Department of Business and Management

Chair of Management of Innovation

GiPSTech and the competition over Indoor Positioning technology. Empirical evidence of the importance of a strong innovation ecosystem behind the emergence of a Dominant Design

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A mio nonno Angelo, prezioso maestro di vita, perseveranza e dedizione

Perché oggi sarebbe contento…

Contents

Introduction

The main objective of this study is to clarify how innovation ecosystems could influence the selection of a dominant design among several technological solutions. Recent management researches have particularly focused the attention on innovation ecosystems considered as the entire network of highly interconnected players, which cooperate with the focal firm in order to deploy a final technological innovation (Adner, Kapoor, 2010; Iansiti, Levien, 2004; Moore, 1996). However, even if these studies highlight some variables that a firm should take in consideration in order to properly deliver its own technological solution, they showed just one side of the innovation ecosystem coin. In fact, innovation ecosystem is a two-sided coin, where on one side we should consider innovation ecosystem as a firm-specific asset, on the other side it should be analyzed as a set of exogenous variables that interact with the innovative process from an external environment (Hwang, Horowitt, 2012).

Given that, we know that during technological cycles the emergence of a dominant design could be recognized only ex-post. Anyway what this study wants to demonstrate is that if we analyze the industry evolution by using the ecosystem's lens we can plot several sceneries that could be useful to understand how different technological solutions are approaching the selection moment within a given industry. Several prior studies analyzed what a dominant design is and its emergence moment. According to Tushman and Anderson (1990) dominant designs are innovations, which show the best technological compromises in terms of different functional characteristics. This is different from simply saying that dominant designs are the best technologies available in the innovative landscape.

In addition, an innovation turns out to be dominant just after a while and during this timespan several competitive factors interact with each other boosting the technology standardization. We can find a huge literature analyzing dominant designs and technological competition, however less attention has been dedicated to understanding the crucial role that innovation ecosystems play in selecting the dominant technology.

As we briefly stated before ecosystems are two-sided variables. On the first side we can imagine them as highly technological hubs where innovative processes constantly reinforce themselves. To make a quick comparison, it could be helpful to think about Paris at the beginning of '900. The French capital used to be the most active cultural and artistic hub in Europe, and this was due the fact that there was an underlying self-reinforcing virtuous cycle where a huge number of artists generated a highly efficient network of surrounding players, who started to orbit the artistic system. Artists, dealers and buyers were so strictly interconnected to each other that Paris received the attention of other foreign artists and buyers, whose the first started to move to Paris, while the second generated an European artistic marketplace, which consequently enhanced the quality of artistic works realized.

This ecosystem perspective is vital when talking about innovation because unfortunately the boosting qualities of innovation ecosystems are concentrated just in few areas owing to several boundaries like geographic distance, cultural differences, and lack of trust and confidentiality. Innovation means changes in already established technological paradigms, and these changes require a strong cooperation between players operating in efficient ecosystems. These players should align and commit to reach the same innovative results, because when a new technology is launched, to be selected as dominant design it is not sufficient that it is a potentially disruptive innovation or that the firm is located in the Silicon Valley. Sometimes for a technology to take off is necessary that the focal firm builds up a strong firm-specific ecosystem. The role played by the focal firm is crucial because it has to coordinate all the efforts of other interconnected players and innovators, which should align and commit to reach the same results (Adner, 2012; Autio & Thomas, 2014).

It has already been analyzed by prior studies that there is a direct linkage between the end of technological uncertainties and the emergence of dominant designs (Utterback and Abernathy, 1975; Anderson and Tushman, 1990) and industry standards (Cusumano, Mylonadis, and Rosenbloom, 1992). In relation to those studies we can assess that efficient ecosystems have the power to solve out a technological uncertainty because it will facilitate the installation of collaborative networks, trusty relationships and strategic interconnections, with a consequent alignment of suppliers and complementors toward the success of the same ecosystem strategy.

It is important to analyze the ecosystem variable because it is a variable that could be actively shaped by the firm while launching a new technology. In fact firms can strategically assemble their own firm-specific ecosystems and even if they cannot influence the external ecosystem variable, at least they can search the optimal ecosystem for their technology to emerge and consequently move there. The according point with previous studies is that, once a dominant design has emerged, it modifies the whole competitive landscape and it will keep on existing until a new discontinuity will manifest itself (Suarez, Utterback, 1995). From this point of view, the fact that the dominance could be spotted out only in retrospect represents a threat for managers because they risk to understand how the market is being shaped when it is too late to adjust the competitive strategy (Anderson, Tushman, 1990).

Given that it is crucial that especially during the fluid stage of rising industries innovation strategies take into account the ecosystem factor, which, as we want to demonstrate later, actively contributes in pushing a technology towards the dominance.

