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History of social Networks :

From the ERA of bartering to the collaborative economy

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Résumé :

Cet article vise à dresser un panorama historique de la notion de réseau et de ses retombées en management. Issu de la sphère technique à partir de la théorie des graphes en mathématiques, le concept de réseau s'étend progressivement à la sphère sociale où les ramifications prennent forme dans le partage du capital social. Au gré des évolutions technologiques en matière de transport et de communication, le réseau social structure progressivement l'économie en réduisant l'incertitude des échanges par la confiance. Aujourd'hui, le réseau social prend une nouvelle dimension, comme un média social, à partir des plateformes sur Internet qui fédèrent des milliards d'anonymes dans l'économie collaborative. En dépit de toutes ces évolutions au cours des siècles, le réseau conserve toujours la même fonction universelle : une structure de collaboration durable avec des intermédiaires gardiens de la confiance.

Mot clé : réseau, collaboration, confiance, don, management

Abstract:

This article aims to provide a historical overview of the notion of a network and its effects in the realm of management. Originally deriving from the technical sphere with graph theory in mathematics, the concept of a network has progressively been extended to the social sphere where its ramifications have been the sharing of social capital. As technology has developed in terms of transportation and communication, social networks haves gradually structured the economy more and more by increasing trust and thus reducing the uncertainty involved in trade. Today, these social networks have taken on a new dimension through social media, based in internet platforms that bring together billions of anonymous people in the collaborative economy. Despite all these developments over the centuries, networks still have the same universal function: they are sustainable structures for collaboration with intermediaries that guarantee trust.

Key words: network, collaboration, trust, gift, management

Introduction

Networks have never been quite so present in society as they are in our day and age: “social networks” on the internet, transportation networks, innovation ecosystems set up in various domains, etc. The need to create connections between individuals can be explained by two phenomena: globalization, which forces us to have a more open economy, without boundaries, where States, administrations, and businesses are connected through shared interests; and technology, which allows us to recreate communities where people live together on a human scale, but at a distance, across international borders.

In other words, we are witnessing an inexorable revolution where networks tend to challenge traditional institutions in all domains: in politics, where digital networks form an “electronic democracy” led directly by citizens; in society, where adolescents’ socialization takes place more and more on electronic platforms instead of with family and at school; and in economics, where businesses change their business model to suit opportunities related to electronic trade.

So as to better understand this reality in the business world, in this article we plan to go back in time and study the notion of a network, beginning with its etymological origins and going all the way to its most recent applications with the impact of digital technology on communication.

Through this progression and by taking a step back from looking at these phenomena from a managerial standpoint, it is possible to understand why the notion of a network has always left its mark on economic history. In our day and age, networks have truly become a precious interpretive framework for understanding the evolution of contemporary management, in that the creation of wealth relies more on intangible capital, such as reputation or trust (Alter, 2010), than it does on tangible resources and professional skills.

1. The semantics of a network

1.1 The function of netting

The French word for network, “réseau,” comes from the Latin “*retiolus*,” which is a diminutive of retis, which means net. It may also be associated with the notion of a “*reticulum*,” which means little net, as this gave birth to noun reticule and to the French adjectives réticulé and réticulaire, which means reticulated and reticular, respectively. Thus, the notion of a network refers to objects that look like a net.
These origins of the word network date back to ancient history. The principle of netting was highlighted as early as the 1st century BC, by gladiators who used a net, a “*reta*,” to immobilize their opponents. Following this, we encounter the word “*resel”* in the 12th century BC; this word refers to the net used for hunting small animals. Historically, we see a fundamental characteristic of networks in this connection to the function of netting: a solid, organized system where the strings of mesh intersect, with free-flowing circulation between the links.

This net analogy was used by Musso (1997) in his description of networks, where he explains that a fishing net, like a gladiator’s net, holds on to things and at the same time lets water flow through. This duality is specific to a net: being able to imprison objects and at the same time let other things flow freely.

The meaning of the word network then evolved with the development of weaving. It was both a technical and mainstream word used by weavers and basket makers to designate the interlacing of textile or plant fibers (Guillerme, 1988). During the Middle Ages, and also in the Encyclopedia of Diderot and d'Alembert, there was thus a slight change in the definition of a network. We went from a net to textiles, with silk made up of links and stitches. This woven piece of clothing will cover a person, while at the same time allowing air to pass through. It thus has the same distinctive feature as a net.

During the 16th century, nets were sewn more tightly, giving rise to mesh bags. In French, they were called "*réseuls*," which over time became "*résilles"*—"hairnets" in English—which generally was a term that designated nets with wide stitching for holding women's hair.

Starting in the 18th century, this concept was applied to different domains, this time in crystallography and spatial cartography. Networks became useful in topography for carrying out triangulation in a spatial context, which is still relevant when it comes to goniometry, and in particular geopositioning using cellular location tracking. In line with these applications in geography, mathematicians use networks in graph theory for measuring and optimizing flow in a geometric figure. The work of mathematician Sainte-Laguë (1941) illustrates this development.

1.2 Circulation of flow

Thereafter, networks were no longer used to designate a united, indivisible system, but rather a system of nodes at a distance from one another, through which flow circulates.

From this period of time through to the end of the 20th century, various technological developments (railroads, electricity, and then computing and digital technology) reinforced this idea of flow circulating between different areas. People then encountered issues with network externalities, such as reducing costs and the time it takes to communicate, move about, and distribute goods and services. As progress was made in computer science, we gradually moved from the concept of a mechanical network controlled by human will to an organic network capable of freeing itself from human will, presaging the coming of artificial intelligence, as Parrochia (2005, p. 78) points out: "*in computer science, we see the appearance of random graphs, queueing networks, Petri nets, and then, following progress in algorithms and the mastery of multilayer networks, artificial neural networks, which were behind the resurgence of the connectionist paradigm in the 1970s-1980s.*"

1.3 Netting and flow: modern recognition of networks

The meaning of the word network as we know it nowadays, which brings together the ideas of dense netting and flow, came about as a result of scientific discoveries and technical developments. Historically, the term was used by artisans, and it was specific to manual labor. With the industrial and scientific era, we moved on to a universe of engineering and scientists.
According to Musso (1997), this semantic change affected the spread and usage (which was sometimes improper) of the word network in language. According to this author, networks were directly impacted by the complexity of human nature. Musso (2005) maintains that the more a society grows and develops, the more technical and complex it becomes. It is thusnatural for humanity to be a model for the organization of networks, as there is nothing more complex than humanity. He points out three phases that support this theory:

- The biometaphysical phase: networks are metaphysical and divine. They allow for humanity to be understood through mythology. They are thus naive attempts to understand and become closer to deities.

- The biopolitical phase: society is regulated in the same way as biology. For example, a network of blood vessels is compared to the circulation of money in the economy.

- The biotechnological phase: the apogee of networks, as they are used in all spheres; they become the method for explaining any social change by linking variables which had until now been isolated, using technological communication tools.

We will now examine how the notion of networks left the purely technical sphere, where it was inspired by scientific theories, and entered the social sphere. In particular, we will study the ways in which the work of Saint-Simon inspired the creation of a more egalitarian society despite territorial disparities, by connecting citizens with transportation and distribution networks.

2. Society as a network

Starting in the Middle Ages, the notion of a network moved out of the technical register and began to play an essential role in the generation of knowledge, thus going hand in hand with the first social revolutions.

2.1 From the cloister to the Renaissance

On this subject, Aboiron and Nicoulaud (2008) explain that social progress in the Middle Ages was based in the thoughts and reflections of the clergymen. These people belonged to various Franciscan and Dominican religious orders, which formed rival communities and attempted to influence the sovereign power. In this era, meditation in cloisters (*clustri*) was, of course, conducive to the maturation of ideas through reading, but it did not promote empirical experimentation and was even less favorable to the circulation of knowledge, because the monks traveled very little.

Nevertheless, in certain situations, either out of necessity or by choice, these clergymen moved about for religious missions, which led them to exchange views with their counterparts in other cloisters (Parrochia, 2005). Starting at the end of the 10th century, missionary monks popularized the practice of pilgrimages all throughout Europe and thus participated in connecting different cloisters, through the exchange of relics and manuscripts. This practice enabled the rise of bank and mercantile networks during the Renaissance, thanks to the diffusion of, sharing of, and confrontation with knowledge.

In this page in history, we find foundational elements of social networks, such as autonomy and mutual dependence. As a matter of fact, we see that the *clustri* were very independent and tied to their religious orders, as was the case for Cluny Abbey, but that they also needed to exchange with the pilgrims from other religious orders to obtain more knowledge. All religious orders were united by the Christian faith, which led them to interact in a connected way, despite their rivalries.

2.2 Saint-Simon's ideal society

Beginning in the 19th century, a new phase began! This phase consisted of the social migration from the countryside to cities, and it forced people to rethink city planning, with the appearance of

railroad networks and the first water supply networks as of 1830 in France. This period of time was inspired by Saint-Simon's "philosophy of networks," according to Musso (2005). According to Saint-Simon's humanist ideas, the privileges stemming from social standing were sources of injustices inherited from the old regime. It was thus right to do away with all privileges, on a secular basis, using principles of fraternity and mutual aid between citizens.

> Saint-Simon used the characteristics of a network to outline an egalitarian society, which replaced the metaphor of the mythological tree, which had proclaimed that there exists a hierarchy of people where deities are at the top: "*In this way, the concept of a network allowed Saint-Simon to structure all of his thoughts and carry out a symbolic operation: using this concept, he could bring the sciences together with myths and exclude God from his consideration, thus giving humanity the opportunity to claim ownership of these myths using reason.*" (Zetlaoui, 2003, p. 96)

From this point of view, Saint-Simon used networks as a vehicle for social emancipation. He saw citizens as forming links of a chain of solidarity, fueled by mutual respect and trust. Without this solidarity, the structure of our society would collapse. According to Saint-Simon, in this "philosophy of networks," each citizen is a kindred spirit of the other citizens with the right to equality in the creation of society, and this right cannot be called into question by invoking a bloodline, for example.

Ever since that period of time, the social dimension of networks has gained traction relative to the technical dimension. In the rest of this article, we will examine the ways in which social networks transform our views of the economy and of business management.

3. Social networks

In economics, organizing into networks is very old, as it dates back to the age of bartering, when commercial exchange could not be realized using a monetary base and instead was based on trust between merchants. From this perspective, networks are neither modern nor old, because trust has always been the key to success in economics in all eras: in the non-monetary era, where barter was safeguarded by trust; and in the monetary era, where transactions are safeguarded by trust, as it reduces the costs associated with the dangers of opportunism.

Neoclassical economists consider people to be perfectly rational. At the same time, new practices for exchanging goods, as well as some old forms of trade, such as bartering, show that it is impossible to separate the rationality of a market transaction from the quality of the social connection involved.

In today's complex world, it is no longer a matter of optimizing economic choices as a *homo oeconomicus*, because this is no longer possible due to uncertainty. It is now a matter of forging social connections, as a *homo reticulus*, so as to best protect ourselves from crises, seize opportunities, and build an identity in our search for meaning. From this point of view, networking is an essential activity, allowing everyone to cultivate relational capital within social networks, as this is more precious than material assets.

In social networks, it is important to consider not only the number of contacts (which is essential for forming the nodes of the network) but also the quality of these connections.

3.1 The theory of strong ties and weak ties

When talking about the quality of interpersonal relationships, we can draw from the work of Granovetter (1973), who asserts that there are two categories of ties between people: strong ties, which convey complete kinship and mutual trust within a limited circle; and weak ties, which are built outside of our circle of trust and which are sources of diversity in the information we gather.

For Granovetter (1973), it is not the strong ties that are sources of added value, but rather the weak ties, that is, the ties that we maintain on an infrequent basis with someone in the form of a relationship that is not consistent. For him, strong ties are sources of isolation because the same information circulates endlessly within a group without being renewed. Therefore, it is the weak ties that allow two groups to exchange views about themes and subjects that are unknown to each of them, thus promoting, for example, the spread of rumors, as Granovetter (1973, p. 1365) explains: *"whatever is to be diffused can reach a larger number of people, and traverse greater social distance, when passed through weak ties rather than strong. If one tells a rumor to all his close friends, and they do likewise, many will hear the rumor a second and third time, since those linked by strong ties tend to share friends. If the motivation to spread the rumor is dampened a bit on each wave of retelling, then the rumor moving through strong ties is much more likely to be limited to a few cliques than that going via weak ones; bridges will not be crossed."*

We thus assume that the relationships that broaden one's social horizons with other people are found in one's weak ties. Weak ties may serve as bridges between different social networks, within which it is possible to pool and share information in order to build social capital.

3.2 Bourdieu's definition of social capital

One of the uses of a social network is to allow members to share their "address books," which constitute club goods, that is, resources that are specific to the network and that are neither transposable to the outside nor privatizable within the network. This matches Bourdieu's (1980, p. 3) definition of social capital: "*social capital is the collection of current and potential resources that are linked to the possession of a lasting network of relationships, which may or may not be connected to institutions and are used for sharing knowledge and gratitude*."

There are two concepts in this definition that should be retained: the feeling of belonging to a network is shared in a way that depends on the social affinities between members (directly or through an intermediary: a friend of a friend, for example); members feel gratitude and show solidarity for one another.

As a result, social networks on the internet are mainly technical networks used for communication because they bring together a number of machines or user accounts which are connected using technology and which share information with each other on the basis of weak ties, using Granovetter's (1973) definition: the users' professional standing, age, sex, etc. There is not necessarily any building of social capital, in the way that Bourdieu (1980) defines it, that occurs through the usage of platforms for discussion on the internet. Nevertheless, social networks on the internet reduce the importance of physical distances and facilitate communication between anonymous people all around the world.

3.3 The small world theory

Let us use the example of the "small world" experiment devised by Milgram (1967), who attempted to set up a bridge between people. The goal of the experiment at the time was to send a file by mail from one person to another randomly chosen person. To achieve this objective, it was necessary to determine the intermediaries that together formed an interpersonal chain. After having conducted this experiment, Milgram (1967) calculated that the average length of this chain was six intermediaries.

Using the same experimental principles, in 2011 Facebook carried out the same experiment in partnership with the University of Milan. This time, using a sample of 721 million people (which was the total number of users on this social network in 2011), the results showed that each person was linked technically, though not socially, to any other person on the internet by a chain made up of an average of 4.74 links. Thanks to long-distance communication networks, physical distances are being reduced, though the same is not necessarily true for social distances.

In fact, "social networks" on the internet are equivalent to social media in that they have the same function as the press, the radio, and television, because of the informational exchanges between senders and receivers, who do not necessarily know each other. In this anonymous context, cohesion is guaranteed mainly by technical interfaces for telecommunication, like for telephones or email. With this type of digital network, it is important to always be further extending the frontiers of communication to strengthen the influence of these platforms: Google, Apple, Facebook, and Amazon. This process is different for a social network made up of non-anonymous members, where each member's face is known by the others, like a selective club, the access to which is locked to make it more attractive.

Consequently, communication has become an essential dimension of social networks, sometimes at the expense of the depth of relationships and the nature of the messages being sent (Wiener, 1971). The free flow of information especially on the internet, has therefore been considered to be something of a new standard for freedom of expression and human rights. In this way, communication through digital networks is becoming an issue of general concern in terms of how it affects the free flow of information, and it most often masks commercial considerations. Everyone is demanding the right to be informed without worrying about the costs, such as the loss of privacy when it comes to data.

"Virtual communities" on the internet may in certain cases constitute an extension of the social networks that had been built between people in-person. They allow for actions to be taken more quickly and for distances to be reduced, but they do not necessarily qualify as
"social networks" that are full of cooptation and solidarity.

This comparison between social media and social networks allows us to highlight a new parameter in the nature of networks that has to do with the unifying factor for its members: affectio societatis.

On this subject, Assens (2003, p. 53) explains that *"the members of a network are inevitably united by a common denominator, some specific asset, which may turn out to be material (an activation threshold, procedures, technical standards, or interfaces) or immaterial (language,knowledge, values, rituals, or culture). This factor unites a network's members; it solidifies their relationships and makes the entire structure more stable"*.

If this unifying factor is only technical, then we must be in the context of social media; if the unifying factor is about identity and values, then we must be part of a social network. In the latter case, the unifying factor allows members to build relationships based in trust for example through gift giving.

3.4 The foundations of the economics of gifts

According to Mauss (1950), professor of religious history from Polynesian ethnic group, gifts initiate a relationship that is delayed in time through the reciprocal gift that is called for in return, such that it becomes an exchange. Although gifts seem to be associated with a form of altruism, they actually create a moral debt for the receiver, who then owes the giver a gift in return. For the people involved, this tacit obligation to engage in reciprocity threatens their reputation, their honor, the legitimacy of their social standing, and even the legitimacy of their professional standing. This logic of "giving and giving back" thus tends to establish an ethical code based in solidarity, which allows relationships to be fortified, not on the basis of hierarchical subordination, but rather on the basis of mutual trust. In "archaic" societies in Polynesia and Melanesia, the ritual of reciprocal gift giving allows social harmony to be maintained.

The theory introduced by Mauss (1950) deals with how relationships function when they are based in exchange, are built over time, and remain uninterrupted. He admits that there may be imbalances between what is given and what is received, but these imbalances never interfere with the relationship in the long term. Putting these two acts into perspective thus shows that they do not meet the classical requirements for commercial exchanges. Indeed, these requirements are based not only upon the notion of rationality of the participant but also upon the principles of satisfaction of desires (giving so as to receive) and synchronous reciprocity (giving and receiving). Mauss's theory is thus based upon a social tie that goes beyond the simple utility of exchange. In this case, the people involved enter into a lasting relationship where the creation of a unique, strong social connection is at the heart of any transaction.

In analyzing this type of relationship, the author suggests an "overall" interpretation of the act, that is, he considers that the economic exchange is inseparable from other dimensions such as symbolism, identity, social matters, emotions, relationships, etc.

This notion of the whole is also connected to these people's personal and professional spheres. Indeed, when we talk about business management, it is also necessary to consider the nature of the game from the perspective of the people involved, which includes values, conventions, a code of ethics, the issue of reputation, symbols, identity, standards of conduct, etc. Thus, this leads us to consider any exchange, whether it be commercial or non-commercial, to be a part of the social activity of the participant. The transposition of Mauss's (1950) nonutilitarian philosophy to the market economy is in fact featured in Alter's (2010) and Caillé and Grésy's (2014) sociological work, and it is the cause of the infatuation with the collaborative economy.

4. The collaborative economy

The capitalist economy functions within a patrimonial framework, within which people gather resources and skills in order to create wealth. This wealth then serves to acquire other resources and skills to improve the business's holdings and further its development. This structure has limits, since financial resources and raw materials are now rarer and more costly to get, and also

because individual skills are not enough to lead to increases in productivity: “doing more with less.”
Given these conditions, in order to continue to develop the economy at a time when talent and resources are becoming scarcer, it is appropriate to pay attention to a hidden, yet fundamental dimension of economic transactions: human relations. Every time a commercial transaction is realized, it furthers a social relationship that is conducive to a climate of trust. This trust then serves to develop cooperation and thus promote access to new resources or collective skills that were unimaginable within a patrimonial framework: “doing more with partners.” In this way, the economy tends to be developed on the basis of sharing rather than exclusive ownership, through consumer networking. The collaborative economy is sustained by this principle, through carpooling, apartment swaps, bartering between private individuals, etc. More specifically, Schwienbacher and Larralde (2010) define four forms of collaboration in the collaborative economy between private individuals :

- Sharing of services: this allows needs to be met when it comes to providing services. This applies in particular to any and all rental services. For example, we could give the example of the sharing of vehicles between private individuals.

- Trading and redistributing goods: the most common ways of doing this in these types of communities are bartering, gifting, or resale.

- Community living: the principle here is supplying community members with intangible resources, such as time or skills. The most common initiatives are sharing work or living spaces, carpooling, home help, private lessons, etc.

Financial solidarity: more commonly called “crowdfunding.” This type of participatory financing mainly brings together private individuals who are all conscious of a single, unifying project that requires startup funding. On a different note, we could mention organizations for group buying here, where consumers come together to make group purchases.

To explain the rise in collaborative practices based on sharing, Bostman and Roo (2011) highlight the disposable and cumbersome nature of certain objects that are useless in everyday life. They also discuss the dissatisfaction that comes from being surrounded by an abundance of possessions. One of the emblematic examples of the nonsensical nature of property highlighted by these authors is a drill, which when used as a tool for home improvements is used an average of 13 minutes over the course of a lifetime!

An entire group within our society is thus adopting this practice of sharing the use of goods and services instead of coveting their property, as Rifkin (2014) points out. This change in consumer behavior is being fostered by collaborative platforms in the digital universe.

According to Bostman and Roo (2011), there are several factors behind the success of collaborative platforms. First of all, cultivating social connections is of major importance when it comes to finding meaning in a totally fragmented society. Relationships that are based in sharing and values of solidarity are an answer to this search for meaning. In addition, collaborative practices contribute to the preservation of resources that are diminishing in the environment. Finally, financial crises also lead consumers to streamline their expenses by searching for the least costly solutions, which are provided by the collaborative economy. As budgets get tighter, some people are forced to adopt this collaborative lifestyle: group buying to save money, or renting out their possessions to obtain additional resources. In the collaborative economy, the

value of a transaction is no longer linked solely to the intrinsic value of the product, but also to the degree of trust built between anonymous people. The role of platforms is to guarantee this trust!

The collaborative economy does not apply only to consumerism, but also concerns other aspects of businesses' relationships with clients (Robert et al. 2014). For example, crowdsourcing is based on users sharing their experience. This pooling of knowledge may then feed discussion forums and thus contribute to the first stage of a business's customer service.

Conclusion:

Weaving, linking, unifying, and creating flow: such are the properties of the concept of a network, which gradually evolved and moved from the technical sphere to the social sphere. Within a social framework, networks are useful because of their ability to unify the different participants of which they are composed, on the one hand respecting participant autonomy, but on the other hand fostering collaboration in the context of affectio societatis. This networking took on various different dimensions over the course of history: networking involving small-scale distances with the barter economy of merchants in the Middle Ages; networking involving mid-sized distances over vaster regions with the migration of religious pilgrims during the Renaissance (Aboiron et al., 2008); territorial networking on a larger scale with infrastructure networks for transportation, water, and electricity as imagined by Saint-Simon in the 20th century; and limitless networking in the digital age with collaborative platforms capable of uniting billions of anonymous people in the 21st century.

Even though the distances have increased as a result of technological progress over the course of the centuries, social networks still have the same properties. The primary reason to become a part of a social network is sharing an "address book," which is like social capital that constitutes a club good, that is, a resource that is specific to the network and that is neither transposable to the outside nor privatizable within the network. To make the most of this social capital, it is necessary to be united and devise plans for building and maintaining trust, such as reciprocated gift giving (Mauss, 1950).

With the rise of tools for communicating at a distance and digital platforms, social networks have taken the form of social media. This term designates a network for communicating at a distance, without an intermediary between the sender and receiver of a message. In social networks, it is thus important to take into consideration not only the number of contacts involved but also the quality of these connections. When discussing the quality of interpersonal connections, we invoked the work of Granovetter (1978), who states that there exist two categories of relationships between people: strong ties, which involve much closeness and shared trust within a limited circle based on a particular affinity, and weak ties, which are developed in a more indirect and involuntary way outside of this primary circle of trust and which are sources of diversity of information.

For this author, it is not the strong ties that are sources of added value, but rather the weak ties, that is, the ties that we maintain on an infrequent basis with someone in the form of a relationship that is not consistent. For him, strong ties lead to isolation because the same information circulates endlessly within the group without being renewed. It is thus the weak ties that allow social media to exist on the internet, while strong ties guarantee that social networks are attractive to people and face-to-face communication allows people to build interpersonal trust.

For businesses, social media represent a major phenomenon that needs to be dealt with, primarily from an advertising and commercial perspective. Taking advantage of rumors on social media on the internet is thus an essential concern when it comes to adding value to a brand through viral marketing, using the cross-contamination of information between users, one step at a time.

Likewise, it is becoming more important for any business to take advantage of the multiplicative effects of social networks on the sales of goods and services, for example, by attempting to take advantage of each member's address book through commercial sponsorship.

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Citizen participation challenges in the healthcare sector: the case for empowerment in French mental health[1]

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Summary

Over the last forty years or so, French society has featured attempts to encourage citizen participation. Healthcare has been no exception to these moves but in a unique way compared to other areas of public policy. Efforts to bolster patients' involvement in improving their own healthcare have been stepped up, with a focus on showing that illness need not hamper citizenship and that this could become a guiding principle for recovery. In psychiatry, patient empowerment is used as a joint care treatment with and by the patient. This paper seeks to explore what such treatments consist of in practice and whether they can be considered a form of citizen participation.

Key words: participation, mental health, citizenship, empowerment, care, patient, user.

Introduction

Citizen participation is not a feature unique to France nor is it a recent issue. Nevertheless, over the last forty years or so French society has featured a growing "participation environment" (*contexte participationniste* - Blatrix 2009) resulting in a patchwork of initiatives designed to further citizen participation, especially at a local level. Certain areas of public policy, such as the environment and town & country planning have been more particularly influenced by this movement and have led to a number of ways of furthering participation, examples being public inquiries, citizen consultations, local referendums, neighborhood councils and various types of debate organized by the French National Commission for Public Debate (CNDP).

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[1] Intermediate versions of this research have been presented by some or all of the authors at the following conferences:

- "Managing Citizen Participation in Decision-Making and Implementation in State Administrations and Organizations" ESSECT- University of Tunis, Tunisia - March 1 & 2, 2018
- IEPA 11 - Early Intervention in Mental Health "Prevention & Early Intervention: Broading the Scope" Boston, Massachusetts, USA, 7-10 October 2018

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While issues such as the environment or town & country planning have been at the forefront of growing citizen participation, which is seen as a way for people to get across their aspirations and views even when merely taking part in the democratic decision-making process, the push for participation seems to have hit other issues much less. For example the cultural sector "is still far behind in terms of societal change, preferring professionals and experts occasionally meeting up in private to talk rather than public debate" (Montero 2013).

So, what about healthcare? It does not appear to have escaped this movement. Some writers also point out similarities between healthcare and environmental issues, which is the "chosen field" in France for the right to participate in decision-making. "Such cooperation between ordinary people and specialists is all the more inevitable and all the more illuminating the closer we get to healthcare or environmental issues, i.e. where knowledge affects in one way or another an entire person (Callon, Lascoumes, Barthe, 2001, p. 141). As regards user's[6] citizenship and them participating in taking care of their own health problems, questions may arise as to their ability to make helpful contributions to the decision-making process, and disagreements may arise with regard to user involvement, specifically in psychiatry. This is because psychiatry in particular requires social care to work closely with medical care, and for this to happen, carers from both fields need to coordinate their interventions (Bartoli, Sebai, Perrin, 2017).

Against this background, two research questions are addressed in this paper: First, to what extent can we talk about citizen participation in healthcare, and specifically mental health? Second, can the key principle of empowerment, which seeks to bring about joint treatment with and by the patient, be considered a form of citizen participation?

