, avec maison de fournitures, avec 3DRPD pour les châssis métal (RPD en anglais), mais aussi différentes maisons d'implantologie Straumann, Nobel. On leur envoie les fichiers et ils nous l'impriment. Nous n'avons aucunes impressions dans notre laboratoire, le coût d'impression est beaucoup trop cher. On a un chiffre d'affaire d'environ 2 millions d'euros, même pour nous c'est trop cher. Il faudrait que les machines tournent 24 heures sur 24. Aujourd'hui, l'humain est moins cher que la machine.

Donc tu ne travaille pas directement avec une imprimante 3D, tu bénéficies des services d'autres entreprises comme 3DRPD ou le laboratoire Bongert qui imprime pour toi ?

Je ne fais que de la CAO, Conception Assisté par Ordinateur, je ne fabrique.

Avec un Scanner 3D pour créer le fichier STL ?

Oui, mais je n'imprime absolument rien. J'envoie mes fichiers chez 3DRPD ou Bongert et ils créent le produit et ils me le renvoient.

Et pour vous qu'est ce que ces produits ont de plus qu'un produit conventionnel ?

Les deux sont les mêmes, le produit est le même. C'est notre processus de fabrication qui change. On a une meilleure adaptation au niveau du travail, c'est à dire que ca devient de l'industrie comme les pièces automobiles, l'ajustage en bouche est parfait.

Donc c'est le principal avantage de l'impression 3D ?

Oui, j'ai beaucoup moins de retour au niveau de mes clients. Je conserve ma clientèle car tout est parfait. On garantie nos prothèses deux ans.

Donc tu fidélises plus facilement tes clients, en proposant un produit de bien meilleur qualité, que lui va devoir vendre ?

Je propose aujourd'hui un produit de bien meilleure qualité et je fidélise ma clientèle. En plus le travail, correspond à une demande artisanal car on fait de la création esthétique, cosmétique. Une fois que les dentistes ont un résultat et un laboratoire avec lequel ils arrivent bien à travailler, c'est difficile après de les faire changer. Donc on fidélise notre clientèle on sait qu'il vont chercher des prix plus bas, au niveau de l'Asie pour avoir des produits low-cost mais il en reviennent vite quand même.

Et sinon, comment as tu découvert l'imprimante 3D ?

En fin de compte tous les ans, ça va faire 20 ans que nous allons dans des salons, en France, en Allemagne. C'est surtout en Allemagne que le développement est vraiment parti, c'est un salon mondial. En fin de compte, c'est en participant à des salons que l'on voit l'évolution des produits. Toutes les maisons de fourniture proposent des logiciels.

Donc vous travaillez avec plusieurs fournisseurs ?

Je travaille avec 3DRPD pour mes chassis, mais aussi pour mes chape et couronnes. Mais aussi avec le Laboratoire Bongert de la Roche Sur Yon, pour mes produits en composite. Un matériel qui permet de gagner du temps, et qui requiert moins de temps.
Je travaille avec beaucoup de maison d'implantologie, car ils ont chacun leur usinage. Ce marché de l'implantologie se développe beaucoup, c'est une part de marché importante on peut dire que c'est une prothèse de luxe.

C'est quoi la différence entre un châssis et un implant ?

Le châssis c'est un appareil en métal amovible, qui a remplacé entre guillemets les dentiers en résine. L'implant est une prothèse fixée, on a pas besoin lorsque l'on perd une dent d'aller chercher les autres dents à côté, on met une vis dans la gencive et on pose ensuite une couronne.
Le châssis métal c'est de la prothèse adjointe et l'implantologie de la prothèse fixée. La prothèse adjointe s'enlève alors que l'implant ne bouge plus une fois fixé.

Les implants sont-ils crées à l'aide d'imprimante 3D ?

Tout est conçu en 3D, après tout dépend quelle technique d'impression tu vas utiliser. Soit de l'usinage dans des galettes en métal, cylindre en métal, des composites ou encore céramique. On usine dans des plaques.

Donc les fournisseurs d'implant utilisent bien des imprimantes 3D pour créer leurs produits ?

Oui, en fait ils impriment la vis qui va dans l'os à partir d'un fichier 3D qu'on leur a fourni, et après nous on conçoit par dessus la couronne, et la dent en résine.
L'implatologie c'est réellement de la mécanique, on va visser en bouche la prothèse. Avec des matériaux compatibles avec le corps humain, comme le titan. Chaque entreprise à une image de marque, qui accompagne leur produit. Les dentistes réclament des implants d'une telle marque, alors nous on doit aller vers ce fournisseur et acheter ces implants, ensuite les retravailler.