The study begins with a deep analysis of the literature related to technological competition and to innovation ecosystems. In fact, it was important to identify the points of the technological competition, which could actively be influenced and modified by innovation ecosystems. The first step was to understand how innovative processes related to different technologies and satisfying the same need, draw technological trajectories on a given technological paradigm. According to G.Dosi a technological paradigm is "*a model and a pattern of solution of selected technological problems, based on selected principles derived from natural sources and on selected material technologies"(Dosi G, Technological Paradigms, page 152).* Indeed technological trajectories are patterns generated by a normal problem solving activity moving inside a given technological paradigm (Dosi G, 1982). When a technological discontinuity opens a new industry, almost automatically a new technological paradigm is set up by highlighting the most important trade-off variables on which firms develop their technological solutions. However, a technological paradigm does not manifest itself just because the innovative process take place; indeed it is also triggered by multiple economic, social and institutional factors, which are able to create a technological discontinuity (Schumpeter, Perez, 1996). This discontinuity represents the birth of a new industry. Generally, everything starts with a radical invention (Jovanovic, MacDonald, 1994), which is the opportunity for a new technological paradigm to be set up.

Be that as it may, the technological paradigm theory does not provide any detail about which technology is going to be the dominant one. In fact, on Dosi's chart we can see different trajectories, which represent the problem solving activity performed by alternative firms to create a new technological solution; however it is impossible to identify the technology that is the closest one to reaching the technological dominance. The new suggested model includes a third variable (market performance) that consider the influence of the ecosystem efficiency while developing a technological solution. Given that, the revised chart is a 3D technological paradigm graph, which gives birth to different plans on which technological trajectories move and which are located at different levels. The higher the plan is, the closer it is to technological dominance. This point of view is important to constantly monitor what happens after.

According to Abernathy and Utterback (1975) when a new industry is created, it is characterized by a fluid phase where firms tend to enter the industry until expected profits are driven to zero. At a certain point, approaching the transitional phase, the dominant design completely manifest itself and it will generate a general shake-out within the industry. Innovation ecosystems directly interact with the industry lifecycle because, as we want to demonstrate, when an ecosystem is efficient the fluid phase lasts less than it otherwise would last. The direct consequence of it is that technologies when propelled by efficient ecosystems turn out to be dominant sooner.

Then, would be notable to analyze the relationship between the entry timing and the probability of technological lock-out. The relationship is represented by U-shaped curve, which aims at evidencing how the best moment to launch a new technology is in the middle between being to early and too late (Schilling, 2002). In fact, first movers do not always gain a first-mover advantage that helps them in imposing a technological standard. As we will see, timing is a crucial variable that a firm has to understand *a priori* if it wants to force other players to switch to its technology (Tegarden, 199).

The right "time to market" generally coincides with the full emergence of complementary technologies and customer needs (Choi & Thum, 1998; Christensen, 1998; Regibeau & Rockett, 1996). However, several case studies have demonstrated that even if a firm is late in launching its technology, it could succeed in reaching the status of dominant design. These case studies (e.g. Apple iPod) support the evidence that if a technology rises in an efficient ecosystem and if the solution is valuable, it could disrupt all the fortresses previously built by competitors. Thus, a late entrant if boosted by the right ecosystem, will be able to impose its technology as the dominant one.

Finally, we will introduce a modified version of the adoption cycle model proposed by Rogers because it is prominent to support our analysis over the importance of efficient innovation ecosystems. As it is going to be presented later, the adoption cycle will be accelerated or delayed considering the ecosystem efficiency. When the underlying ecosystem is efficient the elapsing time between the innovators' adoption and the early majority one lasts less than in the generic model, while if it is no efficient the necessary time for a technology to be adopted will last ages, with the direct consequence that the technology is unlikely to be the new dominant design.

The entire model is strictly connected to the concept of breakthrough innovations, discontinuities and market standards. In fact, after the recognition of a new technological paradigm and the beginning of competition among alternative technologies, the strife is all about triggering the adoption cycle model. In fact, in order to reach the technological dominance, it is necessary to efficiently activate the adoption cycle process before the competitors. (Rogers 1950)

The importance of modifying widely accepted theories with the inclusion of a fundamental variable like the innovation ecosystem one, relies on the possibility for managers to influence the dominant design selection by shaping their strategies after considering the new variable we added.

The methodology that has been followed to confirm our assumptions is centered on a real business case and on several recorded interviews. The business takes in consideration the indoor localization industry. This new industry recently arose because of the need for individuals to find their position inside closed spaces. The need is directly connected to the outdoor positioning one, which is addressed by the GPS localization system. However GPS signals are not sufficiently strong to provide an acceptable solution when the user is inside a building. Starting from this overview, the industry is in a fluid phase where, as we previously studied, several technologies are being proposed to address the need. At this stage there are three main technologies that are competing to obtain the recognition as dominant design: Wi-Fi, Beacons and Magnetic Positioning. In chapter 3 it will be proposed a deep analysis of how the technologies work, what their strengths and weaknesses are, and why magnetic positioning is potentially the best solution to solve the problem.