Some current French healthcare facts :

Healthcare in France seems to have been confronted with singular and distinct citizen participation movements. Since the late 1970s, various principles aimed at ramping up patients' involvement in their own healthcare decision-making have become embedded. In various countries around the world this has ushered in a public health field known as "community health", particularly following the first WHO (World Health Organization) conference that led to the Alma Alta declaration. One of the conference's key topics was expressed as people's right and duty "to participate individually and collectively in the planning and implementation of their health care" (WHO, 1978). Out of this, the participation of communities in healthcare has risen as a major political issue and can be summed up as follows: "Healthcare is said to be community health when the members of a geographic or social community reflect together on their healthcare problems, express priority needs and actively participate in the establishment and running of the activities most suited to meeting such needs" (Manciaux and Deschamps 1978). In 1986 said initiatives led to the founding of the European Secretariat for Community Healthcare Practices (SEPSAC). Its goals include forging links between healthcare professionals and furthering communities participating in defining healthcare needs and developing good solutions.

Since then, and particularly in the late 1990s, voices arguing for healthcare patient involvement in society have regularly surfaced. They seek to demonstrate that illness need not hamper citizenship, and that this could boost recovery. This means treating everyone as a citizen, i.e. a person rather than a patient or user. Being a full member of the community would imply

[6] In this article, we will be using the terms "patient" and "user" indiscriminately. For a discussion on the various understandings attaching to the term "user", please refer to Chauvières, 2006.

developing reciprocal relations between equal citizens (Rowe et al., 2012). From a legal standpoint, this patient as citizen approach emerged in France with the January 2, 2002 Act that overhauled social care and medical-social care policy. Since then, other legislation has been passed to enhance the role and participation of the user and their representatives whilst upgrading healthcare quality. It is in this perspective that the law to modernize the healthcare system known as the "Touraine Act" was adopted in 2016[7]. It constitutes a new step forward towards healthcare democratization.

In society at large, a number of movements to mobilize patients or set up patient representative associations have emerged, sometimes with tremendous publicity, fueled mainly by social media. After studying the rise of AIDS patient movements (Epstein, 1996; Barbot, 2002) or the French Association against Myopathies (Rabeharisoa, Callon, 1999), researchers have shown how patients manage to establish themselves as experts in their own illness, "capable of following researchers' findings, but also capable of cooperating with them on some points, and in all cases playing a core role in building organized and formalized primary knowledge on such illnesses" (Callon, Lascoumes, Barthe, 2001: 110). Sometimes mobilization leads to the discovery of new pathologies and the "scientificization" of hitherto unnoticed conditions. This was the case when residents of a county in Massachusetts rose up about the high incidence of childhood leukemia among their families Their work led to the discovery of the trichlorethylene syndrome (Brown, 1992). This also brings to mind the case of the "Phyto-victim" charity bringing together farmers who were suffering from the effects of the use of pesticides (Jouzel, Prete, 2015). Mobilizing patients or disease victims and how they manage to reveal new knowledge and new causes, has been increasingly documented. (Latté, 2008; Lefranc, Mathieu, Siméant 2008; Lefranc, Mathieu, 2009). The recent case of the drug Levothyroxine and the online petition supported by more than 150,000 patients in a few weeks, bears out a profound change in the relationship between users, healthcare professionals and government authorities, who now find themselves challenged by the modern digital society, people's access to all types of information, and the existence of social media. As a result, new issues are emerging that relate to the interplay between skill use and expertise and which are fueling a change in the citizen-patient concept.

What is the situation with mental health?

In view of the background detailed above, mental health raises bigger issues and challenges. This specific sector represents a major challenge for government health policies: "According to the WHO, mental illnesses rank third among illnesses in terms of prevalence and are responsible for a quarter of disabilities." (Gozlan, 2015).

Mental health users are rarely viewed as positively as users with chronic somatic illness, although they too may have complex care and service histories and needs. This is why improving their ability to adapt to daily life by achieving sufficient autonomy appears to be a key objective of early medical-social care, combining clinical, organizational and human resources to effectively support them on the road to recovery. Indeed, these pathologies can negatively influence a user's social, academic and career development in that cumulative disabilities evolve towards psychological and social handicaps. These observations point to a need to promote the development of new, more comprehensive and better coordinated care treatments, based on ongoing care and services promoting recovery that is perceived as a unique and deeply personal process of change in attitude, values, feelings, goals, skills and roles of users striving to live a

[7] Act no. 2016-41 dated January 26, 2016 on modernization of our healthcare system

fulfilled, participatory life looking forward to the future, despite the ramifications of their chronic disease.

This is what underlies some policies and strategies (WHO[8] action plans) that encourage citizen participation in the coordination of healthcare and life in general. Some user's own tactics are encouraged. Indeed, faced with the challenges of such activities and the need to pinpoint ground-breaking organizational and social solutions, we can see that patient and / or family associations, and "peer helpers" will play an ever increasing role in drafting policy and in care decision-making. One of the key concepts implemented in these new approaches is that of empowerment, which boils down to the patient-user acquiring knowledge, skills and resources they need to achieve their goals, however far reaching these may be.

So, based on the empowerment approach (i.e. recovery and citizenship) leading to "citizen participation / community health" we will seek to focus our arguments on community mental health.

Empowerment, or construction with and by the patient:

The concept of empowerment seems to have been borrowed from circles seeking to establish or protect the respect and dignity of social minorities (Bartoli, Gozlan, Sebai, 2017). From the late 1970s onwards, empowerment has been driving the movement pushing a strict approach to participatory democracy (Bachrach, Botwinick, 1994). Sometimes translated into French as "*capacitation*", it is close to the notion of "emancipation" dear to the French mass education movement and close to the notion of "power to act" (Quebec) or the possibility of "communities" to organize themselves (USA). The concept has been applied to medicine so that when the healthcare system malfunctions user/patients can get involved in organizing their care or in defending their rights. So empowerment is "the degree of choice, decision, influence and control that mental health service users can exercise over their life events." (Lecardinal, 2010 p3-5).

Empowerment is deemed to be the process by which individuals take control over their own lives, learn to make their own choices, participate in decisions that concern them and better equip themselves to know how to contribute to society. Empowerment thus appears as the underlying goal of socialization activities, high quality care and good "help" which may benefit patients in the most acute phases of their life journey.

Empowerment can then generally be taken to mean the level of choice, influence and control that a person can exercise over the events in their life. Individuals need to not only take on board more knowledge they also need to keep their job skills up to date, but they must also adapt to new needs, personal goals and career plans as they go through life as a person, including as an ill person. Shared information, participation, mutual support, self-determination, can contribute individually and collectively to empowerment. Ideally, empowerment assumes people getting actively involved in raising their capacity to "influence reality" (Le Bossé, 2003), to garner helpful (personal, relational, material, informational) resources and to "take their destiny in hand" (ibid.).

[8] First International Conference on Health Promotion, Ottawa, (Canada), November, 17–21 1986.

Underpinning the health promotion view advocated by the WHO, empowerment of mental health sufferers and their full integration into society are increasingly the concern of some mental health institutions. Their stated goal is to build a society where such people are fully- fledged citizens and where care services are set up in a way that supports such people's autonomy and social inclusion, rather than just viewing them as patients.

A policy of empowering mental health patients is closely linked to the lifelong right to training and social integration. Moreover, empowerment is only considered possible if the person has reached "near autonomy"[9] (as defined by Zittoun, 2006, p. 169) allowing him or her to make the most of their specific treatment. The empowerment of people living with a mental disorder is generally represented as useless if their citizenship is not fully recognized and valued. For a form of "participatory democracy" in mental health, we must therefore think of psychiatry as a way to help mentally ill people to get better through their own efforts. To do so, society at large needs initially to change its attitude towards mental illness and mental diversity. This means that institutions and organizations and the health, medical-social or social care they dispense needs to be thought through.

Some moves in this direction have been observed in some countries, but are still rare in France. The recognition of a care service user as an actor in their own medical or social care treatment, or even as a fully-fledged healthcare professional in the role of mediator or peer helper, go in this direction. In North America, allowing patients to take joint legal action under "class-actions" is also a development that furthers the notion of empowerment (Cerminara 1998).

Promoting capacities, skills and participation in community life therefore represents a switch from a medical view to an all-embracing "medical mental social" approach. This is a significant paradigm shift for healthcare professionals vis-à-vis their patients. Care and services, which hitherto have been left up to specialists and institutions, are now also supposed to refocus on empowering patients to manage their disorders with professional help. As such, the goal is to go beyond traditional hospital psychiatry methods, where the user had to put up with medical treatments involving a risk of developing iatrogenic disabilities caused by excessively long hospital stays.

Empowerment pre-conditions: Recovery and Citizenship

Specialist literature puts forward two conditions that are needed for empowerment to work i.e. "recovery" and "citizenship".

While the concept of "recovery" was not formally codified in France until the February 12, 2005 Equal Opportunity Act[10], the concept featured prominently in the 1970s, when it was used by healthcare professionals to confirm whether alcoholic patients could take care of themselves and their treatment. Recovery is the culmination of an individual's treatment and the ability to start

[9] This idea of near autonomy has been developed based on the notion of proximal zone of development introduced by Vygotsky. This is the gap between a young person's current ability to cope with what is happening in their life, and the ability they would have if receiving support. This gap opens up a possible space for empowerment to the extent that the young person, receiving support, could take advantage of that additional autonomy.

[10]Act dated February 11, 2005 for equal rights and opportunities, participation and citizenship of people with disabilities (Act no. 2005-102, published in the French Official Journal (JO) no. 36 of February 12, 2005 page 2,353).

living again. Recovery is described as *"a deeply personal, unique process of changing your attitudes, values, feelings, goals, skills, and/or roles (…). Recovery involves getting new meaning and purpose in your life as you manage to overcome the fallout from mental illness."* (Bill Anthony, 1993).

The so-called recovery approach is widespread in the USA and Canada where most mental health services are based on it[11]. The resulting epidemiological cohort studies show a high percentage of remissions, including for people with severe mental disorders, especially in the field of schizophrenia[12] (Bleuler 1972, Ciompi 1976). Epidemiological research on the fate of schizophrenics also shows that 50% to 70% "recover", i.e. live a life considered satisfactory (ibid). In the light of such examples, recovery-centered care and services promote individual empowerment, respect for their choices, and the need for them to be involved in their own recovery. A practitioner must therefore adapt to this new situation where a patient seeks a new meaning in life (Farkas, 2007).

This is linked to empowerment and is just as important as recovery, being the lever of citizenship i.e. being recognized as someone participating fully in society where everyone's civil and political rights and civic duties are respected, living in a democratic country governed by the rule of law. Citizenship is the guiding principle of recovery and empowerment. In practice, recovery is not only to keep people healthy, but to ensure that they are fully-fledged community participants where they live, just like everyone else. This means considering everyone as a citizen, a person rather than a patient or user. Being a fully participating community member involves building mutual relations between equal status citizens (Rowe et al., 2012). So, now, there is a movement to show that mental health disorders should not hinder citizenship.

It follows that combining the three patient levers of action (empowerment, recovery & citizenship) gives rise to a form of "community mental health", defined as the involvement of outside parties in diagnosing pathologies so they can put their expertise into practice and play a part. It also means breaking down barriers and instilling teamwork and sharing best practices and powers between different departments, disciplines and institutions.

Community health

Manciaux M. and Deschamps (1978) wrote that community healthcare arises when members of a geographic or social community together reflect on their healthcare problems, prioritize their needs and actively participate in establishing and running appropriate activities that meet said needs. Despite a low level of user participation in decision-making processes (Blatrix, 2017), many initiatives have come about in recent years, mostly as a result of teaming up with user and family associations and supervisory bodies, such as House Clubs or Mutual Aid Groups (*Groupes d'Entraide Mutuelle* - GEM), which encourage empowerment and citizenship. In this regard, the Regional Houses for Handicapped Persons (*Maisons Départementales des Personnes Handicapées* - MDPH) placed themselves in 2006 at the center of an administrative system giving entitlement to disability welfare payments covering all aspects of life (health, training, work, daily life, housing, etc.).

[11]A study of their operating charters shows that these services aim at focusing on people's capacity to recover.

[12]Schizophrenia is a term strongly tinged with the notion of non-recovery and stigma.

However, the complexity and careful coordination of actions that is needed in a given a geographic area, the cultural barriers separating different advocates and questions of legitimacy sometimes require a level of consultation which is impractical for some health or social/medical care providers (Bartoli and Gozlan, 2014). This is why organizational changes to implement coordination, integration, case management and empowerment in mental health seem to meet expectations on moving to new all-embracing care models that involve users and seek to curb disruptions in care by ensuring better coordination of care and services. (Laforcade, 2016).

Empirical research

The case study below draws on most of the concepts and principles that have been analyzed above. It is a fairly rare example in France of an early medical-social care provider intended for a group of schizophrenia users with complex needs.

Case study

The provider under review is Samsah Prepsy, a 50-bed home in Paris, providing 14,000 care days per year. It is free and funded by the City of Paris County Council (*Conseil Départemental*), the Regional Health Agency (*ARS*) and the *Fondation de France*. It is an example of a French personalized, multidisciplinary and collaborative medical-social early intervention care home. It is designed for 18 to 25 year-old adults with emerging mental disorders such as schizophrenia, which lead to a general breakdown in their personal and family relations, academic or job abilities and require local medical and social agencies to provide simultaneous care over a long period. It strives to bring about patient recovery by giving them better access to local services. Prepsy describes itself as a personalized medical-social care home with varied levels of cross-disciplinary care, which is designed for young adults with emerging mental disorders leading to a general breakdown in their personal and family relations, school or job abilities. It strives to bring about patients' recovery by curbing everyday handicaps, by improving access to local services and by building an enduring medical-social grouping of the various agencies involved working effectively together in caring for the patient, including patient's lead doctor, freelance or hospital psychiatrist, psychologist or psychotherapist, social worker, local authorities, schools, professional associations, families, relatives and so on.

The Prepsy organization delivers an all-embracing flexible service with a dedicated team covering health, social and medical-social expertise, all of which is backed by other professionals who do not usually work for such care homes such as an ergonomist, a job placement specialist, a dietitian, a sports teacher and non-professionals such as peer helpers. It looks after young schizophrenia patients with complex needs including simultaneous long-term medical and social care. The care home's mission is to provide ongoing local care by tapping into clinical practices in line with the users' neuro-functional capacities, seeking to bring about recovery in everyday life by all-embracing care delivered by all agencies and providers involved with their care, and their family.

In view of financial constraints, such actions mean key experts need to team up together. Given all this, Prepsy's strategy breaks down into three joint service levels: clinical, functional and institutional (Leutz, 1999). For each level, Prepsy has implemented a system of concrete actions aimed at coordinating dealings between care providers, while pointing out the care home's role

and practices in respect of density, scope, centrality or even dealing with cases with several levels of complexity.

Method

Prepsy was selected as a case study given its specific features: it has created a new way to care for mental health patients based largely on the interplay of social and medical services. (Gozlan, 2018). Patients, their families, countless professionals and institutional leaders seem nowadays to expect empowerment and community healthcare.

The stance we adopted for this empirical research was constructivist (Le Moigne 1995) in that the researchers constructed their understanding by interacting with the community studied. The approach was also "abductive" (Peirce 1931, Angué 2009) in that an understanding of what was observed was based on relating all this to a theoretical framework.

The method has been qualitative, based on a case study (Yin 2009) and approximated for scientific research purposes (Eisenhardt 1989). A total of 30 semi-structured interviews lasting an average of 75 minutes were carried out with four groups of people:

- Staff members of the care home under review: special teachers, nurses, doctors, administrative managers, a job placement specialist and ergonomist, etc.
- Some patients and their families.
- Some institutional managers involved in Prepsy operations (local authorities, ministry, agencies, etc.).
- Some national or international experts from the field of mental health[13] coordination and integration.

Interviews were based on answers to questions about ideas, practices and references involved in those practices. Answers were obtained via questionnaires primarily based on ideas and statements from parties involved in mental health on the notions regarding approaches to patient care set out above, and secondly based on practical testimonies about types of all-embracing patient care. These interviews were conducted on a voluntary basis with confidentiality and anonymity guaranteed. When allowed by the interviewee, a recording was made so as to stay true to their answers as far as possible. All data collected was processed under qualitative research techniques used in management sciences, including a complete transcript of interviews (in completely anonymous form) and drawing on secondary data; thematic coding; data structuring to pinpoint common themes within all material and a summary and interpretation of all data collected.

As back-up, we reviewed internal documents and public reports. Finally, it was also possible to include a participating observer (for internal meetings) and non-participants (care home staff). Research is ongoing and we are still gathering further data for analysis.

[13]Interviews with experts are still ongoing at the time of writing and so are not included in results.

Intermediate results

→ Development of a new participative user approach

Under the empowerment approach, Prepsy staff say they encourage patients, who "can talk about their own backgrounds", to find hidden energy within themselves to act and take care of their daily lives. In addition to tailoring treatment models, such support also means users are involved in identifying their own problems so as to encourage self-determination, i.e. the ability to make decisions free from exaggerated influences and interferences, to act and govern their lives. The following quotes illustrate this approach:

A few words from users:

- *"It was my mother who suggested I come here - an organization that could give me direction, help me build myself. I came with my mother, it was my wish".*
- *"My caregiver finds that I don't have enough self-confidence. Before I played a lot of rugby and I felt better. Today not too much ... I ask myself too many questions ... but I can manage. The team here is helping me find ways to find a balance. I need balance. "*
- *"Sometimes I can't get out of the house. The thing is, the staff at the organization contact me and push me to do things. Seeing a caregiver - coming to my place motivates me to go out and do things. "*
- *"Here you can talk about all sorts of things, but above all about my welfare, my psychological and health problems. It's reassuring when people take care of us. When I come here I have a set appointment, there is no worry, this helps me get on - I do things and that pleases me. "*
- *"In this organization - I think it is me who has made progress. I feel better today, and I see things better. My needs have evolved over time, but today, I know what I want, what I can ask for, but in the beginning that was impossible. "*

With the help of care-home team members, the empowerment process takes place mainly in the user's everyday life. Ongoing support and the trust established between the team and the user promotes tailor-made services, linked to expectations and the user's expressed or unexpressed needs. In interviewees' opinion, tailor making services also makes it possible to adapt the intensity of actions throughout the process of social reintegration (citizenship) in accordance with changing needs. It is also with a view to accentuating this individualized approach, closer to everyday life, that Prepsy has chosen, unlike the hospital model of "institutional therapy" based on group activities, not to get users involved in collective (sports, cultural, etc.) activities. Team members' opinion was that group activities can have, in certain cases, a positive and stimulating effect, but can also have devastating consequences on certain patients, for whom self-esteem, sometimes very fragile, could be exposed to the stigmatizing gaze of other patients and impact their recovery, as well as their sense of citizenship.

In addition, working to the "empowerment, recovery, citizenship" three-pronged approach, the Prepsy team has developed 4 specific programs:

- A prevention program for the metabolic syndrome, a condition with significant death risk, and a reduction of more than ten years in life expectancy due to cardiovascular risks. This involves the 3 key professions: doctor, dietitian and sports educator.

- A training apartment program, in which users can "life-size" test the functioning of their nervous system and different levels of autonomy in the acts of daily life. This involves the 3 key professions: ergonomist, neuro-psychologist and carer.
- An assisted rapid return to employment program, based on the IPS (Intensive Placement and Support) method. This involves the 3 key professions: job placement specialist, ergonomist and neuro-psychologist
- An inclusion program for two former patients, now psychically stabilized, "peer helpers", who are full members of the team having successfully re-integrated themselves in the world of work and are at the service of users. This involves the 2 key professions: a graduate peer helper with university training in the field and a "digital peer helper" responsible for the care-home Facebook page.

We therefore find here the basic principles found in the literature, i.e. the levers to achieving greater all-embracing user care.

→ Case management, an innovative model for patient relations:

The (personalized) case manager appears to be the key competence, even the cornerstone at Prepsy. That person is more than a care organizer or a key worker, he/she has a liaison and coordination function. The case manager is also involved in psycho-social rehabilitation and user accompaniment. In all this they need to be able to assume the roles of clinician, rehabilitation agent, adviser or spokesperson prioritizing direct (re)integration into the world of work or resuming studies. But above all, the case manager is the users' trusted ally, whose role is not to do everything but to ensure that everything is done (Rapp, Goscha, 2006). The case manager relies on a team that ensures effective supervision of the various Prepsy professionals involved but also a number of various external players.

The function calls for skills of empathy, perseverance and personal qualities such as great personal and professional reliability, high relational capacity, creativity, imagination, dedication, combativeness and tenacity, in the face of medical-psycho-social situations which can sometimes seem impossible to resolve. Their commitment, right from initial contacts, is the key to successful support because a large part of their action takes the form of physical presence in the user's living environment or home. In this context, each case manager brings a skill linked to their initial training, supplemented by their experience in coordination. He/she is a specialist capable of providing help and a level of support tailored to each case. Their approach is all the more important as involvement is geared primarily towards recovery through inclusion in social life and (re)integration as quickly as possible into the world of work, a return to studies or training or access to autonomous housing. Prepsy staff also highlight the specific nature of this form of support, as shown in the quotes below.

A few words from staff members:

- *"We think we are taking a direction with the user but the user shows us that it is not the right direction so that calls us into question, we can discuss it quickly to make the decisions that suit him/her the best"*
- *"It saves time for the user and I would say means efficiency for us, I think we progress more quickly, that is to say that with the objectives they set out for us we can more easily make sure the user becomes autonomous quite quickly. "*
- *"So, we gather up their requests every six months, we review with the young person what he/she expects from the follow-up and ultimately we know what objectives to set for*

support. We collate all this and summarize it. Then we bring together the young person and the team, who explain to him/her what will happen over the next few months, so in this way things are laid down with the young person and he/she becomes the center of everything, it is ok when it happens like that. "

- *"After all, if I had to work elsewhere in France I would see that as an imposition. I think things would be different if the young person were not at the center of things meaning support would not be successful. "*

Discussion and feedback on research questions:

Empirical research confirms that the Prepsy care home differs from traditional models in that it incorporates the key skills necessary for comprehensive and personalized patient care. These are core skills in an empowerment approach as set out in current scientific literature and recent writings, but which are still not used widely in France. The case study shows in particular that the approaches developed strive to go beyond traditional forms practised in mental health by focusing on: (a) the place occupied by the user in care arrangements; (b) his/her role in the needs assessment; (c) their participation in decision-making concerning their own health and medical-social care.

Therefore, returning to the initial research question, can we talk about citizen participation in healthcare, and more particularly in mental health?

If the concept of participation is taken in the sense of an approach centered on types of patient care, the answer can be affirmative (see table 1 below). On the other hand, going further on citizen participation towards city or community affairs, or even further on to the organization of public health policy, the beginnings of a positive response have indeed appeared, but research does not allow us to come to a positive conclusion as yet.

What level of participation ?	**What interim result ?**
Participation of the patient included in the process for his/her overall care?	*Yes* *In the studied structure*
Participation in the affairs of the city or the community?	*Partially Yes* *Through user or family associations, and communities of peer helpers*
Participation in the organization of public health policy?	*No answer at this stage* *Research to be continued*

Table 1: Interim Findings

More specifically, and according to the terms of the second research question, can so-called empowerment approaches in mental health be considered to be forms of citizen participation? Empirical research has shown that empowerment can lead to the acquisition of a certain amount of knowledge, skills, and resources for the patient to embark on projects to assist in recovery. Therefore, if citizenship means seeing a person as an active member of the community, rather than being a sick person or a mental health user, it seems that the answer

needs to be formulated on a case-by-case basis, meaning that this type of approach is not necessarily perceived or recognized as such.

Research also shows that obstacles to such empowerment approaches can be powerful. In particular, the negative view of society towards psychiatric patients and the negative experiences of users, mentioned by many interviewees, hamper their capacity for initiative. The notion of mental illness should be reviewed to reflect possibilities for remission, recovery and cure. More generally, as in other sectors of citizen participation, a question remains concerning the status of patient participation: are life experiences necessarily knowledge (Lochard, 2007), and can one move from knowledge to expertise?

Conclusion

The research highlights the fact that this approach is based on enhancement of the user's skills and areas of interest (empowerment) placing importance on intensive monitoring in the person's everyday life, training in social skills, return to autonomy, rapid return to employment and access to autonomous housing. Such support, based on case management of complex cases, aims to help limit the risk of mental illness being a handicap. According to a model of service integration driven by a "discipline approach", key skills have been mobilized (i.e. case managers, peer helpers, ergonomists, job placement specialists, dietitians, sports trainers, managers and coordination assistants) to work alongside doctors, nurses, nursing assistants and social workers. Involvement occurs at all three levels: clinical, functional and institutional. The objective is to offer ongoing services, based on integrating key competences (Leutz, 1999).

More particularly, the establishment of "peer-helper" positions, reserved for people who have been, or who continue to be treated for mental disorders, is proving to be decisive for the effectiveness of patient participation. The peer helper seems to be able to be a full member of the team; they intervene in the community and encourage patients to make their own choices ("advocacy") and to assume their treatment plan in a responsible manner (empowerment). Peer helpers, through the experience and knowledge they bring to the team, encourage the development of a culture in which each user's point of view and preferences are recognized, understood, respected and integrated into treatments, rehabilitation, and mutual aid in the community. With their support, parents, siblings and relatives can also benefit from psycho-educational training to reduce the burden of the disease.

The research thus highlights very specific forms of user participation in mental health, through empowerment, the intervention of peer helpers, and involvement of the community of relatives and family. The inclusion of these participatory arrangements in organizational innovation seems to play a key role in the impact of participation.

The research presented in this article is exploratory and has the limitation of relying mainly on the study of one single case. It needs to be continued with other cases and through a deepening of user participation methods. International comparisons will also bring out the specific institutional and cultural nature of the French situation studied here.

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Development and validation of a measure for product innovation performance : The PIP Scale

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Abstract
Innovation performance evaluation is a crucial issue in innovation management research. Based on existing literature, qualitative and quantitative surveys, a measurement scale for product innovation performance (PIP) was developed and assessed. We defined PIP through five dimensions: financial performance, market performance, customer performance, technical performance and strategic performance. The validity of this scale was tested via structural equations modeling (SEM) based on a dataset from the French biotechnology industry. Results supported our conceptual model and showed that all dimensions measurements were validated. In addition, these dimensions were complementary, strongly correlated and, had strong positive link with PIP. These findings underlie the importance to consider these five PIP dimensions simultaneously in order to improve and/or to evaluate new product results.

Keywords: Product Innovation Performance, Measurement Scale, Structural Equation Modelling
JEL Classification: M11; O32; L25; C39

1. Introduction

The new global context is dominated by a rapid pace of technological changes, shrinking product life cycles, increasing customer demands, more productivity and quality requirements and fierce global competition (Evanschitzky et al, 2012). In this context, particularly for Knowledge-intensive firms, technological innovation is regarded as a key element of maintaining and improving competitive advantages (Garcia-Muina et al, 2009). To achieve product innovation performance, firms need a deep understanding of innovation dynamics, well thought innovation strategy, well-defined process of innovation strategy implementation, and above all profound tools to measure innovation performance.