Donc le commercial de cette marque va vendre le produit aux dentistes ou aux laboratoires ?

Aux dentistes. Ils nous disent je veux du Straumann par exemple, et nous on va chercher le fournisseur afin de faire notre dent en 3D.

Comptez vous à court ou long terme vous munir d'une imprimante 3D, afin de faire tes châssis vous même et réduire les couts ?

Non, parce que il ne faut pas mélanger les métiers. Les fournisseurs savent très bien le faire, si j'achète un imprimante 3D c'est beaucoup trop onéreux et je prendrais des risques pour la société. C'est un autre métier.

Car il faut former les gens, c'est compliqué, et couteux ?

Ces fournisseurs avec qui on traite ont beaucoup de volume donc le coût est relativement bas. Si il n'y a pas suffisamment de volume mes coûts seront beaucoup trop élévés

Donc cela confirme mes recherches c'est un peu une limite de l'impression 3D ?

Oui, par exemple 3DRPD a encore besoin de clients. Pour l'instant, le volume est juste voir suffisant. Mais il faut nourrir les machines. Moi, à l'heure d'aujourd'hui je fais un chiffre d'affaire important, mais mon résultat qu'il me reste, à cause de ma sous-traitance je suis obligée d'acheter des produits, je dégage un bon résultat mais beaucoup plus que si je n'avais pas comme dans le temps de machine. C'est quelque chose de nouveau donc les coûts vont baisser. C'est comme l'écran plat, au départ ça valait énormément d'argent, il faut attendre que cette technologie pénètre le marché. Les vendeurs s'en « mettent pleins les poches » mais les coûts vont baisser. Là, on commence à voir les coûts de l'implantologie baisser car on commence à avoir du volume. Avant il y avait peut être 3% de la population, qui pouvait se payer des implants, maintenant ça commence à 20 ou 30%. Donc il y a de la demande, et si il y a de la demande il y a du volume et les prix réduisent automatiquement.
Avant un implant coutait 1000€ maintenant on peu le trouver à 500€ car les coûts d'achats ont baissé.

On peut donc dire que l'imprimante 3D en elle même va voir son prix réduire. Par exemple les imprimantes 3D personnel sont aux alentours de 2000€ et la moins cher était à 300€, donc dans un futur proche l'imprimante 3D va voir ces prix réduire contestablement suivant le même effet que le Smartphone ?

C'est à dire, pour mon avis, on a mélangé un peu, l'impression 3D est très bien pour l'aviation, l'armée, pour les métiers artisanaux, ou on peut faire en 3D. Maintenant ils ont voulu mettre ça dans les ménages ça ne va durer qu'un temps, parce que les cartouches vaudront chères. Et il faut savoir utiliser la machine, on ne clique pas juste sur un bouton pour pouvoir réaliser l'objet. Il faut avoir des logiciels, pas mal d'éléments, et ça c'est couteux ! L'imprimante 3D en elle même n'est pas couteuse, mais si tout ce qui il y a autour. Les logiciels sont couteux, et le SAV et les mises à jour coûtent cher, moi pour chaque logiciel de mise à jour, j'en ai je ne sais pas combien, j'ai 2500€ à l'année de mise à jour sachant que je dois en avoir à peu près 10, c'est énorme !

On peut remédier à ces couts, il existe des plateformes en ligne ou l'on peux télécharger un fichier STL, on n'a pas besoin de logiciel pour concevoir il faut juste la machine pour l'imprimer. Les propriétaires d'imprimante personnelle vont pouvoir concevoir eux mêmes leurs produits, grâce à cette base de données. Ça peut représenter une menace pour certaines industries ?

Non, parce que il faut du temps pour concevoir, et le coût est relativement élevé. Je ne dis pas que dans quelques années ça va changer. Je pense que ça va être un effet de mode. Après ça va être bien pour remplacer des petites pièces de cafetière, ou des petites choses comme ça. Ca sera un outil, un gadget à notre disposition, mais ce n'est que mon avis personnel.

Ok, merci beaucoup pour votre témoignage, j'aimerais vous poser la même question que j'ai posé a Mr BONGERT et Mr THERIAULT, est ce que vous aimeza ce que vous faites ?

Oui, je suis céramiste à la base, j'en fais beaucoup moins qu'avant, car maintenant je gère une entreprise de 28 personnes, c'est beaucoup de ressources. J'aime mon métier en plus il se développe donc je ne tombe pas dans la routine, de l'artisanal je passe à l'industrialisation, c'est intéressant et ça permet de pérenniser l'entreprise.

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