Our business case examines an Italian start-up, which provides a geomagnetic indoor positioning solution: GiPSTech. We already stated that for a given technology is not sufficient to be the best technological solution to automatically be selected as the dominant one, and this is what is happening within the indoor positioning industry. As a matter of facts, even if magnetic positioning is the best performing solution it risks to be overcome by Wi-Fi and Beacons that, albeit they are worse performing because they were not born to address indoor positioning needs, however they are widely accepted and utilized all over the world.

Starting from this business case, we wanted to analyze how different innovation ecosystems are supporting the three alternative technologies and what at GiPSTech they are doing to set up an effective strategy to offset the Italian ecosystem delay. Especially for the second part of the analysis it was necessary to interview GiPSTech members in order to collect their opinions about the ecosystem, their industry and how the first one is influencing the second one. In order to collect the right information that we will explain later, the interviews were semi-guided because they followed a general path of formerly prepared questions, which, nevertheless, allowed the interviewees to openly answer by explaining their vision and their opinion.

Finally we will highlight limitations and we will indicate directions for further researches and insights.

CHAPTER I

Technological Competition

This chapter will be helpful to understand following sceneries because we are going to analyze all prior studies related to innovation cycles, industry births, and technology adoption by end-customers.

1. Technological Innovation

Technological innovation has always been the fuel of our economy. It is a process strictly connected with the economic performances of all entities, from the small sprouting start-ups to much bigger institutions like national states. Even if we have to accept that the innovative process is a risky variable in terms of future outputs and that could be judged only ex-post. However, we must say that innovative processes generate a huge diversity of technological solutions, which allows us to switch from one economic cycle to the next one. In fact, innovation comes in waves, that we call cycles, and spread itself within multiple sectors. An innovative society, an innovative ecosystem should be able to recognize the new wave coming and to be ready to ride it at the right time. This is what cyclically happens in the Silicon Valley. Even if many countries constantly try to replicate its formula, it is pretty evident the difficulty in creating such a fertile ecosystem for new innovations and for new technological paradigm to accommodate.

What is really peculiar in the Palo Alto's economy is its ability to reinvent itself every time the potential exploitation of a given technology reaches its end. There is a never-ending emergence of technological paradigms that allows new start-ups to born and to boost the economy. This is possible not just through the exploitation of the Schumpeterian creative destruction, able to open the doors to new cutting edge paradigms, but instead especially

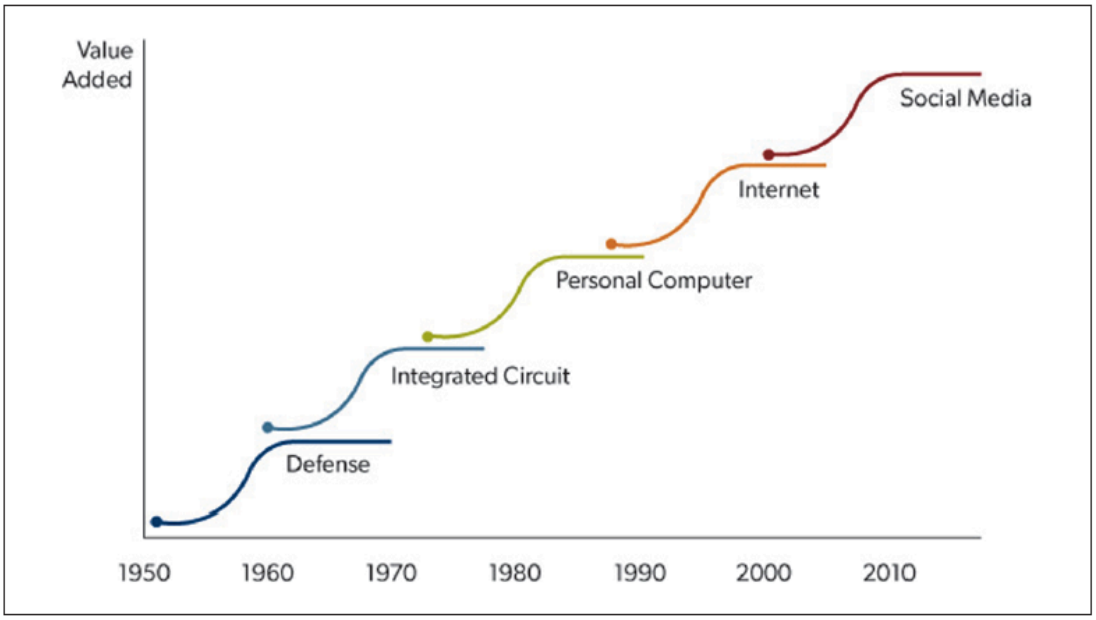


Figure 1 Evolution of Silicon Valley 1950-2010. Source: Silicon Valley Edge

through a *recycling creation*, which allows the exploitation of those technologies, knowledge and institutional transformations developed in previous innovative generations.