Evaluation of Product Innovation Performance (PIP) is a critical issue on innovation management research (Tatikonda 2007; Blindenbach et al, 2010). PIP measurement is gaining importance as its effectiveness and efficiency not only determines an organization's competitive advantage, but also its very survival (Cedergen et al, 2010). Tatikonda (2007) reported that innovation performance measurement is an expansive and elusive subject. This author explained that "This is due to the multiplicity of meanings associated with performance measurement; the varied, but simultaneous, roles that performance measurement plays; and the numerous, distinct customers of performance measurement" (Tatikonda, 2007, p.1). Given the importance of product innovation performance, its measurement is a daunting challenge. In fact, both researchers and managers require a relevant measurement instrument of PIP (Alegre et al, 2006). In that spirit, the aim of this paper was to develop and assess a measurement scale for PIP. We tested the validity of this instrument based on a sample of 100 French biotechnology firms (BF).

The paper unfolds as follows: First, the state of the art is presented. It aims to highlight the importance of developing a measurement scale of the PIP. Next, our expanded understanding of the PIP is described. Then, the research methodology is outlined. Finally, results are presented and main conclusions are discussed.

2. Literature review

2.1. State of the art of Product innovation performance measurement

The PIP is a broad concept, which definitions are various and therefore its measurements are quite heterogeneous. This performance can be presented from many points of view: commercial, financial, technical, global, etc. Given that the primary goal of a product innovation is to generate a profit, the most used criteria by firms to assess performance are based on financial and market aspects (Suomala, 2004). However, using only these criteria is considered so restrictive and narrow since the product benefits range is wider and richer. It was shown that product innovation could have as objectives/ effects: improvement loyalty of existing customers, improvement of the company image, grow into new markets, etc. (Storey and Easingwood, 2009). These authors argued that these effects are of considerable importance to a firm.

However, these benefits - termed “company benefits” by Storey and Easingwood, (2009) - are less frequently used by firms to measure their PIP.

Some empirical research found that some criteria such as customer satisfaction, reputation and competitive advantage produced, despite being considered by managers to be the most useful, are rarely mobilized as measures in reality (Driva et al, 2000).

In a survey of PIP measurements in the U.S. and Europe, the following measurements were identified as being those most commonly used : total cost of the project, on-time delivery of development project, actual project cost compared to budget , actual versus target time for project completion and lead time to market (Driva et al, 2000). These authors compared measures recommended by academics to those used by practitioners. They concluded that measures appearing in common (practitioners and academics) include target time for project completion, total cost of the project, time to market, etc. However, while practitioners placed more emphasis on costs and time, academics attach more importance to customer orientation. This highlights the importance of developing performance measures affecting financial, market, technical and customer sides.

To indicate which firms were in better control of their PIP, AberdeenGroup (2005) mobilized metrics around percent of products meeting targets with regard to: revenue, product cost, launch date, product quality and development cost.

When quantifying practices’ impact of best-performing businesses on PIP, Cooper and Edget (2012) used these metrics: revenue and profits from new products, proportion of projects hitting their targets, productivity, performance against sales and profit goals.

Boston Consulting Group indicated that measures considered most valuable by executives were time to market, new product sales, and return on investment in innovation (Adams et al, 2008).

The common feature of the above measures is that they are one-dimensional order. We present in what follows multidimensional ones.

Blindenbach et al, (2010) defined PIP as the combination of two dimensions: operational performance and product performance. “Operational performance reflects how the innovation project was executed, while product performance evaluates the commercial outcome of an

innovation project" (Blindenbach et al, 2010, p. 574). The first dimension includes adherence to schedule and budget targets and quality. The second dimension comprises financial and market aspects such as adherence to profit targets, growth targets, market share targets, competitive advantage, and customer satisfaction.

Based on a survey among product development managers, Griffin and Page (1996) categorized PIP measurements in three dimensions: (1) customer-based success; (2) financial success; and (3) technical performance success.

Cooper and Kleinschmidt (1995) found that PIP measures they listed produced three dimensions. The first is financial performance, including profitability, payback period, sales, profits. The second is market impact and is measured by domestic market share, foreign market share. The last dimension is termed 'opportunity window' and regroups window on new categories of products, window on new markets.

A study conducted by Storey and Easingwood (2009) on consumer financial services sector in UK about the types of new product performance has identified three distinct dimensions of performance: sale performance, profitability and, enhanced opportunities. Sales performance consists of revenue, market share, growth in sales against the goal. Profitability is measured by the level of profits and profits against targets. Enhanced opportunities "very much show the long-term benefits that can occur from introducing a new product. Repositioning the company, opening up a new market, and a platform to introduce further new products, indicate an improved likelihood of long-term company prosperity" (Storey and Easingwood, 1999, p.195).

Alegre et al, (2006) conceived PIP as a combination of two dimensions: efficacy and efficiency. Efficacy evaluates the success of an innovation, while efficiency assesses the effort carried out to achieve that success. Product innovation efficacy was inspired mainly by the instrument proposed by the OECD's Oslo Manual (2005). Product innovation efficiency was based on a comparison with firms' competitors on these metrics: average innovation project development time, average cost per innovation project, global satisfaction degree with innovation project efficiency.

Hsu and Fang (2009) identified four PIP dimensions: Market performance (revenue, market share, market forecast accuracy, etc.); Financial performance (overall profitability, investment return); Customer performance (customer satisfaction, customer acceptance); and Product performance (quality, competitive advantages, and launch on time).

In what follows, we analyze these works in order to present an expanded understanding of the PIP concept.

2.2. Broad understanding of the PIP

In this section, we present our expanded understanding of the PIP concept. Its aim is to prepare the basis for empirical research to build a PIP measurement scale.

Because no single measurement can evaluate PIP, many authors - as presented above - insisted on a multidimensional approach. For this reason, we choose to do our analysis based on multidimensional approaches. In table 1, we compare four PIP scales in order to determine terminologies to adopt and items to mobilize in our empirical study. Given that PIP scales developed by Storey and Easingwwod (2009) and Cooper and Kleinschmidt (1997) are relatively similar, we include them in the same terminology. We collected forty-two items from previous studies, and removed similar or same items, reducing the total to twenty-eight items as presented in table 1.

1.1.1 Table 1: Expanded understanding of PIP measurement scales

Authors	Griffin and Page (1996)			Hsu and Fang (2009)				Blindenbach et al (2010)		Alegre et al (2006)		Storey and Easingwood (2009)		
Items /Dimensions	Fp	Tp	Cp	Fp	Cp	Mp	Pp	Op	Pp	Ece	Eca	Sp	Pr	Eo
Market share against objectives	x					x			x		x	x		
Profitability against objectives	x			x					x				x	
Opening of new markets abroad											x			x
Improved customer loyalty			x		x								x	
Customer satisfaction			x		x				x			x		
Sales/Revenue against objectives	x					x			x			x		
Improved company reputation									x					x
Enhanced competitive advantage		x					x		x					x
On time delivery/Launch		x					x	x		x				
Adherence to budget		x						x		x				
Better quality compared to your other products		x					x	x						
Better profitability compared to your other products	x			x					x				x	
Better market share compared to your other products	x					x			x		x	x		
Better sales/revenue compared to your other products	x					x			x			x		
Development of environmentfriendly products											x			
Enhanced domestic market share											x	x		
Enhanced foreign market share											x	x		
Repositonning the company														x
Platform to introduce further new products														x
Enhanced profitability of other product									x					x
Overall satisfaction with targeted objectives									x					x
Replacement of products being phased out											x			
Improve health aspects														
Improve safety aspects														
Meet regulatory requirements														
Extension of product range within main product field											x			
Extension of product range outside main product field											x			
Opening of new domestic target groups											x			x

Fp: financial performance, Tp: technical performance; Cp: customer performance; Mp: market performance; Pp: product performance, Op: operational performance; Ece: efficiency; Eca: efficacy; Sp: sales performance; Pr: profitability; Eo: enhanced opportunities

When comparing these scales, we remark that except, Alegre et al work, the most used criteria are based on financial and market aspects. In general, what is classified by Griffin and Page (1996) as technical performance, is classified by Hsu and Fang (2009), Blindenbach et al (2010) and Alegre et al (2006) as product performance, operational performance and efficiency product, respectively. Similarly, financial and market aspects - grouped by Griffin and Page (1996) in one

dimension: financial performance - are integrated in product performance dimension by Blindenbach et al (2010) and in sales and profitability dimensions by Storey and Easingwood (2009). Alegre et al (2006) omit the financial aspects. While customer aspects are treated as a separate dimension of performance by Griffin and Page (1996) and Hsu and Fang (2009), the other authors include them in more general dimensions. The least common dimension between these instruments is "enhanced opportunities". In this context, we note nonetheless that "enhanced competitive advantage" is the most used item by the authors. Oddly, Griffin and Page (1996) and Hsu and Fang (2009) include competitive advantage in their technical and product performance dimensions respectively. However, competitive advantage is not necessarily related to the technical process, but is more likely the result of product features as suggested by Blindenbach et al (2010). Other items such as “Improved company reputation » and « Overall satisfaction with targeted objectives” are also adopted by Blindenbach et al (2010) in their product performance dimension.

At the end of the description of these measurement scales, we see that apart from conceptual differences within each PIP model, differences exist also about which items to adopt and how to group them. Nevertheless, if these models vary with respect to each research tradition, they have a number of common characteristics. This is manifested by some recurring key themes such as financial, market and technical performances.

The scales presented above formed the basis of a qualitative test which aim was to choose the appropriate terminology to adopt and to precise dimensions and their corresponding items to include in our PIP scale.

3. Methodology

In this work, we mobilize a two-stage research design, including preliminary qualitative and quantitative surveys. The purpose of the qualitative study is to obtain compatible measures of product innovation performance in the biotechnology industry. The quantitative survey tests the validity of the proposed PIP scale.

3.1. Preliminary study

To construct the PIP measurement scale, we followed a methodological approach inspired by the paradigm of Churchill (1979). The first step was the establishment of the construct domain. This step was based in part on our review of the literature and is crowned by our broad conception of the PIP. Then, to finish this first step, we submitted this broad conception to a qualitative study. The mobilization of a qualitative method in a positivist research upstream or downstream of a quantitative method is a common and useful practice in social sciences (Gavard-Perret et al, 2008). These latter suggest that to build a measurement scale, the researcher previously needs to go through a qualitative collection phase to be able to understand what the concept covers exactly and to collect the truly used language by professionals about this concept.

In addition, this method has been used by many authors in the innovation management research (Hsu and Fang, 2009).

We conducted the preliminary study was through a questionnaire sent via mail to 11 R&D managers of biotechnological firms. We have received seven usable responses. First, we asked the respondents to adjudicate on the selection of a homogeneous terminology themes to measure PIP. Second, we asked them to comment on these themes to see if they cover the essential assessing the PIP. Then we asked them to judge the items in each theme (dimension); the objective was to ensure the content validity of the scale. Respondents opted unanimously for the terminology adopted by Griffin and Page (1999). They indicated that terminology adopted by

Blindenbach et al (2010) is not adequate since it is somewhat ambiguous and even stranger to the dominant culture in the field. The terminology adopted by Alegre et al (2006) has been discarded since - as explained by respondents - it does not take into account important points such as financial performance, quality improvement and customer satisfaction. Given that the Griffin and Page terminology combines financial performance and market performance in one dimension, respondents criticize it. They believe that firms could be brought to make trade-offs between these two dimensions; hence, the importance of measuring these dimensions separately as suggested by the respondents. The dimension “enhanced opportunities” proposed by Storey and Easingwood (1999) found a good echo among respondents. In fact, these latter suggested that it is interesting to integrate this dimension in the terminology to be adopted. However, they indicated that they preferred to replace the expression "enhanced opportunities" by "strategic performance". They explained that “enhanced opportunities” is an ambiguous term, not usually used in PIP measurement logic. For this purpose, the "strategic" attribute is clearer and more illustrative and insofar as this topic describes the benefits of innovations rather in a long-term orientation. Respondents indicated their disagreement to place the item "competitive advantage" to the “technical performance”. They rather suggest adding this item to "strategic performance." Moreover, we have raised this remark in the previous section. For this reason, we considered this remark by making the necessary adjustments. In addition, this proposal is in line with the «enhanced opportunities» concept proposed by Storey and Easingwood (2009).

In light of the foregoing and in agreement with the literature, we generated eighteen items for PIP measurement and classified them into five dimensions: financial performance, market performance, technical performance, customer performance and strategic performance (Table 2).

1.1.2 Table 2: The proposed dimensions of the PIP scale

Dimension	Statut	Item	Statut
Financial	Initial	Profits attributable to new products are higher than those provided by the remaining products	Initial
		New products have achieved the objectives set in terms of profit	Initial
		New products have achieved the objectives set in terms of return on investment	Added
Market	Added	New product sales are greater than those provided by the rest of the products	Initial
		New products have achieved the objectives set in terms of sales	Initial
		Compared with other products of your company, new products have achieved superior results in terms of market share	Initial
		New products have achieved the objectives in terms of market share	Initial
		New products have allowed the penetration of new markets	Initial
Technical	Modified	The quality of new products is better than the rest of the products	Initial
		New products are launched in the deadlines	Initial
		New products are launched within budget Development Goals	Initial
		New products have reduced environmental damage, improved health and safety	Aggregated 3 in 1
Customer	Initial	Customers are satisfied with the performance of new products	Initial
		Compared with other products of your company, customer complaints regarding new products are fewer	Added
		New products have improved customer loyalty	Initial
Strategic	Added	New products provide the company a competitive advantage	Initial
		New products have reached all the goals set	Initial
		New products have improved the reputation of the company	Initial

These are the dimensions that will be tested in the quantitative research.

3.2. Sample and data collection

This study concentrates on product innovations in the French biotechnology industry. Analyzing a single industry is suitable in the evaluation of PIP since unit analysis (new products) will be homogeneous. Thereby, disturbances from other variables could be eliminated and product effects could be more comparable among sample firms. Selection of the biotechnology industry as our ground research was motivated by some factors. First, biotechnology firms (BF) are innovative in nature and their survival is dependent on their innovation performance. Second, BF qualified as "technology-based" and "science-driven" belong to high-tech sector with high potential of growth (De Luca et al, 2010) thus exhibiting knowledge-intensive and high value added features. Many researchers have used the biotechnology industry in the management innovation field (Alegre et al, 2006). Third, French biotechnology accounts nearly 10% of worldwide turnover (Ricard, 2010) and, ranks third across Europe behind the UK and Germany. In addition, this industry is promising in terms of human and animal health, environmental security, agricultural production, etc. This makes the biotechnology industry a strategic field of the national economy and thus valuable challenging domain of research.

French Biotechnology firms are listed in the national database of biotechnology (http://www.biotechnologiefrance.org/). To improve the reporting accuracy on the resulting performance data, increasing the homogeneity of our sample was taken into account. Indeed, we were only interested in private firms based in France and having produced at least one product innovation. In addition, are included in this study only firms with at least three years of existence as recommended by the OECD (2005). In fact, since innovation is a time dependent process, it is recommended to consider three-year periods to evaluate innovative, scientific and technological activities. Our final target population included 798 BF. We sent the questionnaire primarily to R&D managers because they are typically responsible of innovation programs and thus are well placed to respond to our questionnaire. We carried out fieldwork from February to April 2012. We sent the questionnaire by email with a letter explaining the purpose of our research project, emphasizing the confidentiality of the responses and proposing a feedback report on the survey results. Three weeks later, we sent a reminder email to non-respondents and a second questionnaire. These efforts produced 100 valid responses. Characteristics of our sample in terms of size (77% below 50 employees), age (51% below 10 years) and activity type (mainly in medical biotechnology) are congruent with those of biotechnology firms in France (Francebiotech, 2012). This bestows representativeness to our sample.

3.3. Measures

As indicated above (Table 2), we operationalize PIP as a variable with five dimensions: financial performance (FP: 5 items), market performance (MP: 3 items), customer performance (CP: 3items), technical performance (TP: 4 items) and strategic performance (SP: 3 items). We ask respondents to state the performance of their product innovation with regard to these dimensions using a Likert type scale ranging from 1= “not achieved result” to 5= “perfectly achieved result”. We conceptualized PIP as a second-order variable and these latter dimensions constitute the first order constructs (figure 1).

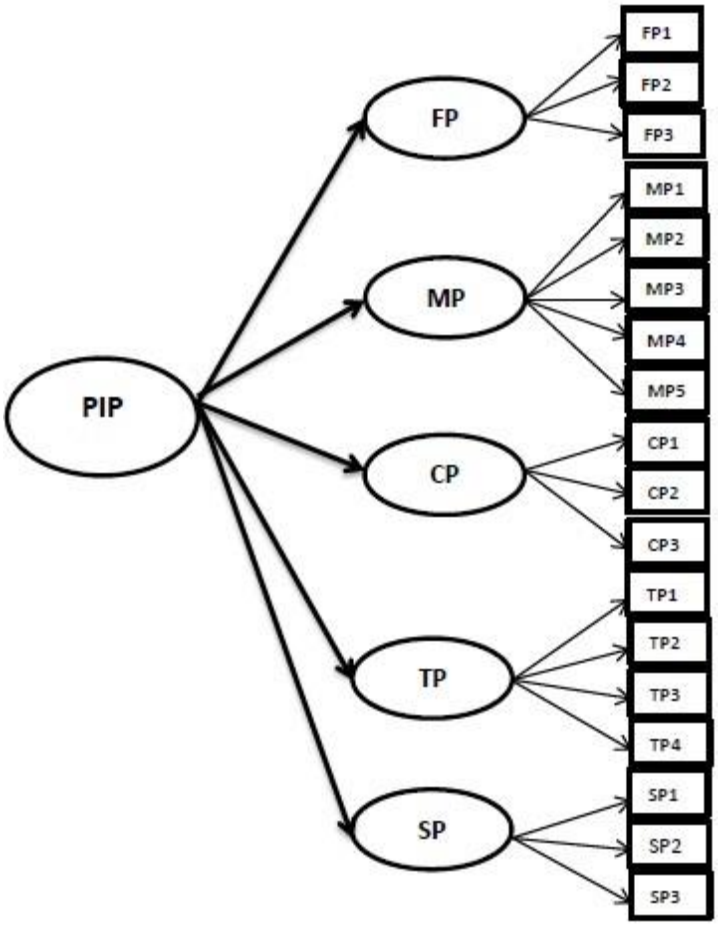

Figure 1: Conceptual framework

3.4. Analyses

The data analyses are set based on structural equation modelling (SEM) method. SEM allows researchers to integrate unobservable variables (latent variables) measured indirectly by indicator variables. The estimation technique we used under SEM is the Partial Least Square (PLS) using SmartPLS package version 2.0.M3. Compared to the Linear Structural Relations (LISREL) technique, PLS-SEM is a construct validation method (Jyothibabu et al, 2010), which is not rigid in multivariate normality and is more flexible in sample size to estimate path coefficients. This is especially relevant for this study, as our final sample size was 100 observations. In addition, PLS-SEM is efficient in modelling hierarchical latent variables (second order constructs) since it can deal with complex models and since it produces consistent parameter estimates (Hair et al, 2013).

4. Results

Given that we conceived PIP scale as a two-second order constructs, assessing its validity requires two steps: evaluation of the first-order model and evaluation of the second-order model. Then, we reserved a third paragraph to the structural model results.

4.1. First order constructs

The first-order constructs are financial product performance, market product performance, customer product performance, technical product performance and strategic product performance. In order to assess the validity and the reliability of each of these constructs, we initially carried out exploratory factor analysis (EFA), confirming their dimensionality. The convergent validity is assessed via item loadings. As shown in table 3, only one item was dropped being under the threshold of 0.7 as suggested by Hair et al (2013). This item is MP5 and refers to the ability of the new products to penetrate new markets. The rest of item loadings, ranging from 0.746 to 0.920, were significant (t > 1.96). The second criterion used to evaluate the convergent validity is the average variance extracted (AVE). AVE values of the five constructs range from 0.645 to 0.776. These values exceeded the acceptable cut off point of 0.5 (Hair et al, 2013) indicating convergent validity. The composite reliability (CR) and Cronbach's alpha (α) were above the required threshold of 0.7 confirming the good reliability of the constructs (table 3).

1.1.3 Table 3: First order constructs results

Dimension	Item	Mean	SD	Loading	α	CR	AVE	1	2	3	4	5
FP	FP1	3,25	1,104	,808*	,855	,912	,776	**,881**				
	FP2	3,30	1,005	,911*								
	FP3	3,22	,949	,920*								
MP	MP1	3,06	1,196	,770*	,838	,892	,675	,785	**,821**			
	MP2	3,18	1,019	,890*								
	MP3	3,21	1,018	,839*								
	MP4	3,12	1,018	,780*								
	MP5**	3,63	1,041	-								
CP	CP1	3,85	,978	,883*	,821	,893	,737	,606	,728	**,858**		
	CP2	3,69	,986	,871*								
	CP3	3,28	1,045	,819*								
TP	TP1	3,25	1,104	,772*	,815	,878	,645	,561	,704	,734	**,803**	
	TP2	3,06	1,153	,878*								
	TP3	3,14	1,239	,810*								
	TP4	3,46	1,137	,746*								
SP	SP1	3,98	1,044	,852*	,811	,888	,727	,692	,772	,778	,710	**,852**
	SP2	3,18	1,175	,809*								
	SP3	3,91	1,006	,894*								

**Significant at 0.001 (2-tailed) ; ** Dropped item*

To inspect discriminant validity, we calculate the square root of each construct's AVE (boldface diagonal elements in table 3) which should be larger than the level of correlations involving the construct (Chin, 2008). Table 3 shows that all constructs satisfied this requirement.

Therefore, we conclude that, at this stage, our model has the adequate validity to continue with an analysis of the second order construct.

4.2. Second order construct

To measure the dimensionality of the second order construct (PIP), we submitted first order construct scores to EFA. Results showed that the dimensionality is respected since the first factor had an Eigenvalue greater than one and the rest of the factors were lower than 1. The AVE value exceeded the acceptable cut off point of 0.5 indicating convergent validity (Table 4). CR and Cronbach's alpha are above the required threshold of 0.7 indicating that the PIP has an acceptable reliability. Furthermore, all PIP dimensions, as shown by table 4, are strongly related to the latent concept (PIP). The path coefficient of these five dimensions, ranging from 0.830 to

0.913, are acceptable as they are above the cut-off point of 0.3 (Chin, 2008) and significant ($t > 1.96$, $p < 0.001$).

1.1.4 Table 4: Second order and structural model results

Dimension	Path coefficient	t	R^2	Q^2	AVE_{PIP}	CR_{PIP}	α_{PIP}	Gof
PIF	,830*	19,514	69%	53.3%				
PIC	,913*	48,170	83.4%	56.6%				
PICL	,880*	26,513	77.5%	55.4%	**,767**	**,942**	**,946**	**76,6%**
PIT	,845*	23,507	71.5%	45.8%				
PIS	,905*	40,738	82%	57.7%				

**Significant at 0.001 (2-tailed)*

4.3. Structural model results

The regularly used criterion to evaluate the structural model is the coefficient of determination R^2. It measures the model's predictive accuracy (Hair et al, 2013). Dimension R^2 coefficients were high overall (Table 4) and range from 69% to 83%. Exceeding the cutoff level of 19%, R^2 values were quite good (Chin, 2008) and indicated a large predictive accuracy of our model. In addition to assessing the R^2 values, we also studied the Stone-Geisser Q^2 value. It is an indicator of the model's predictive relevance. The Q^2 test measures how well observed values are reproduced by the model when observations are removed from the analysis (Hair et al, 2013). Since all Q^2 values were greater than zero and ranging from 45% to55%, we can say that our model had a satisfactory predictive relevance (Wilson, 2010). Consequently, these great Q^2 values further strengthen the predictive ability of our model. Finally, the goodness of fit index (GOF) of the model was large 0.766 (Latan and Ghozali, 2012) meaning that the model was able to take into account 76.6% of the achievable fit. These results lend sufficient confidence that our model fits the data well. In sum, the PIP scale is validated and constitutes an appropriate measurement instrument in the French biotechnology industry.

5. Discussion and conclusions

The marks obtained by French BF for each of the PIP dimensions are all above the average point. This implies that product innovations produced by these firms are well in an acceptable threshold with a small superiority for strategic and customer performances (Table 3). Market performance was the most correlated dimension with the PIP scale. This indicates that the biotechnology

industry is expanding and thus reflecting the increased weight taken by this industry in the national economy. Comes in the last range financial performance with a loading of 0.831. This is a logical result since; in general, new products in this industry, in addition to their substantial production and marketing costs, are distinguished by rather heavy development costs. This could have negative financial impacts with difficulties to recover invested funds.

Based on an effort integrating: (1) theoretical contributions on the product innovation management literature, (2) a conceptualization to take into account the criticisms of previous work, (3) a qualitative study and, (4) a quantitative study, we have developed and empirically validated a measurement scale of PIP in the French biotechnology industry. A rich and coherent set of five dimensions allowed merging and synthesizing disparate and fragmented contributions of the literature on PIP while specifying the neglected aspects. Exploratory factor analyzes showed that the scale has a very satisfactory reliability. Confirmatory analyzes, conducted using the structural equation modelling, and proved goodness of fit to the data collected, the convergent and discriminant validity of the scale dimensions.

Thus, we affirm that PIP is a concept that can be measured by five first order constructs and a second order construct. In other words, PIP is a second-order construct that strongly determines its five dimensions. Validation of the PIP scale as a multidimensional concept is in line with the work of Alegre et al. (2006). These authors showed that PIP is as a second order construct consisting of two dimensions: efficacy and efficiency. It should be noted that Alegre et al. (2006) work has been validated in the biotechnology industry in France. This gives more legitimacy to our study. In fact, we believe that besides the validation of similar approaches in the same context with similar results, our PIP scale is more comprehensive and deeper. In addition, our scale looks like that proposed by Hsu and Fang (2009). These authors mobilized the three dimensions (financial performance, technical performance and customer performance) proposed by Griffin and Page (1996) and added a fourth dimension: the market performance. Here, what distinguishes our scale from these ones is the addition of a fifth dimension "strategic performance". Thus, our results are consistent with previous innovation management literature: they show that financial performance, market performance, technical performance, customer performance and strategic performance can be considered as complementary dimensions of product innovation performance.

If it is necessary to check the stability of the PIP scale structure on other samples (other industries and /or other countries), the proposed scale shows, at this stage of development, satisfactory psychometric qualities. Here, our contribution is important to the literature on innovation management. This scale could be used for further research on innovation performance. Each of the five dimensions of the PIP scale could be mobilized as a variable in a given model, related to the company performance for example. This work also provides managerial contributions. The aim of the scientific validation of a model or a measurement instrument is its future use in practice with a confidence that this instrument is based on a wellestablished theory. Managers could use this scale in setting performance targets towards innovation products. This scale could be also adopted as a post evaluation instrument to assess PIP. It could be a sort of scorecard allowing to ask key questions about various levels of performance (financial, customer, etc.). In doing so, the assessment will pinpoint the necessary changes by determining strengths and weaknesses of a given product innovation. In addition, given the complementary and the inter-correlation of our scale dimensions and their strong positive link with PIP, managers should, therefore, consider these five dimensions simultaneously to improve the PIP.