But let us start with a definition of what technological paradigm and technological trajectories are. We know that a technological paradigm should be perceived as "*a model and a pattern of solution of selected technological problems, based on selected principles derived from natural sources and on selected material technologies"(Dosi G, Technological Paradigms, page 152).* Consequently a technological trajectory should be viewed as the pattern generated by a normal problem solving activity moving inside a given technological paradigm (Dosi G, 1982).

On the axes we can find two main variables that innovators identify as key variables to pursue technical progress. Normally those variables are the result of a trade-off between features that normally do not appear together. For example, considering the emergence of the tablet markets, the trade-off would be among performances and portability. The greatest performance is offered by what we call “laptop”, the greatest portability is offered by mobile phones. Tablets’ producers move on the ground of the technological paradigm they have spotted out, trying to improve its trade-off and to offer a better technological solution to the market.

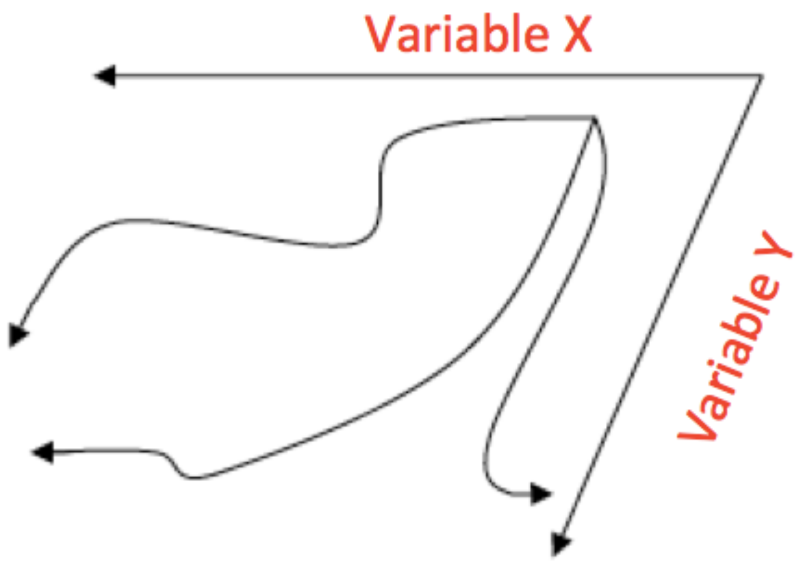


Figure 2 Technological Paradigm and Technological Trajectories

However, a technological paradigm is not just the result of the innovative process, there are several economic social and institutional forces to be taken into account and which make a battle the passage from a paradigm to a newer one (Schumpeter, Perez 1996).

We can almost define the Silicon Valley as proteian, considering that the nowadays-mythological valley is an eco-societal system flexible and adaptable to any institutional change and to any market force. It is the right place to see new paradigms emerging. Perez explain the direction towards a system should structurally change in order to completely absorb an upcoming innovation:

The socio-institutional framework must change to accommodate transformations in the technoeconomicsphere, and is what enables the full deployment of the technological revolution; the economic and non-economic activities become congruent. (Perez, 2002: 17–19)

This is why we should include into the analysis four phases driving the technological paradigm to the overall acceptance (Perez, 2002):

- **Irruption:** This is the moment where a new technology enters the competitive arena. Generally these innovations are technology-push and they strive to emerge among substitutive solutions. Behind this basic innovation it is possible to identify the power of capital, fueling this seed stage. Typically the necessary investments come from the three F (Family, Friend and Fools), Venture Capitalists and Business Angels, and they play a vital role during the development phases of each technology. The technological paradigm is set up.

- **Frenzy:** The new technological paradigm is now surrounded by a well-defined infrastructure and several technologies start competing on its ground. However, something is still not ready for the paradigm to boost. In fact, there are structural tensions that are it is necessary to overcome providing the right solutions in order to avoid any recession and to reach the turning-point where the market modifies its regulations. After that, the paradigm is ready to be fully deployed.

- **Synergy:** The technological innovation at this stage is typically demand-pull. The market has completely accepted the innovation and it is now asking for improvements of it.

- **Maturity:** This is the last phase of every paradigm. Normally we can recognize it through the observation of a decline in the investing activity and in the market demand. After reaching the predominance in the economy and after deploying its full productivity, it is now ready to leave the stage to the approaching emergent one.

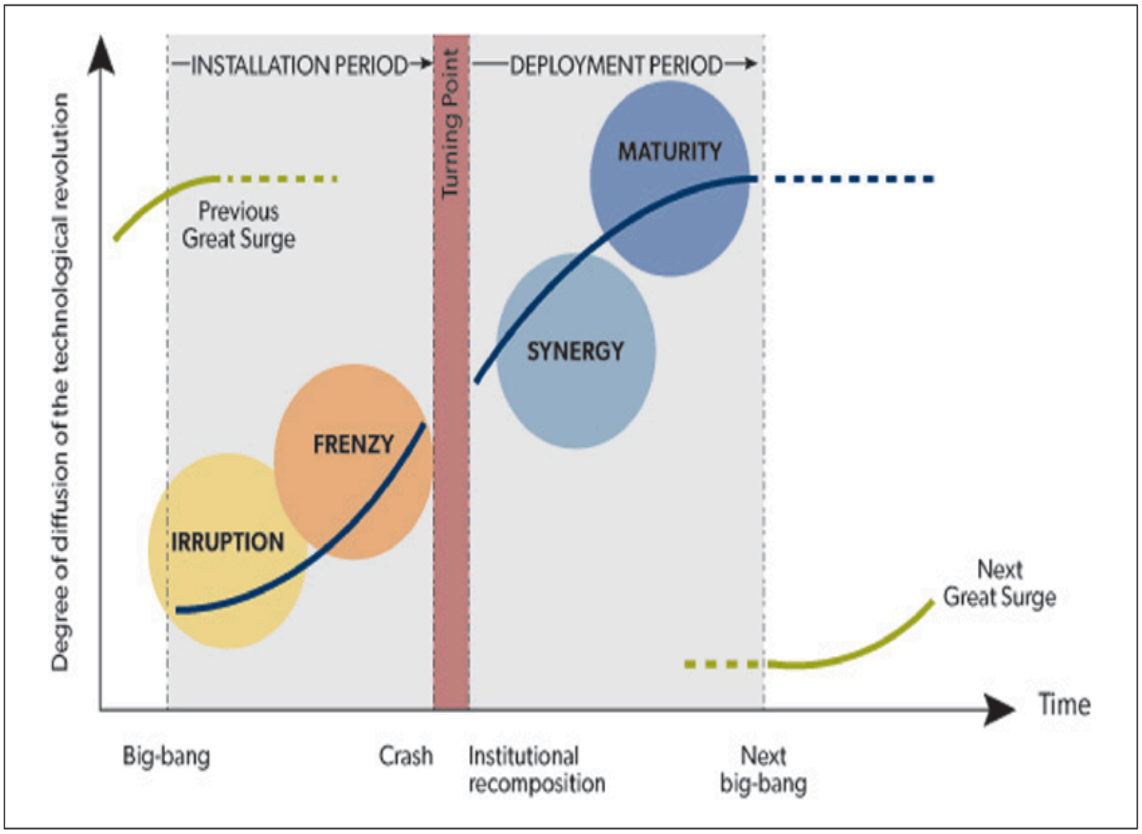


Figure 3 Techno-Economic paradigm: phases of development. Source: Technological Evolutions and Financial Capital

At this point it is good to start reporting the analysis performed by Tushman and Anderson in late 1986. They presented a multi-sectorial study highlighting that the irruption phase is generated from scratch from an innovation that we call disruptive or breakthrough. Those innovations that open a discrepancy in the normal lifecycle of a technological paradigm are labeled as “competence-destroying” by Tushman and Anderson (Tushman, Anderson 1986) because of their ability to make all previous competencies crash down in favor of new ones. The opposite competencies, just to cite them, are identified as "competence enhancing" because of their brick structure: the newer skills fit together on other bricks. We can associate technological competition to the process of natural selection: surviving players competing in an industry are usually those best fitted not to resist to environmental changes but instead to adapt to unexpected shocks, developing the right features and the basic skills to survive.