Our results have to be viewed in the light of the research's limitations. Generalization of the results is relative since this study took place in a single industry. Then, the perceptual measures used in this study with a single respondent could cause the "percept-percept bias". Another limit is induced by the goodness of fit of the model with the SEM-PLS since the index (GOF) adopted is still controversial (Hair et al, 2013).

These limits open perspectives for future research. First, in order to generalize the results, we can test the model based on objective measurements, on larger samples and in other contexts. Second, since the effective management of a performance measurement system is a distinctive organizational competence (Tatikonda, 2007), “future research should address the development and value of a dedicated performance measurement programs office or system” (Tatikonda, 2007, p. 19).

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Mathematics and the real world in a systemic perspective of the school

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Abstract

We will approach the variety of the ongoing debates about mathematics and/or reality in the framework of the interdisciplinary and institutional environments of teaching and learning mathematics. This framework is surrounded and perversely influenced by digital and networked, extracurricular mathematical educational productions. These are extracurricular practices but with very impressive and often superficial representations on the mathematical-reality link, very easily accessible in the real world of students. Thus, understanding the relationship between mathematics and the real world becomes an educational and moral responsibility for teachers. I think this makes the theme of the CME-2018 conference more important.

These environments form a complexity, including and, at the same time, included in the didactic of mathematics situations. Therefore, a new variety of approaches of the relation between mathematics and reality emerges, within which the cognitive, the psychological, the social and the digital are interconnected. It is hard (or impossible) to model the interactions of the aforementioned variety with the underlying epistemological or philosophical variety, because of the complexity of the roles and intentionalities that are interwoven within and in the frontiers the school unit.

The educational need to employ various discipline sources, in order to comprehend the complex phenomena, implies a permanent presence of mathematics and this further complexifies their relationships with reality, because it let the discrete interaction of mathematics with the others disciplines to pass implicitly, which is often ignored by the formal, institutionally constituted, school reality.

Within these environments. the boundaries amongst the priorities of the real world and of the noetic structures, which constituted the opposite poles in the philosophical disputes about mathematics and/or reality, become permeable and porous. In the mathematical thinking, observation and intuition, comprehension and invention, modelisation and application, adaptation and transformation seem to be synchronous.

The role of representations and symbolic languages, playing a crucial role in mathematics, becomes an obstacle in the interdisciplinary learning path of the students in the everyday school timetable across their differentiated uses in the different disciplines. Thus, the widely studied didactical transposition is effectively enriched with the praxeological transposition.

We will present concrete examples of the history and epistemology of mathematics, as well as reforms in mathematical education and, in particular, we will discuss the influence of the work of

Jean Piaget, to animate the discussion between mathematics and the real world in this systemic approach to the didactics of mathematics.

Introduction : Pluralities

In 1990, in Poland in the city of Szczyrk it was organised the 42th Conference of the CIEAEM (International Commission for the study and improvement of mathematics education). The theme of the meeting was *"The teacher of mathematics in the changing world"*.

It was indeed the years that followed '89, when change was the most tangible feature of the world, especially in Europe. A mixture of liberal politics and technology places its traces in the spirit of democratic freedom of the time, gently guiding it towards neoliberalism, globalism (mondialisation) and the financial market. Effectiveness and efficiency should be sought in all areas, including mathematics education. Efficiency was related to skills. Efficiency had to be measurable and the effectiveness to be evaluated. A globalist perspective, developed primarily by the National Council of Mathematics Teachers (NCTM) in the United States, hoped to include the diversity of mathematical knowledge and skills in the concept of skills to be used. In fact, the first recommendation of the Agenda (NCTM, An Agenda for Action,1980) was that "Problem solving must be the focus of school mathematics" (p. 2). The document went on to say, "Performance in problem solving will measure the effectiveness of our personal and national possession of mathematical competence" (p. 2). It was the period of the Standards, described in the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989).

Many international commissions, as CIEAEM have been critical, especially in Europe, where the constructivist perspective was more powerful and mixed with the French structural aspect of modern mathematics reform. and with the phenomenological point of Hans Freudenthal and the perspective of realistic mathematics. Since, critical mathematical education became a special field of research (Ernest, 2015) through which the theories of Didactic of Mathematics approach crucial dimensions of real world, even the recent economic crisis (F.Kalavasis, 2017)

Back at Szczyrk (CIEAEM, 1992), the international research community of mathematical didactic practices directed its efforts towards the study of common mechanisms in the mathematical reasoning activity of the researcher and the student, in order to design adequate teaching situations for efficient schools. In fact, the first question asked by the scientific committee of this conference was: *The teacher must be both educator and expert in mathematics. How does the teacher cope with the changes in emphasis in these roles?*

I think that this plurality of approaches in mathematics education emerged the decade of the 90's, implicitly diffused even in this concern for equilibrium between the two poles of mathematical expertise and teaching effectiveness, has oriented many important initiative to edit new school books. For example in Poland it was the "blue textbook series". We can observe in the front pages of two of them the invariant mathematical pattern background, un-influenced by the changes of the colours and of the real world images.

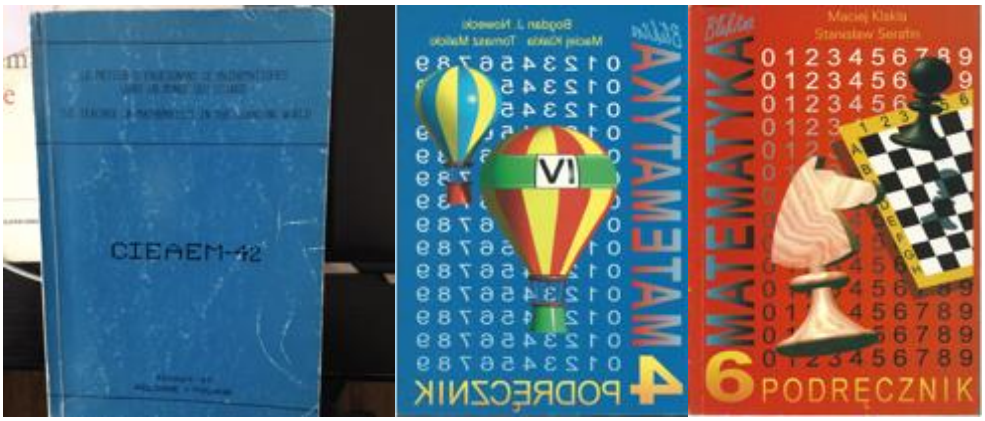

Figure 1: From left to right: CIEAEM 42 Proceedings and two Polish textbooks from the "Blue Mathematics" series (1996)

2. Now, 28 years after, the two poles of our problematic are mathematics and the real world. This means that it is not only the real world that is changing, but also the mathematics as well as the environment of mathematics education. So, our approach to learning and teaching mathematics is influenced by the interaction of these three evolutions, and we will try to view this tripolarity from a systemic and complexity point of view.

Andre Revuz (1914-2008), my first Professor in Didactics of mathematics, published in 1963 the book *Andre Revuz, Mathematique moderne, Matheatique vivante (OCDL, Paris, 1963), (modern mathematics, living mathematics)*. His choice of wording in the title seemed strange to me: Why did he decide to use the term of *mathematique* in singular and not the more frequent term of *mathematiques* in the plural? In the Greek language, we only have the plural noun *mathematics (μαθηματικά)*. But, in contrast, we have the singular nouns for Geometry, Arithmetic, as well as for Analysis and Algebra. In English, the term mathematics, although ending with the s, is a singular noun.

Figure 2: From left to right: Revuz (1965), Bourbaki (1939) and Bourbaki (1974)

Then, I noticed the strange singular noun "mathématique" in the title of *Éléments de mathématique*, the treatise on mathematics by the collective Nicolas Bourbaki; an edition started

at 1939 (composed of 12-twelve books), published by the Editions Hermann. Like Euclid's with his Elements (13 books) before twenty three centuries, the famous group Nicolas Bourbaki tried to recompose the till then mathematics evolution and dispersion, in line with the prototype of the Elements. They based this unification effort in the modern notion of structure. Moreover, they used the term in plural when referring to the history: *Éléments d'histoire des mathématiques*. Perhaps they wanted to emphasize the necessity of Bourbaki's reunification effort, because in their long history since Euclid, mathematics has become a set of scattered disciplines.

I noticed that Andre Revuz, when he approached his 90th anniversary in 2002, was the protagonist of the creation of the project *ActionSciences*, which brings together a dozen of scientific associations for the defence of the teaching of all sciences. So, I could understand that the mechanisms of learning mathematics are involved with their environment. And that they are living mechanisms of the same kind, as the mechanisms of the evolution of mathematics themselves. And of the same kind as the mechanisms of the evolution of our reasoning. The crucial difference is that in a didactical situation all these mechanisms are interacting and are transformed, in order to create new qualities of intelligence, for and by both the student and the teachers, within the school, the family and the society. Thus, in order to study and to improve these situations, I argue that we need tools and concepts from the complexity and the system theory.

Mathematics (m) and reality (r) seem to be at the extremes of a 'tug-of-war', at multiple levels and at several historical periods. We can look for the beginning of this antagonistic game in the divergent positions of Plato and Aristotle and in the hermeneutical oppositions followed. The important thing for us is the impact of this bipolar situation to the third pole, that of mathematical education (e). In which way this phenomenally clear (m)-(r) duel influences the mathematics learning theory or/and teaching models (e)?

If we assume that the objects of mathematics exist per se in a world of ideas, out of any sensible frame, but their comprehension can use analogies in sensible frame? Or, if we assume that the objects of mathematics do not have an existence per se, that they are part of the sensible reality, but the mathematician studies them out of any sensible frame? We can see that the clearness can become obscure for the third pole. In the systemic approach, we try to understand the three poles together, as an interacting system. The complexity aspect allows as to understand that each pole is interacting with this tri-polarity.

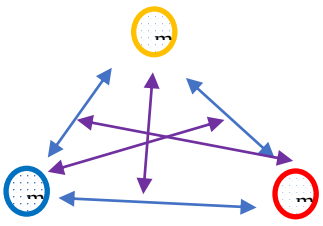

Figure 3: An interacting system of three poles

We could follow the evolution of the conceptualization of these essential Plato's and Aristotle's ideas, to approach the divergences in the philosophy of mathematics, the aspects of the logicism, the formalism, the intuitionism or the constructivism. And so to study their impact in the mathematics education.

Another way to the tripolarity could be to follow the learning theories, opposing for example behaviorism to radical constructivism. Or, even more concretely, we could enter into the problematic of the history of mathematics education; from the modern mathematics reforms, the realistic mathematical initiatives, to the international standards in problem solving and the STEM (science, technologies, engineering, mathematics) trends.

However, I think the most important perspective is that we can conceive the three poles as a coexistence model per se, in a unified perception in interaction with the human act of the mathematician, of the learner or of the teacher. This could be described as the Borromeo interconnected Rings, in which if one ring is cut, the two others are automatically disconnected. In mathematical knot theory, the Borromean rings are a simple example of a Brunnian link: although each pair of rings is unlinked, the whole link cannot be unlinked. (Karl Hermann Brunn (1862 - 1939)

Figure 4: Borromean rings

So, by englobing the phenomenology of the internal opposition of the two poles and by connecting them with the actors in a scientific or learning project (the third pole), we could oversee the polarity in a more systemic framework. Through this systemic approach, a field of questions related to the essential opposition can be studied from the point of view of the space of the phenomenology of the ordered pairs (m, r) and (r, m) in interaction with the educational pole (e).

This approach could allow and motivate the phenomenal opposition to interact with the anthropological aspect of the socio-cognitive activity of learning and teaching system and, thus, could allow our rethinking its poles within the framework of Didactics of mathematics. The Borromean interconnection mode means that, if one ring is absent, the meaning is simultaneously lost for all rings. In isolation, mathematics is dehydrated, the real world seems superficial, the learning and teaching becomes denervated. If we want to study not each pole isolated but their function in a didactical situation or in an educational project, it is impossible to perceive each ring as being independent.

Thus, the opposition as a couple/pair, incorporating the conjunction and the disjunction of its elements, at the metacognitive level, offers us and reveals to us the human unique capacity to construct his perception of reality. So, to separate and to unite, to disjoin and to conjoin, to divide and to rejoin the elements of the real world. Or, in terms of complexity and systemic formulation,

the human ability to conceive together what seems to be disjointed, and at the same time to distinguish what seems to be conjoined.

In mathematics, this means thinking and acting in the space between presentation and comprehension, intuition and reason, between the part and the whole, the discrete and the continuous.

In mathematical education, this means thinking and acting in the emerging space actively constructed by the interactions between the couples of a mathematical activity, on the one hand and the other, their scientific construction in history, their reflexive construction in learning processes and their transformations in teaching situations (Kalavasis and Moutsios-Rentzos, 2015).

In this multi-space, we may recognize the semantic and symbolic traces of the interdisciplinary approach in mathematical learning and teaching processes. The interdisciplinarity enrich the access to reality, because of the high level of variety in coherence. The interdisciplinarity allow the deep intellectual visit into mathematics, because of the high level of logical coherence in the variety of their fields.

My point is that the interdisciplinary approach may enrich the mathematical learning, by re-considering more clearly its own intellectual fields:

- by relating separated cognitive frameworks, using same symbolic/language with a variety of meaning and interactions
- by relating separated actors, in their variety of interactions and meanings.

Especially in our times, in which we can easily remark the *mathematization* of the system of disciplines (the *use* of concepts and mathematical symbols) is confused with a kind of *mathematification* of disciplines (the *transformation* of their concepts into mathematical concepts and mathematical symbols) in a digital environment of the real world. This tendency is evident when considering the transformations in the representations and descriptions of the natural or even the social and financial phenomena. (Kalavasis, 2017).

It is argued that it is crucial to understand in this interdisciplinary and digital complexity from the point of view of the dipole "mathematics and real world" interconnected in the third pole of *mathematics education*, as the essence of the intellectual activity (Moutsios-Rentzos**,** Kalavasis & Sofos, 2017). And, subsequently, to identify the important role of mathematical education for mathematics and for society and to review its content and methods.At this point, I think it is useful to recall four areas that Piaget refers to in explaining his genetic approach to scientific knowledge, as they are important to our interdisciplinary didactic approach (Martin Packer, 2017, pp 414) :

- The transition from logico-mathematical operations of the manipulation of sets of objects to the formal operations of mathematics, as rigorously deductive reasoning, independent of the real but reflecting: Beyond reality, but preparing a deeper knowledge of this reality, providing better conceptual tools.
- The passage from infralogical operations to axiomatic geometry and abstract models of physics
- The problems of explanation in science.
- The trends in the evolution of science and the role of scientific communities.

Piaget distinguished the infralogical operations which are used to deal with continuous objects (e.g. liquids) and are based on judgements of proximity and separation in space and time. In contrast classification and counting are logico-mathematical operations, applied to distinct objects.

He used the term infralogical, “because they related to another level of reality and not because they develop earlier”

The last area is part of what we live in this lovely conference and in other international or local initiatives and commissions.

1st example

Let's look at an example, which seems to dissociate the mental world and the material world, starting in a nominalist manner, but with a beautiful historical journey. We will enter this opposition by the name of the different sets of numbers.

We recall the categories, often presented by an inclusion set relation, N, Z, Q, R, I, C, leaving aside the technical details of the zero and other elements necessary for these constructions.

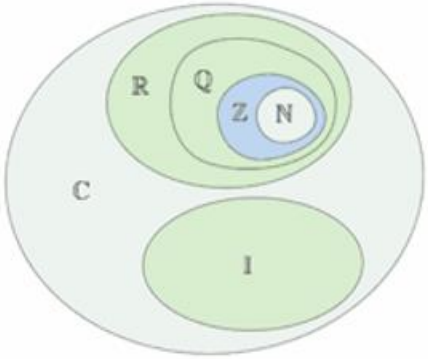

Figure 5: Number sets

Why do we call as natural the simplest, most integer and perfectly disjointed numbers, while we call real, their being more of a mental invention, their transformation into continuous, including their irrational and transcendent nature? The mathematics education specialists seem to converge that it is easier to begin the teaching of numbers starting from the natural numbers. It's easier. Enumeration, cardinality, order.

But which category of numbers is the best approximation of reality? It is easy to answer that it is the real numbers, if not the complex numbers closer to the reality and to the phenomena of nature. Moreover, specialists and pedagogues seem to agree that it is easier to conceive of the real world than mathematical theories. Therefore, we should give priority to teaching real numbers and operations with continuous quantities (infralogic operations)

Nevertheless, if we admit that the basis of the construction of mathematical structures and of logic of propositional calculus, in which is based the construction of set theory and the construction of the continuous of the real numbers, is related to the construction of the set natural numbers, then what is simpler and easier to approach in education: mathematics or the real world ?

Natural, …, imaginary, complex. All sets are contained to the last. But the construction of the last requires the first. So its conception is contained in the theory of the first construction, of the infinite set with the minor cardinality.

2nd example

Pythagoreans conceived the natural numbers from a mental view (theory) in the ordering and counting of discreet, but similar, almost equal, material objects. Broad beans or pebbles, from

which is come the Latin word calculus, a pebble or stone used for counting. At the same time, they re-presented the numbers with geometrical shapes and gave them corresponding names. The figurate numbers. Starting from the distinction between the even (if they can be ordered in two equal collections, covering same space) and the odd (if a piece remained a little separate making the difference, bringing the inequality, bringing the difference of the one between the two), they evolved their representational constructions using the practical and noetic instrument of the *gnomon*. Triangular numbers, rectangular numbers, square numbers, the polygon numbers, etc.

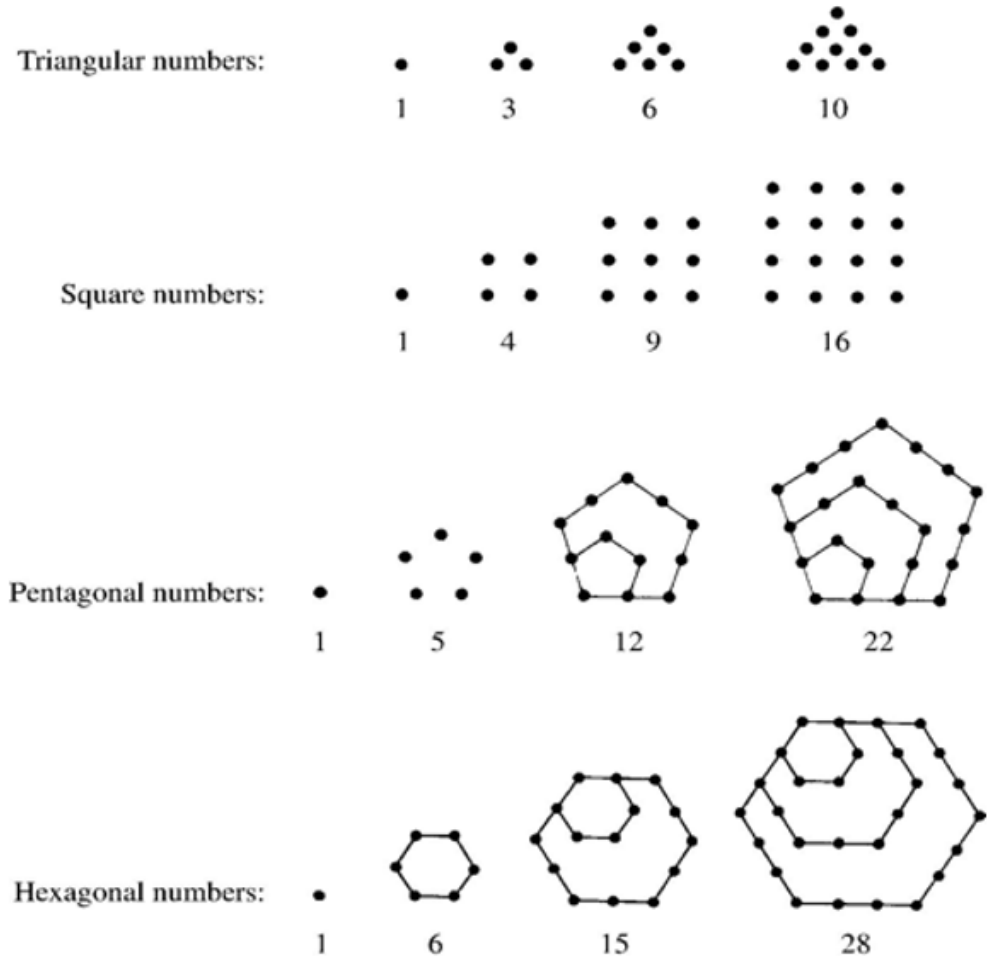

Figure 6: Triangular, square, pentagonal and hexagonal numbers

The Pythagoreans also conceived the natural numbers and the analogies, the ratio of natural numbers, but the ratio was not necessary to have an arithmetic value. They could see in their constructions the repetitive pattern and they used the cardinal and the ordinal version of the concept of number to describe and calculate the next or the successive number of the same category.

1st	$1 = 1^2$	The first 6 squares of natural numbers as the sum of consecutive odd numbers
2nd	$1 + 3 = 4 = 2^2$	
3rd	$1 + 3 + 5 = 3^2$	
4th	$1 + 3 + 5 + 7 = 4^2$	
5th	$1 + 3 + 5 + 7 + 9 = 5^2$	
6th	$1 + 3 + 5 + 7 + 9 + 11 = 6^2$	

In this story, we may also notice, the reflective process, the *aller retour*, the round-trip among: the concrete form of a disposition of points in the space, the area of the spatial form, and the conceptualization of the number in this disposition, the conjunction of its geometrical construction and its algebraic proprieties.

3rd example

Euclid uses the concept of ratio between continuous quantities. He could even write about the ratio between the side and the diagonal of the square, to show that no couple of natural numbers exists that could be describe this ratio. So, within his line of thinking, he could incorporate a seemingly paradoxical way without confusing what should be distinguished, the discrete magnitude as multitude of elements and the continuous magnitude as length. The ability (or the need) to conjoin and disjoin was still important in the conceptualization of what exists in the real world even though not (yet) visible to our experience.

We may recall at this point Plato's dialogue *Menon*, where Socrates tried to persuade Menon that the learning process is a kind of remembering. He did an experiment with a slave who had never been educated. By employing the famous Socratic maieutic or questioning method, he wanted to show Menon that it was possible to lead the slave to find the solution of the duplication of the square, to find the side of a square the area of which is double the area of the initial square. After two trials (the first one being to double the side, thus constructing a four times bigger area square, and the second being to take a side and a half, thus constructing a triple area square), the slave was stay very sceptic.

Socrates said to Menon: You see now, he is hesitating to make a new trial, he is in a state of mystification (aporia; απορία). This is the more important stage of the learning process. At this moment the slave's thought is in the intermediate space between one and two dimensions, between intuition and logic, between analogic thinking using obvious elements and inventing or discovering emerging alternative relationships among the elements and the whole.

He was then lead by Socrates' questioning to mentally disjoin the diagonal in the figure and construct based on it the new square, the one with having double area. This example is considered as the first training lesson in didactic of mathematics.

4th example

At this crucial point, we must travel across time directly about two thousand years later, to the Cantor's perception and construction of the infinities. Cantor, in order to compare two infinite

countable sets, used the 1-1 correspondence (bijection), to prove the unaccountability of infinite sets by employing his diagonal argument.

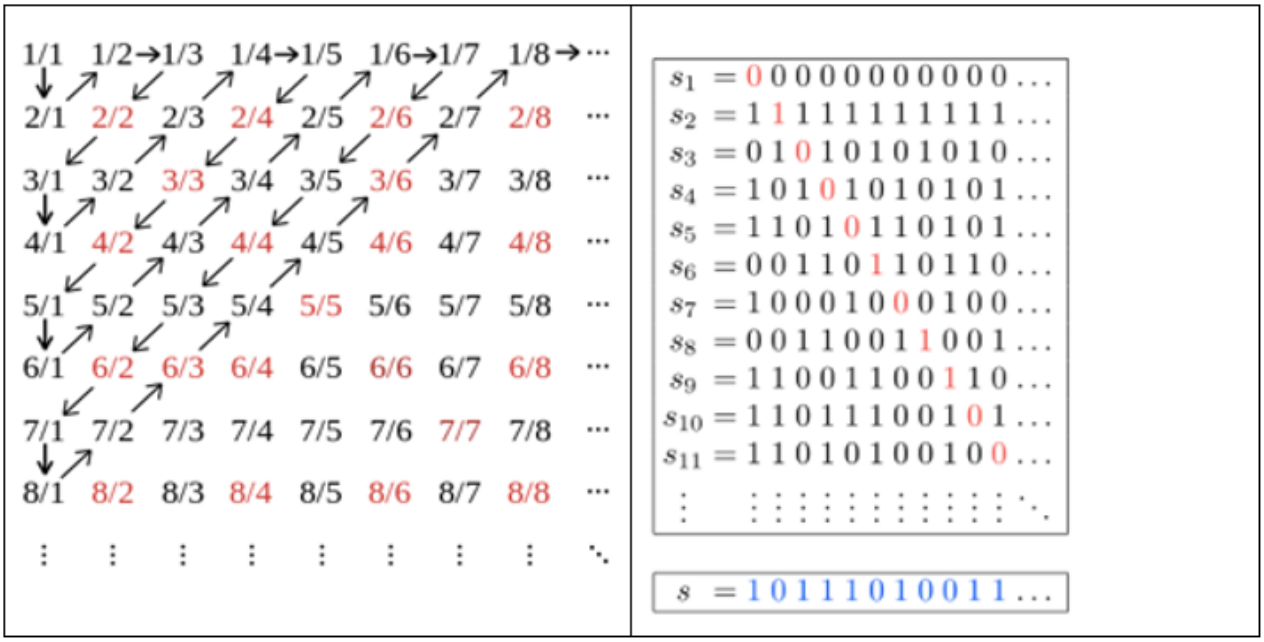

Figure 7: Cantor and infinite countable sets

By using the notion of 1-1 correspondence, Cantor proved that, in the case of countable infinite sets, the part can be equal to the whole. As by definition, all the elements of a countable set must correspond one by one to the elements of the set of natural numbers, we have to find the gnomon of their successive construction, following the order of natural numbers.

Of course there were other mathematicians in previous era who had noticed that the cardinality of the odd numbers is equal to the cardinality of the even numbers (the two qualities that define two complementary halves of the naturals) and that this common cardinality seems to be equal to the whole, to the cardinality of the set of natural numbers.

So, in an ordinary, near the real world syllogism, the half is equal to the whole. But, even if this seams easily verified in some cases of infinity, it remains inthoughtable in real world. But, is that means that the real world a finite world? The perception of infinity, is it not a basic concept of human mental and moral condition?

A geometrical example in the same direction is the following. Let us consider the triangle ABC. If we take a point D on the segment AB and a point E on AC. Then DE have the same number of points as BC. In fact, each line starting in A and traversing the segment BC, cuts ED in a singular point, and the inverse. Of course, that holds true only if we accept that the continuum on the segments has no holes.

By calculating the cardinality of the above set numbers, Cantor proved that N, Z, Q have the same cardinality aleph zero $\aleph_0$, as well as R and R^2, so R and C, the same cardinality aleph one $\aleph_1$.