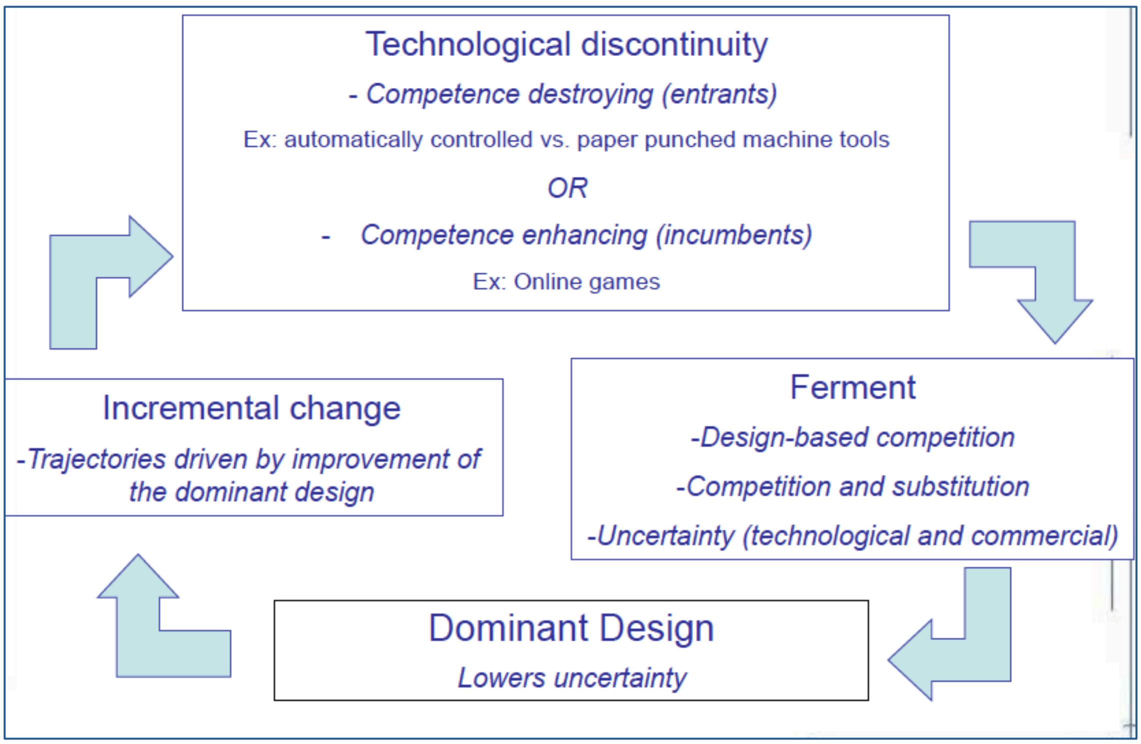


Figure 4 Industry Life Cycle. Adapted from Tushman & Anderson. Source: Management of Innovation University Materials

Considering what population ecologists state, we can basically distinguish between two kinds of players (Utterback, Suàrez, 1991): specialists and generalists. Generalists normally are selected out in stable environments where technological competition is not that heavy and industries are "firm specific". In this case, specialists overcome generalist competitors because they have the possibility to focus their strategy on a well-identified dominant technology and to build their competitive advantage on it. On the other side, in volatile environments, generalists have a greater possibility to survive because they can exploit their adaption capabilities selecting out inerter organizations, which struggle to be flexible.

When a new cycle open we usually find these breakthrough innovations that are worse-performing if compared to the sustaining ones. In fact the former, generally technology-push, introduce in the state of art of the technology a set of features quite different from those historically appreciated by customers. They open a new direction in technology, a new technological paradigm, considered as a discontinuity in the trajectory of progress (Dosi, 1982). As a consequence, customers do not find those dimensions that they used to evaluate and to open their wallet for. In other words, they underestimate the new upcoming technology because they cannot understand that they should judge it from another point of view, from a new technological paradigm. The latter, on the other side, keep on improving their performance satisfying in a better way their customers' needs. This kind of innovation is often demand-pull. It is the market that asks for them and customers appreciate them because they evaluate those performance dimensions as they have always done. But if a customer does not incur in financial losses for being a laggard instead of an early adopter, several time in history it happened that leading companies decided to close their eyes and to stay blind in front of new technologies changing the technological paradigms and consequently the market. This is due to the fact that managers instead of reading the market oscillation through a technology-push lens they prefer to stay close to their customer based, because they feel the risk of loosing it in case the new technology is not going to be accepted.

In addition disruptive technologies, when rising, look particularly unappealing to established companies, because of the technological and commercial uncertainty. This is why this kind of innovations are generally led by those entities that we call start-ups. They do not suffer any kind of incumbent inertia and they know the value of the technology they are handling. Big players however, if not blind, keep always an eye on what is going on in the market, they leave startups struggling to validate a technology and if the results achieved are good they intervene acquiring the startup and generating in the majority of cases a win-win solution. Startuppers are happy because they can sell their company for a great amount of money and they keep on working for it, if they want. Prior investors are satisfied because they receive a payback for the early-stage investment they have made to foster the technology. Big companies are proud for the acquisition because they avoided any early risky investment and they now own the knowledge of a cutting edge technology.

But, going back to the managers' decision moment. Let us say that a manager has two possibilities. The first is to go upmarket. It means investing in a sustaining technology being sure that the result will be appreciated as much as the previous version of the technology. They try to compete in the same market as they used to do before trying to increase their margins battling in terms of prices and value added. The second chance is to go downmarket. This decision will imply the acceptance of consistently lower profit margins in favor of a possible future dominance thanks to the disruptive technology they are going to introduce. The first choice shows them an objective and concretely measurable value, the second one an expected value on which is going to insist a dangerous variable: uncertainty.

Now, given that managers are evaluated on their results, they prefer to keep on serving their historic customer base, thinking that if customers are satisfied they have met their goals. Many researches show that well-managed companies, which usually lead their industries in terms of innovation, are particularly good in developing new technologies to address their market's needs. On the contrary, hardly ever we can find the same big corporations at the forefront pushing on the market those technology that at the beginning of their lifecycle can satisfy only a small share of the market, or whose the direct market is still emerging and not that appealing to justify their investment.