So the above shape of the successive inclusions give a wrong image of the reality! Because we can correspond 1 to 1 all the elements of N with all the elements of Q.

Historians say that when Cantor showed that the cardinality of R is equal to the cardinality of R^2 (as if the side of a rectangle had the same number of points with its surface), he said: *"I can see it, because I proved it, but I cannot believe it "*

We can see the three rings connected.

So Cantor arrived to think in between the part and the whole, in between the common sense of the reality and the mathematical invention of the construction of the real infinity. The important was to perceive the tug-of-war in a united way, escape from the frontiers of the interior oppositions so to be able to return on these oppositions from the point of view of their coexistence in a sustainable couple. Conjoin the disjoined, then disjoin the conjoined.

Then with his famous fundamental theorem that for every set A, the power set P(A) of A (the set of all subsets of A) always has higher cardinality than the set A itself, and the evolution of his theory, lead David Hilbert to say in 1925, seven years after the death of Cantor that "*From the paradise, that Cantor created for us, no-one can expel us.*"

5th example

I would like to remind you of fact that the root of the tool of comparison between countable sets dates back to Homer's Odyssey. There was a monocular giant, Cyclops Polyphemus. You most probably know the story; the giant abandoning the usual custom of hospitality, he began to kill the comrades of Ulysses. Then Ulysses surprised him by offering him to drink wine. Polyphemus, satisfied, asked Ulysses his name, so Ulysses answered the famous "Nobody", after which, while the giant slept, Ulysses blinded his single eye. Everyone made fun of Polyphemus, thinking that he was drunk and blinded by himself, when he was crying "Nobody blinded me". because it would be impossible to exist Nobody as a person in the real world. But Ulysses had still to escape from the cellar of the giant killer and that was not easy.

Ulysses observes that Polyphemus had invented a method to verify that all his sheep returned to the cellar at night. To count the number of sheep, it corresponded to a pebble for each animal at the exit by putting the pebbles in a dish and he checked the pebbles of sheep by the same correspondence on the return. So the ingenious king of Ithaca decided to tie all his comrades underneath the animals and so they managed to get away, each of them under a sheep, and they managed to escape without Polyphemus noticing. This is the first description of a difficult mathematical method in a real world hard environment.

After Cantor's countability, Jean Piaget will be the one to appreciate the important presence of 1-1 correspondence, in the evolving stages of the intelligence and in particular for the conservation of number of elements of a collection independently of the form of their spatial disposition.

6th example

Let us consider another example in the story of Eratosthenes who counted the perimeter of earth. *Eratosthenes of Cyrene (Ἐρατοσθένης ὁ Κυρηναῖος)* (from Cyrene a city situated in modern Libya) was a Greek mathematician, geographer, poet, astronomer , and music theorist, director of the famous Library of Alexandria after 230 BC. Eratosthenes approached the problem to calculate the circumference of earth through analogical reasoning. His experiment and proof is now modelized and used for didactical activities in real circumstances with students of secondary school around the world.

Eratosthenes had heard from travelers about a well in Syene (now Aswan, Egypt) with an interesting property: at noon on the summer solstice, which occurs about June 21 every year, the sun illuminated the entire bottom of this well, without casting any shadows, indicating that the sun was directly overhead. He thought that if earth is spherical, these rays would be oriented to the center of earth.

So, he realized that if he could calculate in the same time that noon, the angle that forms a vertical column with the ray of the sun in Alexandria, and if he could measure the distance from Alexandria in the North to Syene in the South, he could easily calculate the circumference of Earth.

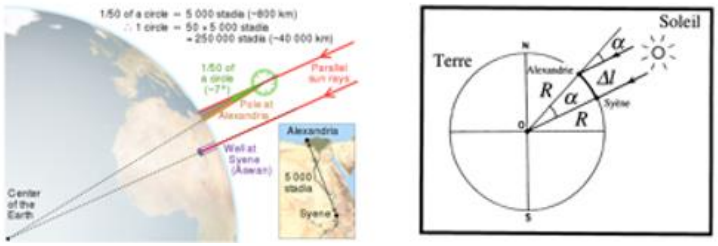

Figure 8: Eratosthenes's measurement of the Earth's circumference

But in those days it was extremely difficult to determine distance with any accuracy. Some distances between cities were measured by the time it took a camel caravan to travel from one city to the other. But camels have a tendency to wander and to walk at varying speeds. So Eratosthenes hired *bematists* (*βηματισταί*, step counters), professional surveyors trained to walk with equal length steps. The bematists accompanied Alexander the Great as specialists in measuring distances by counting their steps. They found that Syene is about 5000 stadia of Alexandria. (stadium, ancient Greek unit of length).

What Eratosthenes had in his mind was sketched, using his geometrical knowledge and transposing the vertical of Alexandria as if it was the transversal of the two parallel lines corresponding to the rays of the sun. So, he used the equality of the two elements into the couple of the alternate interior angles. Thus, Eratosthenes arrived to calculate the Earth's circumference around 240 BC, using:

- geometrical and trigonometrical approaches: Thales theorem on equality of interior and alternate angles, measurement of angles.
- astronomical observation and geographical determination: summer solstice, oriented distance between Assouan and Alexandria.
- estimations of length: stadia, the Olympic stadium of 176.4 m, gnomon to measure the height of the column.
- counting methods and tools: bematists.
- assumptions: the Earth is a perfect sphere, that light rays emanating from the Sun are parallel.
- hypothetical-deductive reasoning: If … so …

We may use modern expressions to re-story what Eratosthenes did: Eratosthenes made the assumption (or used the consensus of his time) that the sun was so far away that its rays were essentially parallel and that Alexandria is in the north of Syene. So, he could calculate the circumference of earth passing from the two poles. But as he assumed that earth is perfect spherical, he implied that the circumference is always the same in length, independently of his direction from pole to pole or in the equator.

Now I invite you to reflect together, where in all this, is reality disjoined from mathematics? In the bematists' experience? In the assumption about the perfect spherical shape of the Earth? In the certainty of the truth of the theorem of corresponding angles? In the axiomatic existence of parallel lines? In the assumption of the sun rays being parallel? In the concept of analogy (ratio) that lead us to take the measure of angle as equipotent and transformable to the measure of a length? Or maybe in the concept of estimation-approximation (implicit convention) that the length of the cord of a circle is equal to the length of the arc?

All this activity, mathematical and real, is integrated into the hypothetical-deductive reasoning, upon which the sense and the connections in the variety of the activities emerge.

My point in this conference is that all this activity cannot be distinguished in different parts, neither analyzed in sub problems clearly taxonomised in more or less mathematical or real world experience. What happens does not occur in the opposition among pure mathematics and the real world, but in the relation of the hypothetical-deductive reasoning with mathematical activity and real world activity. The coherence of the variety gives meaning in each of the discrete activities and vice-versa it assumes sense from the disjunction of these activities and their connection in the hypothetical-deductive project. In a more general way, the mathematical objects and the real world conditions are conjointly disjoints in a genetic cognitive project; that can be a scientific project or a learning project.

7th example

We could find more examples in the projects of Galileo, Newton, Descartes or Pascal and more recently at Von Neumann to appreciate this anthropological complexity between mathematics and reality. It is important for the educators to understand how the paths of mathematics and of the mathematicians' experience are fundamentally connected with the conceptualization of the natural phenomena in a way compatible with the philosophical ideas and beliefs.

Mathematics, with its conical curves (the form then regarded as the most advanced and abstract) was the only science capable of expressing fundamentally the law of the fall of the bodies of Galileo Galilei at the end of XVI century. According to Dhombres (2017) this was the objective factor of disinherence of the Aristotelian type physics. It allowed another natural philosophy to take hold, which became deeply structured by mathematics, to the point of giving this science (mathematics) the power to conceptualize reality.
The parable (parabola) of Apollonius - this author of the third century BC who named the conic sections or curves obtained as the intersection of the surface of a cone with a plane by metaphorical denominations, as hyperbole (exaggeration) or ellipse (lack of); now with Galileo also refers to the uniformly accelerated motion; a mechanics idea before becoming a mathematical concept through subsequent calculation and acceleration as a second derivative. We can see at this point the fragile transition in *mathematisation* and/or *mathematification* according to Lichnerowicz (1967).

It is the transformation of an idea of mechanics into a mathematical concept. It is also the human need to understand and express his understanding of nature. The line of the parable is the common border, the contact between experimentation, observation, intuition, geometry and calculation. Acceleration, a natural phenomenon, becomes a derivative, a mathematically constructed object. This is why Galileo writes in the Il Saggiatore (The Assayer) introduction that the language of nature is mathematics:

"Philosophy [i.e. physics] is written in this grand book — I mean the Universe — which stands continually open to our gaze, but it cannot be understood unless one first learns to comprehend

the language and interpret the characters in which it is written. It is written in the language of mathematics, and its characters are triangles, circles, and other geometrical figures, without which it is humanly impossible to understand a single word of it; without these, one is wandering around in a dark labyrinth."(Opere Il Saggiatore p. 171., https://en.wikipedia.org/wiki/The_Assayer)

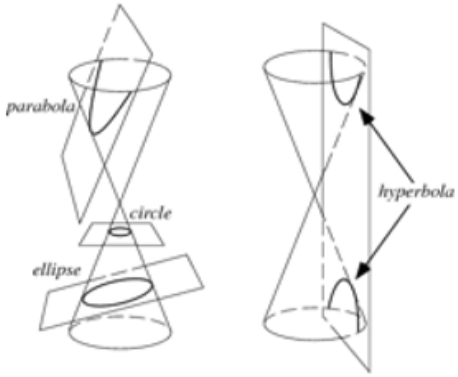

Figure 9: The conic sections

This parable makes the movement to be recognized as independent of the weight and the form of what falls and reduces the falling thing to a numerical value. This curve allows us to recognize the fundamental independence of the movement towards the initial impetus. The movement remains uniformly accelerated irrespective of the momentum, which goes beyond its previously purely numerical role and acquires both the direction of a principle of conservation (principle of inertia) and of a spatial form (directed quantity).

Newton's *Philosophiae naturalis Principia mathematica* in 1687 launches a new period

in which mathematics dominates the most. Interactively, the science of Euclid itself has been metamorphosed by the invention of a calculus, bearing the name of differential and integral calculus. It provides efficient means to approach the mechanics and the optics but also by the infinitesimal seems to be able to express the intimate structure of the physical objects, such as the curves of trajectory.

Conclusion: complexities

The problem of the relationships between mathematics and real world, as we noticed in the introduction, can be approached from the point of view of philosophy (what is mathematics, what is the real world), or from the learning theories (how the human constructs and develops mathematical concepts), or from epistemological views (the mathematical activity), or from the Mathematics Education history.

My view is based on the systemic approach from the didactical point of view of mathematics, trying to study and improve what is happening in the mathematics class between mathematics and the real world interacting with the wider framework of the interdisciplinarity in our digital age (Kalavasis & Kazadi, 2015).

In this approach of the learning project, the interdependencies between mathematical activity, the real world and the teaching of mathematics give a dynamic meaning to the phenomenal oppositions. Learning difficulties and obstacles are managed in order to enhance the variety and consistency of mathematical knowledge in didactic school situations.

Didactics of mathematics has transposed the questions of the type “What is mathematics” to the type “What do mathematicians do? What is their way of working?” because these questions could lead to two genetic approaches: that of mathematics’ historical evolution and that of Piagetian epistemology of the construction of mathematical knowledge. This transition from the science as object to the project which involves the human being, transfers the question to a more participative framework, in a mixed and multi-variant environment, so closer to the real world and, speaking academically, from sciences to the field of humanities.

Piaget used the term 'Constructivism' to create for a fundamental connection between knowledge and reality. His work went against the established idea of a knowledge being a static entity and something out there to be discovered, considering rather that human systems generate their own knowledge. In *The construction of reality in children* (La construction du reel chez l' enfant), published in 1937 by Delachaux and Niestlé (Neuchâtel and Paris), Jean Piaget studies the stages by which, during the first two years, the child is able to represent a permanent objective world independent of this representation itself.

This construction is carried out by two complementary movements: the accommodation of thought to things and the assimilation of new data by the previous acquis. Piaget highlights the complementarity of two categories of acquisitions: the organization of intelligence and the organization of reality that take place both jointly and one by the other. This complementarity results from that which unites the accommodation of thought with things and the assimilation of new data by the acquired of the previous.

Piaget, with *The Genesis of Numbers in Children* (La genèse du nombre chez l'enfant), in 1941, highlights the link between the construction of the real world and the mathematical construction. He followed the construction of the whole number by the child. He emphasizes that this construction is operative, that it is carried out from groupings of classes and relations. He shows that the verbal acquisition of spoken numeration is not enough. The concept of number appears as a synthesis of classification structures and order structures, but it exceeds them both by its superior flexibility and the degree of generality obtained by successive abstractions.

Then, in his Introduction to Genetic Epistemology (3 volumes, Paris, PUF 1950), Piaget emphasizes that the multiple interactions between the subject and the object, both in the history of adult thought and in the genesis of cognitive functions in children, lead to the formation of knowledge which is eventually included in the scientific disciplines, characterized by their specific problems, their particular methods, their own results.

Here we can see the traces of the systemic point of view that resemble the subject of learning and the object of knowledge with its interactions in the concept of the project.

It is easy to notice in this point the importance of transforming of the antagonistic relationship between mathematics and the real into a reflective relationship between the construction of mathematics and the construction of the real and, even more profoundly, the impact of this relationship process of building scientific knowledge.

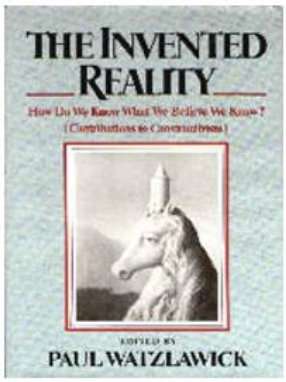

Figure 10: From left to right: Piaget (1967) and Watzlawick (1984)

Piaget in *Logique et Connaissance Scientifique* (Pleiades, 1967)) puts himself in opposition to the positivist hierarchy of science. He argues that, although autonomous in many respects, the various scientific fields are linked by a series of connections, which makes it possible to postulate a "circle of sciences" ranging from formal sciences (logic, mathematics) to physics, then to biology, human sciences (psychology and sociology) to return to the formal sciences. Von Glasersfeld took this further in showing how meaning is built up from experience and how we understand and construct our knowledge of the world around us through continual negotiation with the external world. His two books *'Construction of Knowledge'* (Von Glasersfeld, 1987) and *'Radical Constructivism: A way of Knowing & Learning'* (Von Glasersfeld, 1995) traced the history of constructivism from Vico to Piaget and put forward the model of Radical Constructivism.

An important moment in the thoughts about the phenomenology of learning and teaching mathematics into school situations was the influence of the cybernetic theories and the systemic approach.

Through the 'meeting' of constructivists and cyberneticists, we may more appropriately situate the phenomenon of learning mathematics as inter-influenced within the environment and I think that we can situate the reflexive construction of mathematical knowledge within the circumstances of the school unit as a learning organism. So to conceive the learning and teaching mathematics as a system of internal interactions and external relations, described in the form of a pentagon-within-a pentagon.

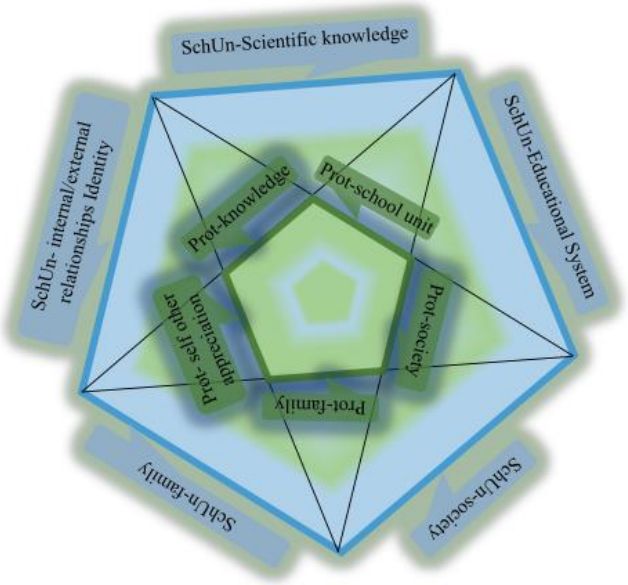

Figure 11: A self-similar approach to the Sch(ool) Un(it) – Prot(agonists) complexity
(Moutsios-Rentzos & Kalavasis, 2016)

The interdisciplinary approach in the Didactic of Mathematics could be described as the stage of complexity. It assumes the emergence and the didactical management of the symbolic connections, the conceptual interactions, but also of the divergences and diversities in the methods and the objectives between mathematics and sciences in the school situation of learning and teaching, under and beyond the didactical transposition effect.

In this overwhelming complexity, where is mathematics and where is the real world or more precisely, the phenomenology of their connections with the human learning activity? How can we make distinctions between the whole and its parts in a dynamic connection, between the world and the words or forms that describe the various versions of our interactive experience in it? Trying to understand the school reality, the real environment in which we teach mathematics, I soon realized that the learning of mathematics happens not only in school, but also in family situation. And more particularly in between the school and the family. In this in-between space emerges the role of the shadow education, all these structures and practices growing in parallel and at the same time in close ties with the school and of the digital and network environment. In which way may we conceive this multi-dimensional reality?

Paul Watzlawick in *The Invented Reality. How Do We Know What We Believe We Know?* (1981 in German, 1984 in English, 1988 in French) notes that:

"any so-called reality is - in the most immediate and concrete sense - the construction of those who believe they have discovered and investigated it. [...] In other words, what is supposedly found is an invention whose inventor is unaware of his act of invention, who considers it as something that exists independently of him; the invention then becomes the basis of his world view and actions." (p.10)

Moreover, one of the contributors in this edition, Ernst von Glasersfeld stresses:

"The only aspect of that 'real' world that actually enters into the reality of the experience is its constraints. (…) Radical constructivism, thus, is radical because it breaks with convention and

develops a theory of knowledge in which knowledge does not reflect an "objective" ontological reality, but exclusively an ordering and organization of a world constituted by our experience. The radical constructivist has relinquished "metaphysical realism" once and for all and finds himself in full agreement with Piaget, who says, "Intelligence organizes the world by organizing itself"(p.24)

Mathematics are in the real world and the real world in mathematics, like in Eschers' 1948 lithography "*mains dessinant"* ("*painted hands painting*").

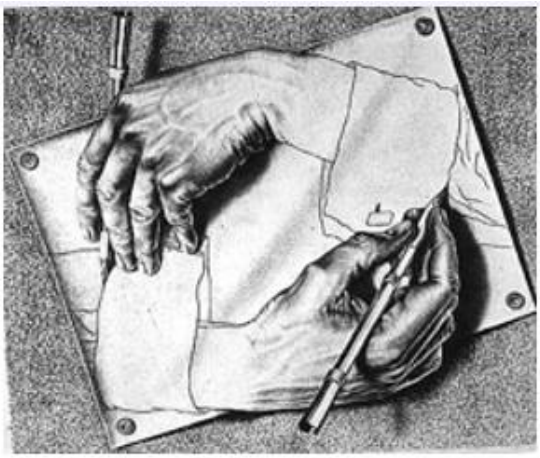

Figure 12: Mains dessinant (Escher, 1948)

This self-reference is an interference between a message and the support of this message, like a book that tells the story of the writer who writes this book. Mathematics is in the real world and the real world in mathematics, because the perception of world supposes the capacity to organize all the information that we receive, so we do it in our mind by connecting information in a common way which is the logic-mathematic and by this procedure we construct the real world.

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WORKING PAPERS

Fera-t-il bon vivre dans les villes intelligentes ?

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C'est inévitable, avec la multiplication des villes et territoires intelligents et divers autres projets relevant d'idées proches, certes souvent dissemblables mais se rattachant au concept de territoires apprenants, on peut observer des points similaires entre eux qui méritent de soulever l'attention. Ils peuvent même, parfois, sembler inquiétants pour les habitants des villes concernées. En conséquence, on doit tous, dès à présent, se poser l'importante question de **la qualité de vie des citoyens** en ces lieux autoproclamés intelligents et en plein développement sur toute la planète.

Sans doute les intentions profondes des villes ou des territoires qualifiés d'intelligents se distinguent-elles les unes des autres. Elles s'inscrivent tantôt dans des *datapoles*[14] (ou *smart cities*)[15], tantôt dans des *participoles*[16] au sens où l'entendent des organismes internationaux. Toutes ont en commun de faire un appel de plus en plus conséquent aux possibilités nouvelles du numérique, certes prometteuse, mais aussi opaques et menaçantes en particulier avec le recours conséquent à de l'intelligence artificielle. Dans ce texte, il ne s'agit pas de tomber dans la paranoïa, même s'il y aurait de quoi ; nous allons donc y veiller en proposant des analyses distanciées.

Idéalement, une *smart city* est l'association réussie entre une volonté politique locale et l'usage adéquat de technologies avancées faisant un appel très important à de l'intelligence artificielle. Entre les projets, que ce soient des *datapoles* ou des *participole*s, diffèrent la philosophie de référence dominante et les intentions principales (mais souvent obscures) vis-à-vis des usages des outils employés et l'importance de l'appel aux plus sophistiqués d'entre eux qui emploient des algorithmes complexes et opaques. L'intelligence artificielle devenue omniprésente, écrasante, même menaçante, semble pour beaucoup aller de soi sans être vraiment questionnée. Ces technologies ont elles des buts à elles ou sont-elles de simples instruments d'un Grand projet démoniaque de nouvelle société ? Pour le moins, elles appellent à la vigilance citoyenne, c'est certain.

Les nouvelles technologies semblent piloter les évolutions sociétales que l'on observe sur le terrain à travers beaucoup de projets, mais avec très peu de précisions sur les finalités réelles poursuivies et qui, de ce fait, souvent demeurent obscures quand elles ne se montrent pas menaçantes, voire effrayantes. Les exemples font florès. Nous en avons déjà cités dans un précédent texte[17] et nous en évoquerons quelques autres dans celui-ci. Au point que, sans céder à de vulgaires délires que l'on rencontre sur les réseaux-sociaux, certains se demandent parfois s'il y a un pilotage mondial masqué de tous ces projets. Ainsi se développe le complotisme, en pleine expansion depuis près de deux décennies. Heureusement, les expositions universelles servent de vitrines plus objectives pour ce secteur d'activités planétaires. Elles permettent d'observer, de faire des comparaisons, de poser des questions comme nous le faisons ici, et

[14] Les concernant, nous parlerons de *smart city* ou de villes intelligentes.
[15] Alain Bouvier (2020) : **Des villes intelligentes aux territoires apprenants**, *in* Introduction aux villes et territoires apprenants (2020), dir. Alain Bouvier et Laurent Rieutort, collection guide méthodologique, Clermont Ferrand, Éditions IADT.
[16] Nous les qualifieront de villes apprenantes pour les distinguer des *smart cities*.
[17] *Opus cit.*

surtout de débattre du bien-fondé des projets et de leurs finalités. En résumé, il est légitime de se demander, pour les habitants concernés, s'il fera bon vivre dans les villes et territoires intelligents.

Proximité : une revanche des villes moyennes ?

En France, on observe l'organisation en *clusters,* formels et informels, de certaines villes moyennes. Ce processus est devenu possible et plus facile grâce aux technologies numériques. On peut même estimer que l'on est devant une sorte de revanche de ces cités vis-à-vis des métropoles et des mégapoles qui parfois les méprisent. En fait, on assiste plutôt à la conquête par ces villes d'espaces différents. Par exemple, en janvier 2021, le réseau des villes apprenantes de l'UNESCO comprenait déjà 229 entités (petites et très grosses) dans 64 pays, alors que d'autres villes sur différents continents frappaient à sa porte. Mais, pour la France il y avait : Amiens, Angers, Brest, Suresnes, toutes des villes moyennes, ce qui va dans le sens de notre remarque.

De nombreux exemples peuvent illustrer les efforts faits à travers ces démarches de villes intelligentes et qui toutes prétendent mettre en avant la future qualité de la vie des habitants, même en France. Il en va ainsi, à Dijon, avec notamment l'installation de 34 000 lampadaires et points lumineux intelligents pour tenir compte de la biodiversité, du confort des citoyens, de leur sécurité, des évènements sportifs ou culturels. Bien qu'étant plutôt une *smart city*, Dijon est un exemple de ville intelligente mise au service du bien-être des habitants, avec une forte visée écologique. Grâce à un poste de pilotage central pour tous les équipements urbains, 65% d'économies d'énergie sont attendus par la ville. Autre exemple de ce type, Grenoble qui dispose d'un générateur d'itinéraires pour les personnes à mobilité réduite. On devine donc que, l'intelligence artificielle aidant, l'imagination des acteurs va trouver matière à s'employer et que des projets, plus originaux les uns que les autres, vont voir le jour et s'accumuler. Seront-ils vraiment au bénéfice de la qualité de la vie quotidienne des habitants ? C'est la question essentielle.

D'une toute autre nature et d'ampleur considérablement plus réduite que les projets de territoires, se multiplient les « *maisons intelligentes* ». Elles ont commencé à faire leur apparition avec le développement d'Internet il y a plus de quinze ans, lorsque Bill Gates présenta au grand public son premier projet, révolutionnaire à l'époque, mais devenu banal aujourd'hui. Les maisons intelligentes visent à augmenter la sécurité des résidences (pour les personnes et pour les biens), ainsi que leur confort au quotidien, tout en diminuant le montant des factures d'eau, d'électricité, de gaz, d'entretien et de maintenance et en accroissant leur sécurité. Par des algorithmes sophistiqués, elles adaptent les usages électriques et de chauffage aux habitudes de vie des habitants de la maison. Elles tiennent compte des différents tarifs pratiqués par les fournisseurs tout au long de la journée et de l'année, ainsi que des habitudes de vie des habitants. Les progrès visés maintenant (ce sera sans doute encore très long et onéreux) portent sur les possibilités de stockage de l'électricité, encore bien médiocres. On construit aussi des « *immeubles intelligents* » qui ajoutent d'autres dimensions, écologiques notamment.

La proximité a eu son heure de gloire et c'est encore un puissant thème commercial pour les consultants en organisation. Au point qu'aujourd'hui, pour aller plus loin, on évoque *l'hyper-proximité*, notamment, comme le fait Maif-Magazine, à travers le concept attractif de « *ville du quart d'heure* » où tout service au citoyen doit pouvoir lui être rendu avec, au plus un temps de déplacement de 15 minutes à pied (ou 30 minutes dans les territoires moins denses) ou de 5 minutes à vélo ou en trottinette électrique. But principal : éviter aux habitant d'avoir à utiliser une voiture. Cette idée a été lancée en 2019 par l'urbaniste et chercheur franco-colombien Carlos Moreno, professeur à l'IAE de Panthéon-Sorbonne, inspiré selon lui par Edgar Morin et par l'anthropocène. Il collabore aussi avec le prix Nobel Muhammad Yunus. Soucieux du climat, il

travaille sur les villes intelligentes durables et sensibles, selon un concept qu'il a présenté lors de la Cop 21. Depuis, son utopie a été valorisée par la pandémie. Il préconise de créer des « lieux intermédiaires » qu'il nomme des « *hubs* » pour favoriser les fonctions sociales sans saturer les transports. Pour lui, le bien commun n'est pas seulement l'eau que l'on boit et l'air que l'on respire. C'est aussi le lien social, la maitrise de sa vie, la culture, le sens donné à sa vie. On sent bien que dans de tels projets la qualité de vie des citoyens est l'objectif principal. Ce concept peut aussi concerner des quartiers de grandes villes, surtout de métropoles ; il est essentiel lorsqu'elle dépassent 100 kilomètres de diamètre, mais aussi dans des villes de moindre superficie. S'engagent dans cette direction : Copenhague, Melbourne, Ottawa, Utrecht, Edimbourg. En France : Nantes, avec le quartier Prairie-au-Duc, Pantin… Quant à elles, les villes de Dijon et Mulhouse font de nouvelles expérimentations. Des villes comme Copenhague ont d'autres pratiques encore pour diminuer les temps de déplacements. Elles veillent à la synchronisation des feux pour les vélos. Ainsi, peut-on traverser la capitale danoise à vélo, sans mettre le pied à terre.

L'éthique de la donnée

Les données numériques, très souvent citées sous le terme de *datas, d'open datas* et de *big datas*, se multiplient à une vitesse folle. Les « oasis numériques » se multiplient et tissent des liens entre elles. On en vient à imaginer des « *lacs de données* » qui constituent autant de risques d'inondations, car malgré les algorithmes sophistiqués et puissants, trop de données tuent les données. Le sens des projets disparaît derrière des instruments abscons (souvent volontairement) malgré les progrès phénoménaux de ces derniers.

Sur la planète, la gestion des données est désormais un enjeu majeur au centre de saines polémiques, comme ce fut le cas à Toronto[18], désormais exemple de référence. Les *open* et *big datas* interrogent donc la manière de gouverner les territoires, avec en France l'émergence de plateformes de données dans les collectivités territoriales et les villes moyennes. Ce sujet sensible est l'objet du N° 18 de la revue Horizons publics[19].

En France, sont concernées par ces débats les villes de Dijon, Angers, Rennes… mais aussi la communauté du Pays Haut Val d'Alzette dans le Grand-est, qui est l'un des premiers territoires périurbains à engager une stratégie ambitieuse de territoire intelligent. Le principal défi rencontré par la gouvernance des projets est de rendre appropriable par la population les ambitions annoncées en termes d'intelligence collective et surtout de qualité des services. Techniquement, pour la réalisation des projets dans ces territoires, comme à Dijon ou à Angers, le choix de la collectivité est de s'appuyer sur un consortium industriel *ad hoc*, avec de lourds contrats incluant de grosses entreprises, dans des logiques de PPP[20], avec le risque que connaissent bien les élus car elles poussent à la surenchère technologique, à des projets au coût déraisonnable et sans garantie de succès. Ainsi va le marché !

L'éthique de la donnée devient donc l'enjeu des partenariats territoriaux et pousse à la création de *comités d'éthique* (comme à Dijon en 2019), indispensables pour obtenir la confiance de citoyens méfiants vis-à-vis des GAFAM et des grosses entreprises internationales liées au numérique, au management ou au *design*. En termes d'éthique, les habitants sont rassurés par la présence d'acteurs publics, en particulier relevant de l'État. De plus, les données doivent rester la propriété des collectivités territoriales concernées. Ce qui s'est passé à Toronto[21] (à quelque

[18] Cf. Alain Bouvier (2020), *opus cit*. pp 27-29.
[19] ***Big data* dans les territoires : comment garder la main**, Horizons publics, N° 18, Paris, Berger-Levrault.
[20] Projets Public Privé, encensés il y a 20 ans, souvent décriés depuis.
[21] Cf Alain Bouvier (2020) Op. cit.

chose malheur est bon…) aura eu le mérite de placer l'éthique et les principes démocratiques au centre des nouveaux projets territoriaux. Le marché et l'éthique ne font pas bon ménage. L'humain doit rester premier. Tout ne se réduit pas à des enjeux financiers aussi considérables soient-ils, ni et à des intérêts commerciaux concurrentiels. Cela peut se faire autour d'un cahier des charges, élément essentiel, comme c'est le cas pour le projet de ville intelligente « *Montréal en commun* ». Nantes à fait le choix d'une « charte territoriale de la donnée ». Le principal danger que l'on peut observer sur la planète réside dans d'alléchantes propositions faites de « *smart cities* vendues clés en main », comme nous l'avons évoqué dans un précédent texte[22].

Les données (l'or du XXI[e] siècle) sont donc l'enjeu majeur du futur. En France, l'Institut Montaigne, *think tank* libéral, pousse les villes à s'approprier les *datas* qui contribueront – dit-il - à l'amélioration de la qualité de vie, à la mesure des impacts environnementaux, à l'optimisation des services publics… Mais des *think tanks* de gauche pourraient faire les mêmes recommandations, car ce qui importe est d'abord la qualité de vie des habitants. L'Institut Montaigne s'appuie sur une étude et un guide pratique portant sur 11 villes françaises dont Paris, Bordeaux, Lille, Grenoble et Angers. Notons que toutes affichent leur méfiance vis-à-vis des géants du numérique qui les poussent à de grands projets démesurés et irréalistes, mais bonheur des cabinets de consultants en organisation et des entreprises nationales et internationales. Ils fournissent des équipements numériques et de l'ingénierie, en faisant fi de l'éthique.

Je gage qu'Audrey Azoulay qui vient brillamment d'être réélue Directrice générale de l'UNESCO, va chercher à faire débattre tous les États de « l'éthique de l'intelligence artificielle » et donc sur ce qui règne déjà dans les *smart cities*.

De nouveaux projets fous !

Chaque mois ou presque, de nouveaux projets sont annoncés, on pourrait presque dire plus fous les uns que les autres. L'historique et déjà ancienne leçon de Brasilia sur la qualité de vie des habitants dans une ville artificielle sortie du néant n'a pas porté ses fruits. Il aura fallu un demi-siècle pour rendre la capitale du Brésil agréable à vivre… et encore ! D'autres expériences internationales (il y en a plusieurs[23]) ont montré qu'il est difficile de créer de toute pièce une nouvelle ville à qualité humaine, même une capitale. Les prouesses et promesses technologiques ne suffisent pas pour donner envie de venir y vivre. En termes d'échelle temporelle, Brasilia a montré que cela nécessite beaucoup d'efforts des pouvoirs publics sur plusieurs décennies et nous savons que certains projets asiatiques déjà engagés semblent proches d'un échec.

L'Arabie Saoudite a lancé la construction d'une « *ville du futur* », linéaire, de 170 kilomètres de long, sans voitures, d'une superficie de 250 fois celle de Paris. Baptisée « *The line* », elle sera au milieu du désert. Les travaux ont commencé en 2020 et elle devrait être achevée (mais quand peut-on dire que la construction d'une ville est terminée ?) en 2050, s'inscrivant dans la volonté de sortir le royaume saoudien de sa dépendance aux hydrocarbures. L'ambition de ce projet du prince héritier Mohammed Bin Salman (surnommé MBS) est donc grande ! Ce colossal projet vise à concilier la protection de l'environnement avec les impératifs du développement humain. Cette ville sera non seulement sans voiture, mais aussi sans rues (pourra-t-on encore parler de « ville » ?). MBS la déclare « construite autour de la nature et non pas sur elle ». Difficile à imaginer ce que cela veut dire, nous verrons… *The line* sera autonome, hyperconnectée, administrée par un système d'e-gouvernance et surtout emploiera la reconnaissance faciale : rien de bien rassurant ! Dans *The Line*, c'est l'intelligence artificielle qui

[22] *Op. cit*. (2020).
[23] Alain Bouvier (2020) Op. cit.

surveillera tout. La ville n'utilisera que des énergies renouvelables. Les déplacements seront assurés par des navettes autonomes, souterraines, intelligentes et à grande vitesse. La partie extérieure et visible de la ville sera dédiée aux piétons (ce qui supposera obligatoirement de considérables et efficaces protections contre le soleil et la chaleur). Aucun trajet ne devra prendre plus de 20 minutes. Les écoles et les cliniques ne seront jamais à plus de 5 minutes de déplacement. Sur les 30 ans à venir, son colossal financement est estimé à 500 milliards de dollars ! Elle envisage de créer près de 400 000 emplois. Notons encore un signe inquiétant qui, en termes d'éthique, fait penser à Toronto : l'architecte anglais Norman Foster, qui en assurait la conception, a jeté l'éponge pour des raisons politiques touchant à de multiples problèmes relatifs aux droits de l'Homme. Néanmoins, *the show goes on* !

Bill Gates travaille sur un projet de ville intelligente dans le désert de l'Arizona, à 45 kilomètres de Phoenix, beaucoup plus modeste que *The Line*. Pour cette ville qui s'appellera Belmont, il a acheté en 2017 un terrain et déjà investi 80 millions de dollars. Ce projet a « seulement » la superficie de la ville de Paris. Belmont vise à accueillir 180 000 habitants. Entre les promoteurs de cette ville intelligente et ceux qui la qualifient publiquement de « ville idiote », les débats sont vifs.

En Égypte, la future capitale administrative, connue sous le nom de *Wediam* (nom provisoire sans doute ; de façon humoristique, certains la nomment *Sissi city*) à 45 kilomètres à l'est du Caire, elle aussi en plein désert, mais proche du canal de Suez. Elle sera une vitrine du numérique et un satellite de la capitale historique peu distante. Le budget de ce projet pharaonique (normal pour l'Égypte !) commencé en 2016 est de 37 milliards de dollars. Son inauguration officielle, initialement prévue en 2020, a été retardée en raison de la crise sanitaire. La Chine, qui apporte le tiers du financement, est très impliquée dans ce projet qui inclut 400 kilomètres d'autoroutes (en grande partie achevées) et de nombreux hauts *buildings* s'inspirant de Dubaï (le chantier est aussi financé par les pays du Golfe). Le gouvernement égyptien accélère la formation au numérique des fonctionnaires. Il l'a déjà assurée pour 18 000 agents sur les 52 000 qui seront concernés. L'objectif global est de contribuer à la construction d'une « *Égypte numérique* ». Cette future mégapole devrait accueillir 6,5 millions d'habitants (c'est moins que le Caire et ses plus de 20 millions[24] d'habitants). Elle proposera 2 millions d'emplois permanents ; c'est un objectif ; nous verrons. Tout sera entièrement numérisé. Les habitants pourront, grâce à une carte à puce ou un QR-code, obtenir tous les services qu'ils recherchent et les payer, y compris les différents types de transports. Les mesures incitatives pour faire venir la population dans cette ville encore en construction comprennent un plan de logements. La citée sera fermée et surtout très sécurisée. Pour l'instant, sans s'inscrire explicitement dans les réseaux internationaux de *smart cities*, ce projet en est donc proche par son esprit et par l'option totalement numérisée choisie.

Pour les nouvelles villes du futur, une tendance lourde se dégage donc en termes de « *villes connectées* », avec une promotion de l'économie circulaire, la multiplication de bâtiments à énergie positive, l'objectif « zéro carbone » et « zéro émission », la course aux labels écologiques (devenus un véritable commerce international, le *commerce des labels).* On observe un mélange de perspectives : respect de l'environnement, mais optimisation des services aux usagers, e-administration, transports intelligents, pilotage intelligent des équipements urbains. Entre eux il n'y a pas opposition mais complémentarité. Notons toutefois un paradoxe : les économies potentielles promises aux contribuables et supposées être importantes (nous verrons…) exigent d'abord des investissements très conséquents ! On peut même parler « d'économies qui coûtent cher ! ». Pour y croire, il faut la foi du charbonnier ! Les propagandes électorales sont redoutables. Il n'est pas sûr que Shanghai, la ville qui se targue d'être la plus

[24] Estimation fréquemment citée.

connectée au monde, soit celle qui apporte la meilleure qualité de vie à ses habitants. L'éthique, la liberté de penser et d'agir, l'humanisme, les rapports humains, la solidarité collective comptent beaucoup plus.

Existe-t-il un modèle français de territoires intelligents ?

Le nombre considérable de villes françaises inscrites dans l'un des différents réseaux internationaux de villes intelligentes[25] amène à se demander s'il existe un modèle français de telles citées. Pourquoi, malgré ce nombre élevé n'existe-t-il pas en France d'espace public de capitalisation et de consolidations d'expériences ? Bien qu'il soit encore trop tôt pour répondre à ces questions légitimes, on peut déjà formuler quelques remarques au moment où, dans ce but, l'État français investit 30 millions d'euros pour faire émerger de nouvelles *smart cities* ainsi que des territoires intelligents et durables (remarquons, en nous étonnant, que ce dernier point sur la durabilité n'est pas souvent abordé).

Se pose en premier lieu la question des modèles économiques et de la gouvernance de ces nouveaux territoires, sujet que nous avons abordé dans notre précédent texte[26]. En lançant ce projet, l'État compte favoriser le partage de retours d'expériences et la mise en place de nouvelles méthodes, ainsi que la diffusion de « bonnes pratiques » comme il se dit parfois. En octobre 2021, une trentaine de projets avaient déjà été retenus (département de la Haute-Savoie, métropole de Montpellier…) et s'étaient vu accorder 5 millions d'euros. Sur le plan financier, rien à voir avec les projets pharaoniques cités plus où tout se chiffre en milliards ! S'il y a un modèle français, sa modestie financière est notable. En opposition avec certains exemples cités plus haut, présents ou émergeants en Asie, en Afrique, aux États-Unis, il se veut d'abord respectueux des libertés publiques, de la culture et s'inscrit dans une perspective de développement durable. Sans doute le modèle français intègre-t-il systématiquement des dimensions écologiques. On discerne même des projets qui visent à basculer vers le concept de « *safe cities* » alors que d'autres commencent à se demander ce qui, dans leur projet, est exportable, voulant sans doute s'inscrire sur le lucratif marché international des *smart cities* proposées clés en main.

Les dangers de la reconnaissance faciale

Le reconnaissance faciale, l'un des grands enjeux des années présentes et futures, est de plus en plus évoquée dans le moindre projet, bien au-delà des strictes questions de sécurité qui ont été les premières à mobiliser cette possibilité. De plus en plus acceptée, elle s'étend à de multiples domaines en étant censée faciliter, en toute sécurité (dimension très valorisée), l'accès des citoyens aux services qui leur sont destinés. Par exemple, dans les villes moyennes au Japon, le projet « *Face pass* » est un système de billetterie par reconnaissance faciale qui équipe des bus autonomes. Dans la mégapole d'Osaka, le dispositif déployé comprendra 133 stations en 2024 et sera présenté lors de l'Exposition universelle de 2025. Un an avant l'Exposition universelle de 2021, Dubaï, la métropole émiratie avait déjà mis en place un système de reconnaissance faciale dans ses transports en commun à des fins de sécurité. Un tel système a montré son efficacité lors de la simulation d'attaques terroristes. Se considérant comme « la ville la plus intelligentes du Moyen-Orient », Dubaï à l'ambition de devenir un centre mondial des technologies numériques et surtout de l'intelligence artificielle, en concurrence avec de nombreux autres lieux sur la planète qui ont la même prétention (c'était le cas à Toronto). Il serait intéressant

[25] *Cf* Alain Bouvier et Laurent Rieutort (2020) *Op. cit.*
[26] Op. cit.

de disposer d'enquêtes d'opinions relevées auprès des habitants de cette ville, mais dans ce pays il y en a peu (euphémisme !).

Les matériaux les plus banals, comme les lampadaires urbains rendus intelligents deviennent aussi des outils de surveillance (bruits et odeurs inhabituels, reconnaissance faciale…). Heureusement, on l'a vu avec la ville de Toronto, pour l'instant rien de vraiment conséquent ne peut se faire sans l'accord des habitants à condition de se montrer vigilants et d'en débattre publiquement.

Plutôt que de s'inscrire explicitement dans des démarches de villes intelligentes, certaines citées en France, comme Suresnes, cherchent à intégrer de l'intelligence dans des systèmes déjà existants ou en développement. Par exemple, avec l'utilisation de caméras de vidéosurveillance déjà placées dans les lieux à hauts risques, afin de détecter en temps réel les comportements « suspects » et limiter les patrouilles inutiles (police, pompiers…), avec toutes les ambiguïtés qui accompagnent de telles démarches. L'objectif est d'ajuster quantitativement et qualitativement l'envoi d'équipes aux besoins effectifs et surtout aux dangers encourus à travers des traquenards. La ville va lancer une expérimentation pendant 18 mois, en s'appuyant sur un partenariat avec une entreprise privée. L'accord préalable de la CNIL était encore attendu en juin 2021. Pour l'instant, ce projet exclut les procédures de reconnaissance faciale et les stockages de données ; mais pendant combien de temps ? Existe une dynamique qui pousse à leur développement tous azimuts. Il est déjà envisagé de l'étendre à divers types d'incivilités : incendies volontaires, dépôts sauvages d'ordures, rodéos à motos, etc.

Les outils numériques, notamment ceux de reconnaissance faciale, installés afin de développer l'intelligence de certains systèmes, d'améliorer la qualité des services rendus aux citoyens (sécurité, détection de foyers de Covid-19…) et d'accélérer des procédures (arrivée des pompiers, d'ambulances ou de transports par exemple), peuvent être utilisés à des fins discutables, soulevant des questions d'éthique. Ruili, petite ville chinoise près de la frontière avec la Birmanie, utilise la reconnaissance faciale pour surveiller les déplacements des habitants grâce à des « applications de suivi » (redoutables !). La Russie va déployer de semblables dispositifs dans les écoles, et ailleurs, d'autres villes de différents pays le font déjà ou envisagent de le faire dans les quartiers résidentiels afin de veiller à leur protection, ce qui en dit long sur les intentions de ces projets et sur les valeurs qui les portent. La qualité de vie dans les *smart cities* est-elle destinée seulement aux populations aisées, voire à très hauts revenus, afin de leur permettre de vivre dans un univers surprotégé ? Avec finesse, Maxime Schirrer professeur au CNAM demande « que l'on me montre des villes connectées où vivent des pauvres ! ».

Pour traquer les incivilités et les infractions au code de bonne conduite sur la voie publique, guetter les comportements sociaux indésirables, les rassemblements de plus de 10 personnes, Singapour vient d'installer des robots patrouilleurs qui traquent les consommateurs de tabacs dans les zones interdites, le colportage illégal, les marchands ambulants, les mauvais stationnements de véhicules, les trottinettes circulant sur les trottoirs, etc. Ainsi, les agents de police pourront être affectés à des tâches plus importantes. Les données recueillies sont analysées et traitées en temps réel. Ces robots vont encore évoluer pour assurer d'autres missions. Est prévu un projet de « robot-chien » pour faire respecter les règles de distanciation sociale dans les espaces publics et d'autres pour désinfecter les hôpitaux ainsi que différents lieux publics. Cela vient de permettre à Singapour d'être classée première *smart city* mondiale.

Vie privée, éthique et humanisme

Comme le Canada propose de le faire, faut-il durcir les règlementations sur les usages de l'intelligence artificielle et envisager des sanctions pécuniaires envers ceux qui dépassent les normes fédérales fixées ? Est-ce une solution pour éviter les usages abusifs, non conformes à l'éthique et pour respecter la vie privée considérée comme un droit humain fondamental ? Faut-il créer un nouveau domaine du droit avec des diplômes encore à imaginer, pour que les citoyens puissent contester des décisions prises à travers des procédures entièrement automatisées et opaques comme cela se fait déjà, même en France ? Comment limiter l'utilisation des données personnelles à l'insu des personnes ? De nouveaux domaines juridiques vont apparaître à l'université.

Si le numérique, l'intelligence artificielle et les *big datas* sont au centre des projets de la majorité des villes intelligentes, même des participoles, on sent de plus en plus quelques inflexions en direction de projets humanistes faisant une place centrale à des idées inspirées par l'écologie. Comme la « *smart city* à la grenobloise » impulsée par Éric Piolle ou comme les « territoires apprenants », cette utopie éducatives et politique du début du XXI^{e} siècle, ou encore avec « l'internet des territoires » au sens où l'entend Jean-Pierre Jambes[27]. Ainsi, des territoires deviennent apprenants grâce à plus de coopérations entre les acteurs et à des stratégies territoriales enrichies par de l'hybridation[28] : service universel d'accès à Internet – le rêve pour tous ceux qui vivent encore dans des zones blanches que les décideurs parisiens ou des métropoles oublient – plateformes de e-commerces de proximité, informations et interactions partagées, mobilité facilitée. Pour Jean-Pierre Jambes, ce qui compte plus que jamais, c'est « le lien plus que le lieu », d'où la grande valorisation « d'internets de proximité », conçus sur et pour un territoire.

Principalement pour des questions d'éthique et d'atteinte au respect de la vie privée, après avoir soulevé beaucoup d'intérêt pendants deux ou trois décennies, les *smart cities* ont, semble-t-il, moins la côte aujourd'hui. En effet, la surveillance des risques peut conduire à de l'hypersurveillance à la chinoise ou à la turque. Demain faudra-t-il un QR-code – le grand gagnant de la crise de la Covid-19 – pour accéder au moindre lieu public où même pour pénétrer un immeuble résidentiel où habitent des amis auxquels on veut rendre visite ? Au point que poussant à l'extrême, certains comme Hubert Guillaud, parlent de *Dark cities* et voient le concept de *smart cities* en déshérence. Sans doute est-ce excessif. Se dirige-t-on vers de nouveaux modèles rendant la résilience collective essentielle, ainsi que le respect des individus et de leurs droits ? Va-t-on vers des villes bourrées de *data centers* monstrueux mais qui ne se visiteront pas car elles n'auront rien d'attractifs à montrer à d'éventuels touristes, ni aucune qualité de vie à mettre en lumière ? Saurons-nous éviter de tels cas extrêmes et désolants ?

Un avenir plus attirant peut s'envisager à travers l'utopie politique et éducative des territoires apprenants, à condition de privilégier l'humain par des projets et des constructions d'abord culturelles et humanistes. Comme nous le verrons plus loin, la ville de Clermont-Ferrand s'inscrit dans cette perspective. Ainsi, par un renouvellement des imaginaires, se marquerait un retour en grâce de la proximité et surtout des réalités vécues : comme dans plusieurs communes italiennes, il s'agirait de privilégier les communs[29], pour faire avec les autres (donc pas seulement par l'utilisation d'algorithmes abscons et d'outils intrusifs comme les drones), pour apprendre ensemble, dans des espaces flexibles aux contours variables.

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[27] Jean-Pierre Jambes (2020) : **Territoires apprenant et invention des internets des territoires**, (à paraître).
[28] Jean-Pierre Jambes, *Opus cit.*
[29] *Cf* Horizons Publics N° 21

Service rendus aux usagers *versus* services rendus au système

Pour analyser la situation d'ensemble, il est utile de distinguer les « services rendus aux individus », des « services publics » qui visent à améliorer le système. Beaucoup de personnes espèrent dans les innovations technologiques, estimant qu'elles peuvent apporter un nouveau modèle de ville qui sera durable, ouvert, prospère, économe et attractif, alors que – le paradoxe est là - l'usage intensif d'algorithmes de toutes sortes induit chez les habitants de la méfiance, de l'incompréhension et fait même parfois effet de repoussoir. C'est donc la quadrature du cercle. Contrairement aux discours racoleurs de certains, notamment de nombreuses *start up*, d'entreprises, de groupes de consultants, d'experts plus ou moins autoproclamés, rien n'est résolu. Peut-être y a-t-il une antinomie fondamentale à vouloir, à la fois, d'une part accroitre l'efficacité des systèmes et des services, réduire les coûts de toutes sortes, et d'autre part améliorer la qualité de la vie individuelle des habitants.

D'une ville à une autre, les pratiques se diversifient et certaines peuvent nous surprendre. Par exemple, à Oslo, les élèves sont officiellement devenus des « espions » pour relever, dans les rues sur le chemin qui les mène à leur école, les problèmes et anomalies qu'ils détectent, pour « en temps réel » les communiquer aux services municipaux. Une telle pratique est culturellement possible dans certains pays, mais pas dans tous ; la France et les pays latins ne semblent pas ouverts à une telle idée. Plus neutres peut-être, mais assurément fort utiles, sont les capteurs intelligents placés auprès des personnes âgées afin de détecter leurs problèmes sans qu'ils aient à intervenir et lancer très rapidement des alertes adaptées. Idem pour la multiplication des plateformes de télémédecine utiles pour les gens isolés pour différentes raisons, pas seulement dans les zones rurales à faible densité humaine. L'amélioration de la qualité de vie des personnes est donc possible et recherchée à travers des usages de certains outils numériques, mais pas seulement. À Oslo encore, divers véhicules autonomes sont activement expérimentés.

Pour l'amélioration de la qualité du système, Las Vegas a utilisé le premier éclairage urbain alimenté par les pas des passants qui marchent sur les dalles piézoélectriques, combinées avec des panneaux solaires (pourtant, que je sache, on ne marche pas beaucoup à Las Vegas !). Barcelone vise une meilleure transparence sur les services rendus aux barcelonnais ; elle est assurée par un service dédié, alors que la ville de Durham, en Caroline du Nord le fait par l'usage d'un portail unique. Se multiplient aussi les plateformes pour le partage de données entre parties prenantes et partenaires, mais, évidemment, ces échanges de *datas* sont opaques aux citoyens et soulèvent leurs craintes. Se développe aussi le très utile suivi du mouvement mondial des containers réfrigérés.

Clermont-Ferrand ville apprenante

En 2017, Clermont-Ferrand a été la première ville de l'Hexagone à rejoindre le réseau UNESCO des villes apprenantes, faisant ainsi office de chef de file pour la France. Depuis, elle a été rejointe par d'autres agglomération de taille plus ou moins modeste : Mantes-La-Jolie, Montpellier et Évry-Courcouronnes, avec lesquelles ont été établis de réguliers liens d'entre-aide et des rencontres. La première fut organisée à l'IADT de Clermont-Ferrand en 2019.

Aucun doute à ce sujet, la capitale auvergnate ne s'inscrit pas parmi les *smart cities*. En partant de « la viande et des métiers de la viande » et par son approche humaniste faisant de plus en plus la part belle à la culture, elle se classe parmi les *participoles culturels*, même si ses nouveaux développements urbains ambitieux la conduiront inévitablement à faire, elle aussi, appel (mais un peu tard ?) à des usages sophistiqués des technologies numériques.

Ses actions sont variées et certaines concernent l'enseignement, l'éducation, la formation. Par exemple, la ville s'est dotée d'un collège d'experts pour « l'observation des réussites éducatives » accompagnant une alliance éducative qui se veut une « alliance apprenante ».