However, new disruptive technologies are particularly tricky to identify. In fact, if on one side they have features that, at least at the beginning, do not match any need of the original customer base, on the other hand the set of key performance indicators improve with a sharp rate that they overcome the performance of the sustaining technology. At this point our radical innovation is ready to conquer the established market, which at least at the beginning used to ignore it (Bower L, Christensen C, 1995).

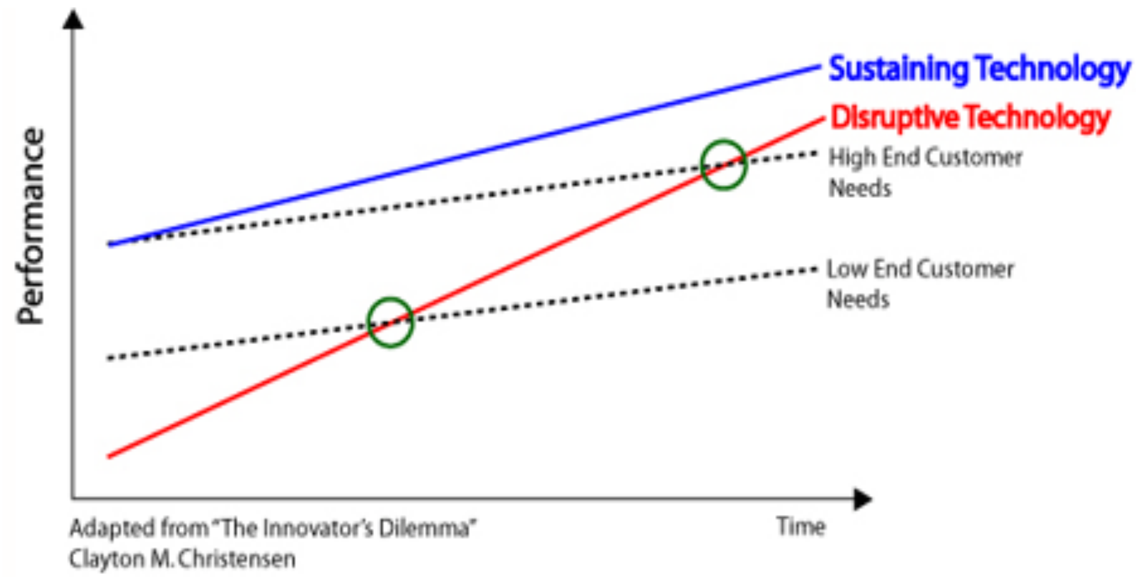


Figure 5 Disruptive Technologies. Source: http://www.copyblogger.com/how-bloggers-profit-from-niche-media-disruption/

Taking a look at the graph is pretty evident the path followed by a disruptive technology. At the beginning its performances are quite low, while as time goes by its performances ridiculously improve ending up ahead of the sustaining technology. This is what exactly happened with Kodak and the digital photography. Kodak, paradoxically invented the digital photography, but considering that the performances offered by this technology used to be very low if compared to the film based one, Kodak decided to stick with the prior technology. It stayed blind in front of those technology fanatics claiming for the digital revolution even if the trade-off was to accept lower performances, at least at the beginning; Managers opted to keep on satisfying its original customer base, preferring to pursue a demand-pull strategy instead of a technology-push one, when the second one was required. Everybody knows the end of the story.

In fact the risk for the established players, often big corporations, is to open their eyes to late. What happens on a constant base is that pioneers already dominate the new market protected by well-structured barriers to entry (patents, copyrights, loyal customer base, suppliers etc.) and without leaving any operating space for new entrants to compete. But not competing in the new market is not the only threat for big corporations; it usually happens that once a new paradigm is set and a new technology has started its development path, it aims at cannibalizing the established market because of its financial appeal. Foster (The attacker advantage, 1986) assess that attackers, who launch new technologies in the market, have the possibility to leverage their competitive advantage, while incumbents are challenged to offset it as soon as they can. At this point, incumbents generally are forced to accept to fight entering the competitive arena naked and unarmed. In fact established players do not know the competitive soil given that they