Ces derniers mois, Clermont-Ferrand vient de franchir un cap remarquable et remarqué. Le 27 octobre 2021, le Réseau mondial UNESCO des villes apprenantes (actuellement 230 villes dans le monde) a organisé en Corée du sud la cinquième conférence internationale. À cette occasion ont été désigné les villes lauréates du « Prix de la ville apprenante ». Cette distinction visait à mettre en lumière 10 mégapoles ou zones urbaines dont les politiques publiques favorisent les opportunités d'apprentissage au profit de toutes les générations. C'est donc bien la qualité de vie des citoyens qui vise ainsi à être récompensée. Parmi 380 projets éducatifs retenus sur recommandation d'un jury indépendant d'experts internationaux, la ville de Clermont-Ferrand a été sélectionnée dans le *Top 10* pour l'apprentissage tout au long de la vie. Elle a même été reconnue comme « la meilleure ville éducative ». La capitale auvergnate compte près de 40 000 étudiants, 1300 chercheurs, 35 laboratoires de recherche et consacre 43% de son budget municipal à l'éducation et à la jeunesse et 10% à la culture. Principe retenu, mis en œuvre et affirmé par la municipalité : « ne jamais cesser de transmettre aux autres les savoirs que l'on a acquis, ne jamais renoncer à échanger les bonnes pratiques et les expériences positives ». C'est en ce sens qu'il y a apprentissage, notamment à travers des apprentissages collectifs. Parmi ses projets emblématiques, on citera le déploiement du programme municipal de « ville à hauteur d'enfants », la création du « centre d'initiation à l'art pour les moins de 6 ans » et l'octroi du « label cité éducative » décerné à deux des quartiers nord de la ville, considérés comme étant les plus en difficulté sociale, économique et culturelle. Ils vont s'inclure dans un projet plus vaste et plus amitieux d'aménagement du territoire urbain, qui relève du développement durable et qui contribuera à beaucoup « verdir » la ville.

Comment organiser les activités logistiques dans le milieu hospitalier ?

Cas du groupe des Hôpitaux Universitaires Paris-Ouest

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Mots clés : Organisation, Logistique, Optimisation, Hôpital,

Résumé :

L'hôpital réorganise son mode de production des soins de l'amont vers l'aval. Notons que dans la plupart des cas, la logistique hospitalière présente une vision tronquée ou fractionnée par une limitation du champ d'action à des missions d'intendance (approvisionnement, restauration, blanchisserie...), du fait d'une restriction du pilotage des flux dits « classiques ». À ce jour, dans beaucoup d'hôpitaux, les activités logistiques sont encore réduites aux services d'approvisionnement et/ou économiques. Pourtant, comme dans toute organisation, la logistique dispose d'une structure organisationnelle autour des activités d'achats, d'approvisionnement, de stockage, de production et de distribution. Ces activités nécessitent une organisation rigoureuse, coordonnée et synchronisée en des flux informationnels et physiques gérées par les nouvelles technologies informationnelles.

L'objet de notre recherche est de montrer qu'à l'hôpital, au-delà de l'approche segmentée de la pratique logistique on peut avoir une démarche globale coordonnée intégrée malgré la complexité des activités hospitalières. L'utilisation et la maîtrise des Technologies d'Information et de Communication Appliquées à la Santé (TICAS) permettent de mieux gérer les interfaces entre les métiers pour donner une vision transversale de toutes les fonctions opérantes. Les pratiques industrielles démontrent que l'approche par l'intégration des informations et la coordination des activités logistiques est indispensable pour mieux répondre à la satisfaction de clients.

Notre recherche est basée sur une étude de cas. Nous avons réalisé des entretiens auprès de gestionnaires d'activités logistiques (achats-approvisionnement, services hôteliers, pharmacie, stérilisations, services de soins). Ensuite, nous avons réalisé des visites d'observation des services en charge de la gestion et le pilotage des activités de sites visités. Ces entretiens et visites ont été pertinents pour effectuer une évaluation de différenciations de modèles logistiques. Les données et les informations collectées sur l'organisation des activités logistiques ont été ensuite croisées avec des informations secondaires. Les résultats obtenus ont permis d'élaborer le schéma de l'organisation logistique globale de l'HEGP.

En s'appuyant sur la revue de la littérature et sur l'analyse de cas (le Groupe des Hôpitaux Universitaires Paris-Ouest), il est montré cette approche globale du processus de la satisfaction du patient. Il s'agit de retracer les stratégies d'organisation des activités logistiques (d'approvisionnement, de production et de distribution) et de proposer un modèle organisationnel permettant de structurer, d'intégrer et de coordonner de manière cohérente l'ensemble d'activités de production pour une meilleure performance globale d'un établissement hospitalier.

Key words: Logistics, Organization, Hospital, Optimization, Satisfaction

Summary:

Hospitals are currently reorganizing their care production system from upstream to downstream. In most cases, the vision of hospital logistics is truncated or fractionated by limiting its scope to stewardship tasks (supply, catering, laundry ...), due to a restriction of “classic” flows steering. To date, in many hospitals, logistics activities are still reduced to supply and/or economic services. Yet, as in any organization, logistics has an organizational structure built around the purchase, supply, storage, production, and distribution activities. These activities need to be integrated and coordinated by informational and physical flows synchronization that is being facilitated by new information technologies.

The purpose of our search is to show that, beyond the segmented approach of the logistic practice; an integrated coordinated global approach is possible despite the complexity of hospital activities. Use and control of Information and Communication Technology in Healthcare (ICTH) allow to better manage the interfaces between activities to offer a broad vision of all operating functions. Industrial practices demonstrate that the approach based on the integration of information and coordination of logistics activities is essential to better meet customers' satisfaction.

Our research is based on a case study. We conducted interviews with logistics operations managers (procurement, supply, hotel services, pharmacy, sterilization, care services). Then, we carried out go-and-see visits to observe the management services and the piloting of the activities on the visited sites. These interviews and visits were relevant to make an initial assessment of logistic models’ differentiations. Data and information collected on the organization of logistics activities were then crossed with secondary information. The results were used to develop the scheme of the overall logistics of HEGP.

Based on the literature review and the case study (the Group of Paris West University Hospitals), we highlight this comprehensive approach of the patient satisfaction process. It is a question of recalling strategic planning of the organisation of the logistic activities (supply, production, and delivery) and of proposing an organizational model making it possible to structure, integrate and coordinate in a coherent way all production activities for a better overall performance of a hospital.

Introduction

La démarche de rationalisation et d'optimisation des dépenses de santé (Loi nº 91-748 du 31 juillet 1991) a eu des répercussions fortes sur le fonctionnement et la gestion des hôpitaux. Ainsi, la mission sociale de l'hôpital s'est trouvée perturbée par un contexte économique moins favorable nécessitant *de facto*, la maîtrise des coûts de soins. Les établissements de santé sont contraints à se repositionner et à mener une réflexion globale sur leur propre organisation. Ils se trouvent face au dilemme suivant : comment continuer à conserver, voire améliorer la qualité des soins tout en réduisant les coûts ? À cette problématique, la démarche logistique apporte une certaine solution en termes de maîtrise des coûts, de qualité des soins (Chow et *al*, (1994), Aptel, (2001), Rivard-Royer et Beaulieu, (2003)) et d'amélioration de la performance d'établissements hospitaliers (Jobin et *al*, 2004).

Dans la plupart des cas, la logistique hospitalière présente une vision tronquée ou fractionnée par une limitation du champ d'action à des missions d'intendance (approvisionnement, restauration, blanchisserie...), du fait d'une restriction du pilotage des flux dits « classiques » (Sampieri-Teissier, 2004). À ce jour, dans beaucoup d'hôpitaux, les activités logistiques sont encore réduites aux services d'approvisionnement et/ou économiques. Pourtant, comme dans toute organisation, la logistique dispose d'une structure organisationnelle autour des activités d'achats et approvisionnement, stockage, production et de distribution (Rivard-Royer et Beaulieu, (2003), Landry et Beaulieu, (2002)). Ces activités nécessitent d'être intégrées et coordonnées via une synchronisation des flux informationnels et physiques que facilitent les nouvelles technologies informationnelles (Bert et all. (2011), Dégoulet et *al*, (2003), Segade et *al*, (2006))**.**

Dans ce contexte, l'objet de notre recherche est de montrer qu'à l'hôpital, au-delà de l'approche segmentée de la pratique logistique on peut avoir une démarche globale coordonnée intégrée malgré la complexité des activités hospitalières. L'utilisation et la maîtrise des Technologies d'Information et de Communication appliquée à la Santé (TICAS) permettent de mieux gérer les interfaces entre les métiers pour donner une vision transversale de toutes les fonctions opérantes. Il convient de montrer qu'au-delà de la complexité organisationnelle de la chaîne des activités, depuis le fournisseur jusqu'au patient, la logistique hospitalière est structurée en : logistique d'approvisionnement, de production, et de distribution. Le modèle organisationnel proposé incite à une réflexion sur la gestion globale de toutes les activités structurant la production des soins.

Les recherches sont basées sur l'exploitation de la littérature pertinente existante et une étude de cas du Groupe des Hôpitaux Universitaire Paris-Ouest (GHUPO).

La présente communication comporte trois parties : (i) la démarche logistique conceptualisée à travers la revue de la littérature (la logistique d'approvisionnement, de production et de distribution) ; (ii) la méthodologie de recherche et l'analyse de cas du GHUPO, avec une présentation détaillée de l'organisation logistique de l'Hôpital européen George Pompidou ; (iii) des énoncés clés qui peuvent apporter un nouveau regard sur le développement continu de la logistique hospitalière grâce à la mise en place des TICAS.

1. La démarche logistique dans les établissements hospitaliers

La satisfaction des patients est aujourd'hui, au cœur des préoccupations des acteurs des établissements hospitaliers. Cependant, la nouvelle donne économique conduit impérativement à concilier l'objectif d'optimisation de la satisfaction patient et la rationalisation budgétaire. De ce fait, la culture de la performance globale structure progressivement le champ du fonctionnement opérationnel des hôpitaux. Ainsi, au regard de nouvelles exigences de l'environnement socioéconomique, les facteurs temps, qualité, sécurité, confort sont pris en considération dans les mesures clés de la performance lors du processus d'organisation du parcours du patient dans un système en flux continu (Dormont et Milcent, 2010). En effet, pour améliorer la qualité de soins, il

faut d'abord améliorer le fonctionnement des établissements. Comme le souligne Benanteur et *al*, (2000, p. 7): *« les secteurs logistiques et techniques sont les plus simples à rationaliser, contrairement aux services cliniques qui traitent la personne qui souffre…, la qualité passe par l'optimisation de procédures*». Une structure organisationnelle efficace joue un rôle majeur dans la performance logistique, souligne Kim (2007). En intégrant les TICAS à la gestion, les structures organisationnelles s'ouvrent vers d'autres types d'organisation, au-delà de celles classiques, d'une manière rationnelle et harmonieuse, plus modernes et plus flexibles, en vue de satisfaire les besoins de tous les acteurs (Lorino, 1995). Les organisations hospitalières s'adaptent au processus de satisfaction non comme à une structure de simple combinaison de facteurs en vue de produire des services, mais comme à une démarche de performance globale (Hubinon, 2004) et, ainsi apporter une valeur ajoutée aux patients (Pascal, 2003).

1.1. Le concept logistique

Il y a encore quelques années, la logistique hospitalière était connue comme un service technique de l'hôpital qui gérait les achats de produits hôteliers, lingerie, restauration, transport, etc. (Benanteur et *al*, 2000). Aujourd'hui, la logistique est vue *« comme un concept d'optimisation de la coordination des flux entre l'amont et l'aval* » (Mathé et Texier, 1987). Elle gère les opérations physiques, les flux d'information internes et externes (les informations de marché) apportant une réponse à la complexité organisationnelle des activités productives (Dornier et Fender, 2010). Selon Christopher (2005), tout processus de création des biens se traduit par la gestion coordonnée des flux et l'agencement de l'ensemble d'opérations (manutentions, stockage, contrôle, etc.) d'amont en aval. Une pratique qui subit des transformations au fur et à mesure qu'évolue l'environnement technico-économique global. La logistique hospitalière est « *un réservoir d'économies potentielles* » qui fournit aux différents acteurs de l'hôpital les moyens de fonctionner en impactant les activités cliniques (Landry et Beaulieu, 2002).

Nous définissons la démarche logistique comme une démarche d'optimisation de la coordination et d'intégration de l'ensemble des fonctions structurantes et des supports aux activités médicales par l'organisation synchronique des flux informationnels et physiques, et ce, en vue de prodiguer de meilleurs soins aux patients tout en assurant une satisfaction globale de l'hôpital.

Il s'agit ici, de la gestion de la chaîne logistique globale où on retrouve une collaboration de plusieurs sous-systèmes de production partageant la responsabilité de la planification de l'offre de soins, de la gestion et de l'exécution ou de l'évaluation d'une activité et tout cela par un échange d'information (Min & al. 2005). Plus l'intensité de la collaboration est élevée, plus l'organisation doit bien préciser son intention stratégique (Roy, & all. (2005).

Rappelons que le processus d'offre de soins dans la chaîne logistique est déclenché par l'expression de la demande du patient (par l'aval). L'information de cette demande est transmise au centre de pilotage pour organiser la chaîne des activités d'approvisionnement, de production et de distribution des services de soins vers le patient. Ces activités dans la chaîne logistique sont appelées des sous-systèmes logistiques (Harvey & al. (1988). Dans le Schéma Nº 1, nous représentons l'enchainement des activités logistiques comme un modèle organisationnel de la logistique hospitalière globale.

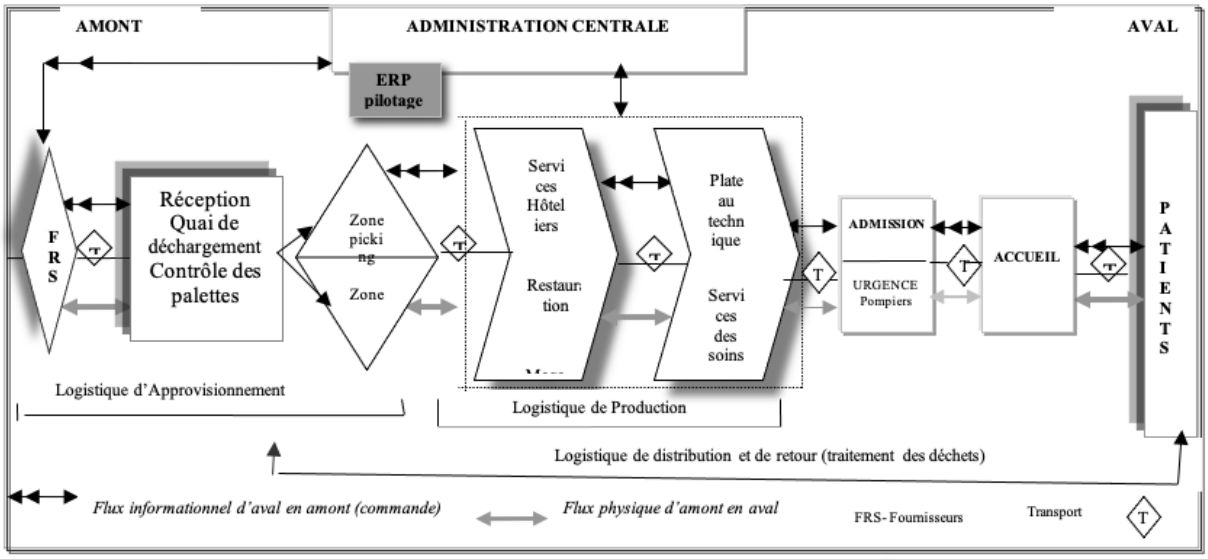

Schéma Nº1. Structure organisationnelle de la Logistique globale hospitalière. (Source : À partir de Chitou, 2010)

La demande de soins est symbolisée par un flux d'information (flèche à double sens de l'aval vers l'amont). Dans le cadre de cette structure, chaque sous-système ou maillon joue un double rôle : il est à la fois, fournisseur de tout maillon en aval et client, de tout maillon en amont. Ce double rôle de chacun des maillons explique le caractère intégrant de la chaîne logistique et, de surcroît, lui confère une dimension systémique. Chaque maillon de la chaîne (fournisseur, hôpital, plate-forme logistique, centre de distribution) est en lui-même, un système complexe composé de multitudes d'activités nécessitant leur coordination efficace et la rationalisation de leurs interfaces. Les fonctions administratives, logistiques, de soins, etc., devraient être pilotées par le Centre de pilotage général à l'aide d'un progiciel (intégré) de type ERP, adapté aux activités de chaque établissement.

En faisant le parallèle entre le système hospitalier et les organisations marchandes classiques, on peut aisément faire référence à la remarque de Power (2005). Ce dernier souligne que dans la chaîne logistique, l'intégration des informations est indispensable. Elle permet la capture et le transfert des données aux partenaires en amont, de façon à mieux planifier et synchroniser les activités de réapprovisionnement aux besoins exprimés par les consommateurs (patients). Dans le cas contraire, on risque d'avoir des inefficiences de toutes sortes (Landry, 2005).

La logistique d'approvisionnement

La logistique d'approvisionnement (LA) est le premier sous-système de la chaîne logistique et elle concerne le service achats et celui de gestion des approvisionnements. La LA a une position stratégique dans l'organisation hospitalière. Selon Chow et *al*, (1994), le service achats, l'entreposage et le réapprovisionnement sont des activités qui permettent de maîtriser l'équilibre financier et apporter une économie globale de 5 à 10 % sur les budgets achats (Landry et Beaulieu, 2002). Les achats en France représentent en moyenne, plus de 20 % du budget d'exploitation et 70 % du budget d'investissement d'un établissement public de santé (Legouge, 2008).

L'objectif de la logistique d'approvisionnement est d'apporter les matières premières nécessaires pour alimenter les sites de production (Beaulieu et Patenaude, 2004). Il s'agit d'assurer la circulation optimale des fournitures médicales, des produits pharmaceutiques, des aliments, du linge, etc. vers le patient (Jobin et *al*, 2001). La gestion des approvisionnements a un effet direct sur la performance globale d'un établissement de soins (Landry et Beaulieu, (2002), Chow et *al*, (1994)). Ainsi, les CHU de France sont amenés à revoir intégralement l'organisation du service

achats et des approvisionnements pour privilégier les projets innovants liés à la modernisation de ces activités (la mutualisation, la dématérialisation par la création de centrales d'achat). Par conséquent, de nouvelles techniques et méthodes de gestion des stocks et de réapprovisionnement se mettent en place. Il s'agit notamment de la méthode plein-vide ou des armoires modulaires de dispensation (*Supply Station Systeme)* (Landry et *al*, 2004).

De même, le principe de réapprovisionnement « stock zéro » ou *stockless* est utilisé, où le fournisseur gère le stock de produits dans les centres de distribution de ses clients (Rivard-Royer et Beaulieu, (2003), Rossi Turck, (2011)). Selon Rossi Turck, appliquée à la gestion logistique d'un bloc opératoire, une approche de type MRP pour le calcul des besoins couplée à un approvisionnement *stockless* permet d'avoir un contrôle permanent sur les coûts, d'assurer la sécurité, de réaliser des gains : de temps (plus de 67%) ; de stocks (81%) et rotation de stocks (76%) ; de surface occupée (90%) et de maîtriser la traçabilité des produits. Ainsi, la réorganisation des achats et des approvisionnements hospitaliers permet une maîtrise plus importante de la qualité, des coûts, des délais et des procédures, basée sur le retour d'expérience.

Logistique de production : logistique technique et médicale de l'hôpital.

L'hôpital se trouve depuis plusieurs années, confronté à la recherche de « productivité » et à l'utilisation des techniques de plus en plus automatisées. L'hôpital a été déjà étudié comme un « *système de production de services* » (Minvielle, 1996) ou comme « *un centre de production* » (Flagle, 2002) avec des spécificités et des caractéristiques identiques (le déploiement de diverses ressources pour satisfaire une demande critique et partiellement incontrôlable). Le processus de production de soins est vu aussi par Pascal (2003, p. 194), comme un « *processus dont le résultat n'est pas répétitif et qui n'utilise aucune méthodologie fixe* ».

L'hôpital est une entreprise multi produit où chaque produit correspond aux séjours des différents GHM (Groupe Homogène Maladie) (Dormont et Milcent, 2010). Chaque GHM correspond à un ensemble de soins réalisés dans les unités ou services de soins, conçus par un ensemble d'acteurs hospitaliers (médecins, infirmières, administrateurs) qui définissent le traitement à partir des ordonnances, nomenclatures, etc. La gestion de la production se fait avec le concours des services de soins et des services auxiliaires comme : la pharmacie, le laboratoire, la stérilisation, la blanchisserie, la cuisine, etc. Ces activités sont regroupées dans le volet « production » et considérées comme des unités de transformation et de production (Chow et *al*, (1994), Landry et Beaulieu, (2002)).

Landry et *al*, (2004) déterminent la logistique de production autour de deux types d'activités : médicale et non-médicale ou de soutien. Le processus de production est défini par un ensemble d'opérations coordonnées et intégrées constituant en elles-mêmes de métiers interdépendants d'amont en aval, et ce, dans la mesure où l'hôpital est confronté à la nécessité d'optimiser sa production ou non. Contrairement au mode de production classique, l'organisation modulaire des activités, nécessite des regroupements par pôles. Les nouvelles technologies (robotique, productique, informatique) favorisent le regroupement des opérations et leur traitement efficace. Cette nécessité est générée par l'intensité de la pression de l'environnement : plus la pression de ce dernier est forte sur l'établissement, plus la nécessité de rationaliser le système de production est accentuée. Lorsque la pression extérieure reste constante, l'organisation tend à maintenir un niveau juste satisfaisant de rationalisation et d'optimisation de la production auquel elle s'accommode dans le temps.

Comme l'indique Cremandez (1987, p 286) « *les services logistiques traditionnels (cuisines, buanderie…) appartiennent à l'univers administratif* ». Ils se situent dans une dynamique de recherche de rentabilité, ce qui les sépare de centres opérationnels (les services de soins), alors même qu'au quotidien, des liens étroits sont nécessaires pour assurer une qualité optimale aux soins des patients. Cependant, l'efficacité de cette politique qui trouve une traduction dans la démarche de certification passe également par une contractualisation avec les services de soins

qui doivent s'engager à assumer certaines tâches, en échange d'une prestation de meilleure qualité des services logistiques.

Logistique de distribution

La logistique de distribution consiste à acheminer les différents produits et services, directement vers les patients, vers les zones d'entreposage ou différents points d'utilisation. Elle prend également en compte, l'organisation de l'acheminement des déchets (contaminants et non contaminants) des zones d'expédition vers les centres de traitements (la logistique de retour). Notons que dans un établissement de soins, il existe de nombreux circuits de distribution regroupés en « circuit interne » et « circuit externe » (Landry & al., 2006). Ces circuits de distribution structurent des modes de transport interne entre différents maillons, par exemple : entre la zone d'approvisionnement et le centre de production ou en flux inversés (les centres de production vers les points d'approvisionnement), de centre de production vers les quais d'expédition et de traitement (transport des déchets).

Dans le processus de distribution, la livraison des produits doit se faire dans des délais courts, vers un service déterminé de l'hôpital ou à destination d'un patient précis. La gestion rigoureuse des interfaces entre le stockage et les points de consommation est donc fondamentale. L'optimisation de la logistique de distribution est fonction de la maîtrise des flux qui dépend par ricochet de la maîtrise du temps. L'optimisation doit se faire par voie de la planification ou par la méthode de flux tirés.

En somme, l'hôpital est considéré comme une entreprise avec un fonctionnement complexe. Dans le contexte d'un environnement économique exigeant, les opérations logistiques deviennent des activités plus élaborées faisant appel à des innovations technologiques de plus en plus sophistiquées. Chaque maillon structure et organise son propre système logistique au regard des autres maillons de la chaîne d'offre globale. Une telle pratique d'organisation d'activités logistiques est exposée dans l'étude de cas (voir la deuxième partie de la communication).

2. Observation des pratiques logistiques : cas d'illustration.

2.1. Méthodologie

Compte tenu de l'objectif de cette recherche, l'étude de cas est une méthodologie appropriée (Yin, 1994). Celle-ci vise à étudier les pratiques d'organisation et de fonctionnement de la logistique du GHUPO. Ce dernier fait partie du Centre Hospitalier Universitaire (CHU) de l'Île-de-France – l'Assistance Publique-Hôpitaux de Paris (AP-HP). Sur un territoire qui compte 12 millions habitants, l'AP-HP dispose de 37 hôpitaux, regroupés en 12 groupes hospitaliers, dont 128 pôles d'activités médicales. Dans une démarche de performance globale et pour gérer rigoureusement les finances publiques, l'AP-HP a contraint les hôpitaux de Paris à se regrouper pour rationaliser et optimiser les dépenses de santé. C'est dans ce contexte que le GHUPO a été créé. Il est formé de trois établissements : l'Hôpital Européen Georges Pompidou (HEGP) (820 lits), l'Hôpital Corentin-Celton (504 lits) et l'Hôpital Vaugirard Gabriel-Pallez (320 lits). Les directions du Groupe sont organisées comme suit : Direction générale, GRH, Finance, Services techniques et développement durable, Pharmacie, Qualité et Hygiène, Soins et Infirmiers siégeant à l'HEGP. L'Hôpital Corentin-Celton abrite la Direction de Services économiques et logistiques (Schéma Nº 2).

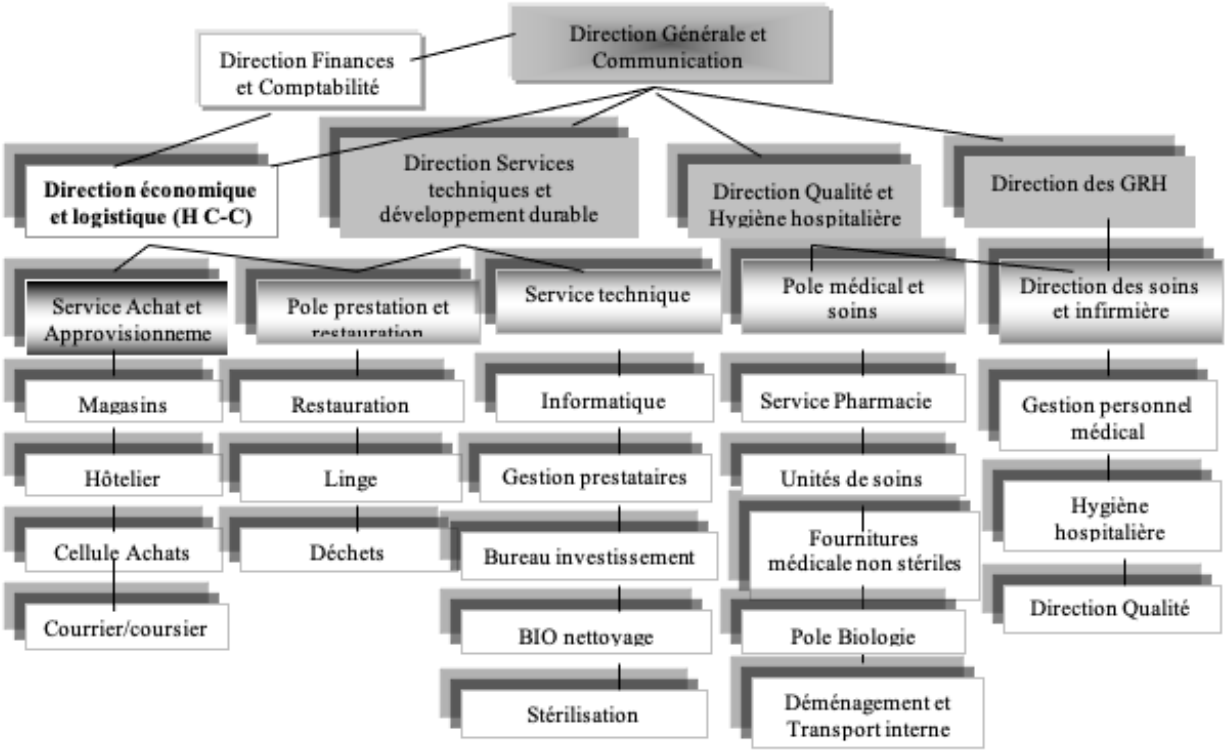

Schéma Nº 2. Structure organisationnelle du GHUPO

Le GHUPO couvre les activités de proximité, les activités intermédiaires et les activités hyperspécialisées. Depuis 2004, le Groupe développe des pratiques logistiques segmentées ; mais elles sont en train d'être unifiées dans une vision globale des activités. C'est pour cette raison que ce Groupe a été choisi comme cas d'étude. En accord avec la Direction du Groupe, une entrevue avec le Chef de Direction de Services économiques et logistiques a été organisée, afin d'établir un planning des rencontres et d'entretiens ainsi que des visites de sites logistiques. Les entretiens avec les gestionnaires d'activités logistiques (achats-approvisionnement, services hôteliers, pharmacie, stérilisations, services de soins) ont permis de cerner l'architecture organisationnelle des flux. Ils ont ensuite été complétés par des visites des services en charge de la gestion et le pilotage des activités de sites visités. Ces entretiens et visites ont été pertinents pour effectuer une première évaluation de différenciations de modèles logistiques. Les données et les informations collectées sur l'organisation des activités logistiques ont été ensuite croisées avec des informations secondaires. Les résultats obtenus ont permis d'élaborer le schéma de l'organisation logistique globale de l'HEGP.

2.2. Démarche d'organisation logistique globale à l'HEGP

L'HEGP a été conçu et organisé sur le plan architectural, en fonction de ses activités, des flux de patients (des urgences, des consultations...), des flux physiques (la restauration, linge, plateau technique, des examens biologiques, etc.).

Informations générales sur le mode de fonctionnement.

L'HEGP est réputé pour ses activités multidisciplinaires. Il dispose de deux spécialités principales : médecine et chirurgie. En 2011, l'HEGP a enregistré une hospitalisation complète de 27.767 séjours et 47.156 passages aux urgences, dont 21,6% des passages hospitalisés. La

durée moyenne de séjour (DMS) est de 8,2 jours. L'HEGP emploie un effectif de presque 860 de personnel médical à plein temps et plus de 2.535 salariés permanents relevant du personnel non médical.

Son budget annuel est de 368,5 M€ et ses recettes de 352,7 M€. Pour combler le déficit, l'Hôpital envisage de nouvelles mesures de rationalisation et d'optimisation des activités logistiques et notamment, la mutualisation de la cuisine et autres services (HEGP, 2011).

La pratique de la logistique d'approvisionnement observée.

A. Les Achats

Notons que tous les achats hospitaliers sont gérés par la Centrale d'Achat (ACHAT- Achats Centraux Hôteliers, Alimentaires et Technologiques) de l'AP-HP. Dans une problématique de restriction budgétaire et dans le but de réaliser des économies et d'optimiser les ressources, l'AP-HP mutualise ses services achats à l'instar d'autres groupes hospitaliers qui ont créé au sein de l'Hôpital Cochin et de l'Hôpital Salpetrière deux principales plateformes uniques de distribution.

Au fait, tous les cinq ans, l'AP-HP lance un appel d'offres (marché public) pour sélectionner les meilleurs fournisseurs concernant les produits médicaux et non médicaux. Il s'agit notamment d'achats consacrés à la production des soins et ceux hors production. Les premiers regroupent les achats de médicaments et les dispositifs médicaux stériles achetés par la pharmacie. Les dispositifs médicaux non stériles (les équipements, les consommables de l'environnement immédiat du patient, les équipements et consommables biomédicaux et les équipements et consommables de biologie et médico-techniques) sont achetés par la direction des approvisionnements. Les achats hors production concernent tous les achats généraux comme l'hôtellerie, la bureautique, ainsi que des produits pour les travaux d'investissement et d'entretien et d'exploitation des bâtiments. La gestion des achats et des fournisseurs se fait grâce à la mise en place du progiciel d'information globale SAP. Désormais, lorsqu'un besoin d'achat est défini, dans un hôpital de l'AP-HP, l'information est transmise via SAP directement à la Cellule d'Achat.

B. Les approvisionnements

La gestion des stocks est une préoccupation majeure dans chaque hôpital de l'AP-HP. Il s'agit de minimiser les coûts liés au stockage en limitant la durée moyenne de stockage à 21 jours. Dans les établissements de soins, il est nécessaire de toujours disposer d'un stock de sécurité ; cela permet d'éviter des ruptures de produits qui pourraient nuire à la qualité des prestations médicales. Afin d'optimiser l'organisation physique du stockage et libérer du temps soignant, la direction de services d'approvisionnements des trois établissements hospitaliers a mis en place deux nouvelles méthodes d'approvisionnement et des mécanismes rationnels pour alimenter les sites de production. Chaque méthode d'approvisionnement est fonction de la nature des flux. Il s'agit de la méthode plein-*vide* (un système de réapprovisionnement continu) et de la méthode d'approvisionnement par *complémentation*. La première est utilisée à l'HEGP tandis que la seconde est employée à l'Hôpital Vaugirard et à l'Hôpital Corentin-Celton. La dernière répond mieux aux spécificités qui caractérisent le mode de fonctionnement des services de gérontologie d'un établissement d'une moyenne taille.

En ce qui concerne la méthode du *Plein-vide*, elle est basée sur le principe du réapprovisionnement, déclenché par le prélèvement de la dernière unité du stock de dotation. En effet, les services médicaux disposent d'armoires métalliques (casiers) équipées de compartiments à doubles bacs dans lesquels sont rangés des produits. Lorsqu'une dotation arrive à épuisement, le réapprovisionnement se déclenche automatiquement par positionnement de l'étiquette de dotation, induit par la dernière unité consommée. Un agent logistique passe dans chaque service une à trois fois par semaine, selon l'activité de l'unité de soins, pour scanner les étiquettes codes-à-barres du système. Grâce aux échanges technologiques et la maîtrise de l'approvisionnement, l'information est transférée vers la plateforme chargée de préparer les

commandes d'achat. Ensuite cette information est couplée avec le logiciel institutionnel SAP en vue d'assurer la gestion des stocks.

Une telle méthode d'approvisionnement est efficace si le stock central est à proximité, et le temps de réaction entre l'ordre de réapprovisionnement et la livraison effective de la commande est court (le seuil critique étant d'environ une heure).

Pour ce qui est de la méthode d'approvisionnement par *complémentation* (apparemment simple), elle est utilisée pour les approvisionnements en linge, consommables, etc. En effet, chaque unité de soin est dotée d'une réserve de stockage de produits, équipée de placards où sont rangés les consommables et le linge. Il s'agit de réapprovisionner ces placards, juste la quantité manquante ; autrement dit, il revient à compléter les quantités manquantes à partir d'un seuil d'alerte afin d'éviter des ruptures de stocks. Le magasinier muni d'une liste de fournitures passe dans les services une, à trois fois par semaine, après 10h, pour comptabiliser le stock restant. Ensuite, avec sa fiche complétée, il retourne au magasin pour préparer les commandes qui doivent être expédiées après 14h. Pour libérer du temps aux soignants, le personnel logistique se charge lui-même de la livraison et du rangement des produits. Afin de faciliter le travail de comptage des magasiniers, il est demandé aux agents des unités de soins de maintenir propre et rangé la réserve du service. Le processus se déroule comme l'expose le Schéma Nº 3.

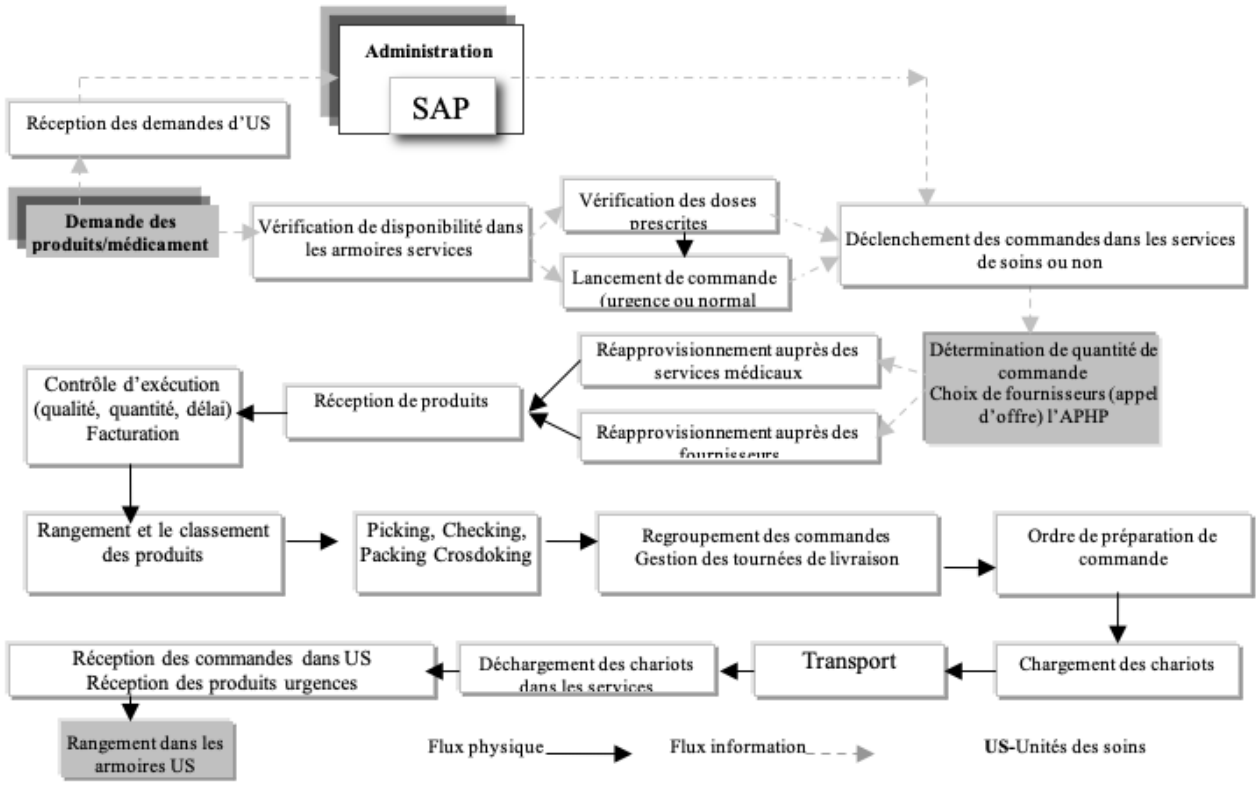

Schéma N° 3. Le processus de réapprovisionnement

La mise en place de ces méthodes d'approvisionnement a permis au service Achats et Approvisionnements d'établir une organisation efficiente de gestion des stocks (réduction des stocks à 25 jours, auparavant 35 jours). Il a été établi pour chaque article une dotation permettant le fonctionnement entre 2 périodes de livraison sans rupture de stock (sécurisation de

l'approvisionnement) et sans sur-stockage (limitation des stocks) ; ainsi les soignants ont gagné du temps pour apporter une meilleure qualité de soins.

Il est à relever que le mode de réapprovisionnement par la méthode de *Plein-vide*, telle qu'elle est appliquée actuellement à l'HEGP présente des limites. Des réflexions sont en cours pour son automatisation en vue d'améliorer sa performance. Le système de Plein-vide peut être relié à la technologie d'information telle que la RFID (identification par radiofréquence) qui permet de tracer les produits et ainsi d'éviter les éventuelles erreurs de leur acheminement. La RFID est un puissant outil de rationalisation de la gestion de stock et d'optimisation du réapprovisionnement continu par le fait qu'elle fournit l'information en temps réel ; ce qui permet – par ricochet – aux différents acteurs de la chaîne d'approvisionnement de synchroniser leurs décisions. La RFID est en plein déploiement dans les hôpitaux (CHU de Marseille, CHU de Dijon, CHU de Strasbourg, etc.).

La pratique observée de la Logistique de production.

Dans une démarche de restructuration et d'optimisation des coûts de production, la Direction du GHUPO a dû s'engager dans le processus de transformation ou de réorganisation (mutualisation) de certaines activités en les regroupant sur d'autres sites en services généraux. Il s'agit, en particulier de la pharmacie, la stérilisation, la blanchisserie, la restauration, etc.

En ce qui concerne le linge, l'HEGP et l'Hôpital Corentin-Celton ont opté pour une politique d'approvisionnement centralisée en se faisant fournir du linge propre auprès de l'usine parisienne de l'APHP. Cependant, l'Hôpital Vaugirard a fait le choix de s'approvisionner librement sur le marché, mais a décidé de confier le nettoyage des vêtements des personnes âgées à deux prestataires : la « Blanchisserie Blésoise » et la Société « Bulle de linge ».

Pour ce qui relève de la gestion cuisine, l'HEGP et l'Hôpital Corentin-Celton l'ont externalisée auprès de la Société de restauration AVENANCE (société certifiée ISO 9001). Cette dernière assure une gamme complète de repas aux malades, au personnel, aux visiteurs et aux enfants de la crèche de l'hôpital. La production et la distribution des plats sont opérées en liaison chaude et en liaison froide.

D'une manière générale, la tendance est au regroupement des activités dans le but de réduire les coûts tout en optimisant la satisfaction du patient. L'organisation logistique dans une approche globale s'avère indispensable pour mieux cerner les interfaces entre les différentes activités.

La pratique de la Logistique de distribution.

Le modèle de la logistique de distribution est fonction de la nature des besoins. Pour ce faire, il existe différentes pratiques de distribution dans les trois établissements étudiés. La plateforme commune de distribution apparaît comme un méga entrepôt où l'architecture globale des flux d'approvisionnement est structurée en mode de flux tirés (l'expression des besoins déclenchant la livraison). Cet entrepôt dispose d'un quai d'approvisionnement et d'une zone d'expédition qui permettent une gestion aisée de la régulation des flux entrants et des flux sortants.

Les pratiques de distribution interne commencent à bénéficier des innovations technologiques. Par exemple, à l'HEGP et à l'Hôpital Corentin Celton, pour les flux des matières (fournitures médicales et non médicales, linge du service des approvisionnements vers les unités des soins), il a été conçu des voies de transport spécifiques destinées aux chariots filoguidés. En effet, c'est un mode de transport automatisé lourd (ou *Automated Guided Vehicule*) géré par une entreprise privée. Le système de transport est conçu de telle manière que les chariots filoguidés (partant d'une gare d'approvisionnement) sont conduits à travers des corridors et des ascenseurs dédiés, jusqu'à une gare de réception. Au quai de réception (sortie des ascenseurs dédiés), les assistants logistiques informés (via un système de téléphone portable) réceptionnent les produits pour les stocker dans les unités de soins appropriées.

Les chariots filoguidés sont également utilisés pour distribuer les mets de la cuisine vers les patients. Les chariots sont équipés d'une partie chaude et d'une partie froide pour servir les plats chauds et froids, tout en assurant la sécurité alimentaire. Cela suppose que le matériel garantisse la conservation des plats préparés selon les règles d'hygiène strictes.

En ce qui concerne les fournitures de bureau, les courriers, les examens médicaux et dans certains cas, des produits pharmaceutiques, ils sont distribués par le système de valisettes. Ce type de distribution se fait par de mini voies ferrées conçues au plafond des corridors ; ces valisettes y sont acheminées directement vers les services concernés. Dans le cas des produits pharmaceutiques, en fonction des besoins, les produits sont acheminés par le système des AGV ou par le système de valisettes géré par le service de coursier.

L'Architecture organisationnelle de la logistique hospitalière.

Le Schéma ci-dessous (n°4), représente un modèle d'architecture organisationnelle de la ''*logistique hospitalière*''. L'ensemble des sous-systèmes organisés structure l'architecture des flux et le maillage des métiers formant ainsi une chaîne d'activités d'offre d'amont en aval le patient (client) en est le vecteur structurant.

A l'HEGP l'ensemble des activités (administratives, logistiques et de soins) est piloté par un centre régulateur des flux (informationnels et physiques) commandé par le progiciel SAP adapté aux métiers de l'hôpital.

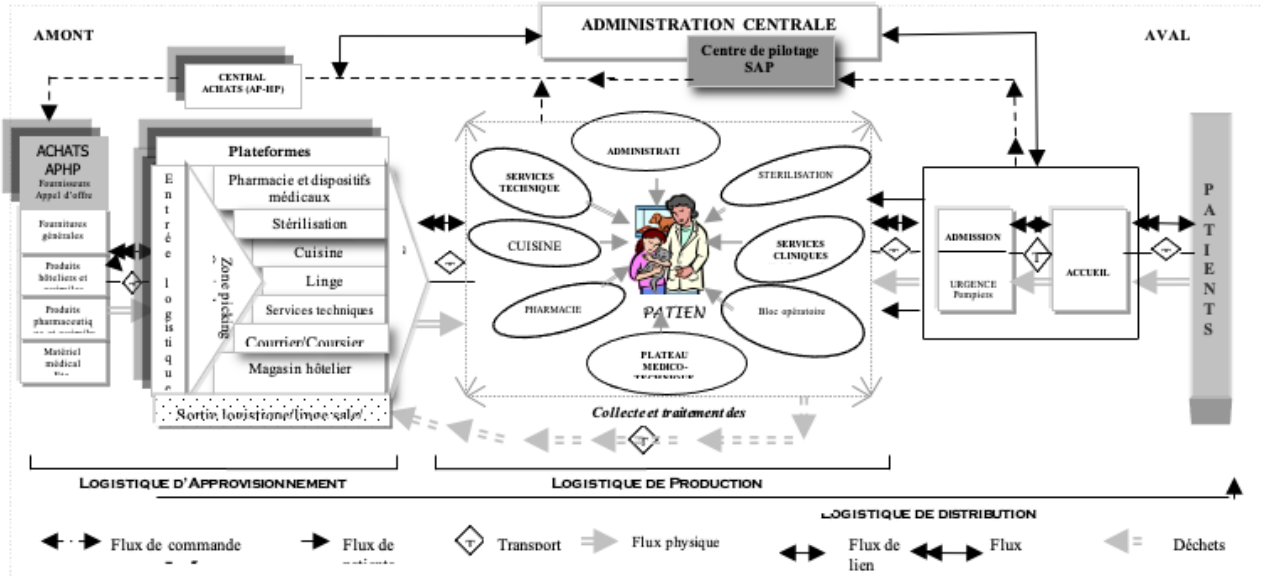

Schéma Nº 4. L'architecture organisationnelle de la logistique de l'HEGP

3. Perspectives de la logistique hospitalière

L'hôpital moderne s'inscrit dans l'ère du numérique ; ce qui lui donne une plus grande capacité à maîtriser l'organisation de ses flux en vue d'améliorer son fonctionnement global. Les TICAS constituent des vecteurs structurants de l'organisation des hôpitaux (i). Ainsi, convient-il de noter que, sous les effets des TICAS, la logistique hospitalière connaîtra des perspectives de développement autour des problématiques de coordination et d'intégration des activités concourant à l'optimisation de la satisfaction du patient (ii).

3.1 Les TICAS dans l'organisation de l'hôpital

Au regard de la complexité du système hospitalier, les TICAS constituent des outils fondamentaux permettant aux hôpitaux de mieux maîtriser leur fonctionnement et d'avoir une grande visibilité et lisibilité de l'ensemble des métiers qui structurent l'organisation des soins. Jouant un rôle de supports des fonctions logistiques, les TICAS contribuent à améliorer les activités logistiques en facilitant les échanges d'informations ou d'opérationnalisation des tâches (synchronisation des différents acteurs et des actes, échange de données informatisées, de référentiels documentaires, de codes, etc.). Ces technologies offrent un cadre plus aisé de traitement des soins et de travail pour le personnel, car elles permettent de disposer de la bonne information au bon moment pour les soins du bon patient. Les TICAS font émerger dans l'univers hospitalier, une nouvelle culture de travail. Par un partage d'informations, à l'aide de référentiels documentaires, elles facilitent le travail en commun des différents services et acteurs de la chaîne des activités tout en améliorant leur collaboration (Allab, Swyngedauw et Talandier, 2000). Il revient donc à dépasser la vision locale, segmentée délimitée par des domaines d'attributions du service d'appartenance. Elles offrent un large spectre des moyens de coordination des activités tant au niveau local qu'au niveau global tout en favorisant des pratiques de collaboration synchronisée. Une vision globale de l'organisation logistique permet d'assurer la maîtrise et la fiabilité du chaînage patient-soins et ainsi, de mieux optimiser la gestion des interfaces entre les différents métiers de l'hôpital.

Le système hospitalier relève de la complexité organisationnelle. En effet, des activités et métiers très divers organiquement regroupés nécessitent des formes doctement structurées de leur intégration et coordination afin de donner une cohérence intelligente globale au processus de satisfaction du patient. Pour ce faire, la culture de travailler (ensemble) de façon interdisciplinaire ou transdisciplinaire en réseaux s'impose dans les hôpitaux. Dans ce cadre précis, seules les TICAS permettent cette capacité structurante de la réduction de la complexité qu'implique la gestion agrégée et intégrée de toutes les fonctions opérantes de la chaîne de satisfaction des patients. Elles permettent de remodeler en permanence l'organisation de la gestion transverse des activités hospitalières synchrones et les mécanismes d'ajustement instantané des moyens de réponse aux exigences des besoins, de par leur capacité incommensurable à traiter des myriades de données et à les diffuser en temps réel. Les TICAS offrent la possibilité d'une meilleure connaissance de l'état de nombreuses variables du système de la chaîne de satisfaction du patient et, par ricochet permettent un meilleur contrôle du processus de production des soins au moindre coût, tout en renforçant les points de résilience du triptyque approvisionnement-production-distribution. Par ailleurs, étant donné leur capacité à structurer une analyse organique et à favoriser la compréhension des relations de pilotage et d'informations entre les variables et les sous-systèmes, les TICAS constituent ainsi des vecteurs structurants indispensables à l'organisation rationnelle des activités de l'hôpital.

3.2 Les problématiques d'intégration et de coordination des activités hospitalières

À l'instar du secteur industriel, l'organisation hospitalière s'insère dans une démarche de maîtrise de son cycle d'exploitation (approvisionnement, production, distribution). Or, la maîtrise du cycle d'exploitation suppose la maîtrise des flux et du temps. Mais, comment maîtriser les flux dans un système très complexe, comme le système hospitalier ? Le développement de la logistique hospitalière dépend de cette première équation. La deuxième équation a trait à la maîtrise du temps en procédant à de meilleures gestions des interfaces de trois segments de cycle qui composent le cycle d'exploitation. Autrement dit, il revient à structurer une démarche d'optimisation de la coordination et d'intégration de l'ensemble des activités et des fonctions opérantes permettant de prodiguer de meilleurs soins aux patients sous des contraintes budgétaires. Comment peut-on coordonner efficacement de nombreux métiers très hétérogènes tout en assurant la sécurité des patients et des personnels tout au long de la chaîne d'offre de soins ? C'est la troisième équation. La formulation d'une logistique hospitalière performante doit

prendre en compte cette complexité des processus. Le Schéma Nº 5 (ci-dessous), représente un modèle général de coordination et d'intégration globale (Chitou, 2013, p. 181).

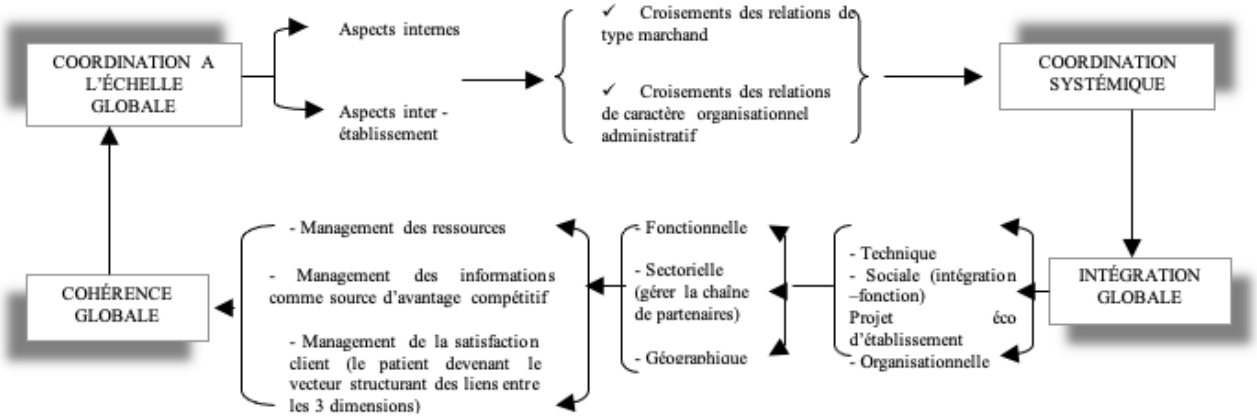

Schéma Nº 4. Processus de coordination et d'intégration globale

La coordination des activités opérantes et structurantes doit se faire au niveau global, dans une approche d'intégration totale. Celle-ci permet de réduire les tâches improductives, sans valeur pour le patient, tout en assurant la cohérence entière du système hospitalier. Les TICAS maîtrisées offrent de nombreuses perspectives de développement de la logistique hospitalière. Mais, elles n'auront de véritable sens que si le patient reste l'essentiel vecteur structurant du fonctionnement de l'hôpital.

Le GHUPO s'inscrit dans cette dimension organisationnelle de la logistique hospitalière. Cependant, il doit d'abord s'affranchir de nombreuses difficultés pour espérer structurer une logistique hospitalière performante. Le GHUPO a encore fort à faire pour optimiser ses flux. L'investissement rationnel dans l'automatisation des activités logistiques et des progiciels hautement intégrés est nécessaire pour y parvenir.

Conclusion

L'hôpital est un système organisationnel très complexe (grande hétérogénéité des métiers et activités). Il se transforme progressivement sous l'effet de l'évolution et des exigences de l'environnement socioéconomique et technologique. Pour répondre efficacement à la demande des soins, les hôpitaux ont besoin d'une excellente organisation. Par ailleurs, nous considérons que progressivement les établissements de soins doivent sortir de la culture de traitement segmenté des activités et s'insérer dans une démarche de gestion globale, de coordination et d'intégration de toutes les activités logistiques. Il s'agit de structurer une organisation maîtrisée par un pilotage rationnel des flux informationnels et physiques, très divers et parfois incompatibles. Une telle démarche permettra d'optimiser la satisfaction des patients en diminuant les délais d'attente, de prodiguer des soins au moindre coût, d'assurer une meilleure qualité sans négliger la sécurité des patients et du personnel.

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