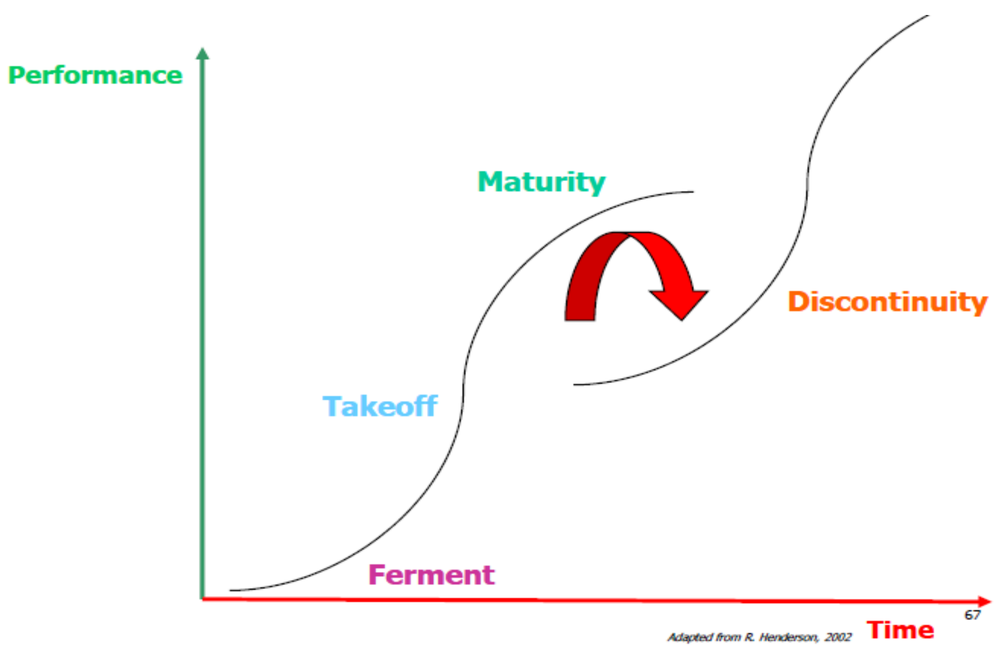


Figure 6 Industry Lifecycle as an S-Curve. Source: http://innovajourney.blogspot.it/2012/05/s-curve.html

have been going upmarket staying unable to acquire the new paradigm's capabilities and ignoring the rampant threat represented by those players coming from a downmarket.

But let us analyze what comes next, during the ferment period. Abernathy and Utterback, showed us what cyclically happens into an industry flourishing from scratch. Let us assume that a new industry is born after a technological discontinuity is verified, then we can observe a period of high turbulence affecting the industrial demography and a period of intense competition based on the concept of product innovation. From a closer point of view it happens that, when a new technological need emerges, and a new possible technological paradigm is set (Khun, Dosi, 1882) several new firms enter the industry and try to overcome each other offering differing alternatives on the market.

This process of gross entry involve the participation of small firms, typically start-ups characterized by high flexibility to continuously changing competitive environment, non-innovative big players which struggle against their myopia to survive and highly innovative big corporations operating in proximal industries which spotted out an opportunity to compete in the emerging market and to expand into it developing their own strategy. These last ones confirm the rule saying that firms, which innovate in time t, are likely to innovate in time t+1 too (Malerba). Non-innovative enterprises on the other side could undertake two different strategies in order to avoid obsolescence and to survive: to acquire an existing player or to follow the first mover. In the first case entrants acquire an already existing incumbent, which has developed specific skills to compete in the rising market, while in the second one they behave as a follower, monitoring what goes on in the market and than decide whether a diversification from their core business is a viable alternative or not. Of course in this last option the main risk is to miss the time to market and to be locked-out. Due to following industries' dynamics some firms decline and exit the industry while others grow dominating the market. Normally this period of high turbulence and fluidity lasts more or less five years.

After this timespan where a large number of entrants exit the industry because of failings, acquisitions, mergers or simply because of technological inferiority, it could be highlighted that surviving firms are the ones with a higher initial size or a higher initial growth rate (Dunne et al. 1988, Baldwin and Gorecki, 1991; Acs and Audretsch, 1991, 1992). However, turbulence is not a stand alone variable. On the contrary it shows us a negative correlation with variables like the rate of innovation and a positive one with others like concentration (Acs and Audretsch 1991). In fact, on one side high rates of innovation could not be associated to an entry barrier for new small firms, instead we can see this innovativeness as a sort of fertilizer for potential entrants. To support this opinion it should be noticed that in certain industries characterized by continuous changes and innovations, a great percentage of total innovative activities is small firm driven, then there is no place for long-term competitive advantage. Firms feel the right to enter the market promoting their technological solution and the industry presents higher than normal birth rates. On the other side, concentration seems deterring small firms from entry but it is ineffective against the entrance of big corporations.

But let us study the model proposed by Abernathy and Utterback from a closer point of view.

The model proposed by Abernathy and Utterback represents one of the most effective tools to understand the way the innovation process works. It is a theory that, if well studied and completely understood, could help firms in studying their industries and to assess if it is the right time to invest in developing the technology that best fits the market demands. They developed a dynamic model where given a life cycle of an industry it is possible to distinguish an alternation of two main innovations in terms of predominance: product innovation and process innovation. The model breaks down the industry life cycle in three stages (fluid, transitional and specific), which differ the ones from the others because of the different attention and investments firms put on the two typologies of innovation. But first things first, let us present the three phases.

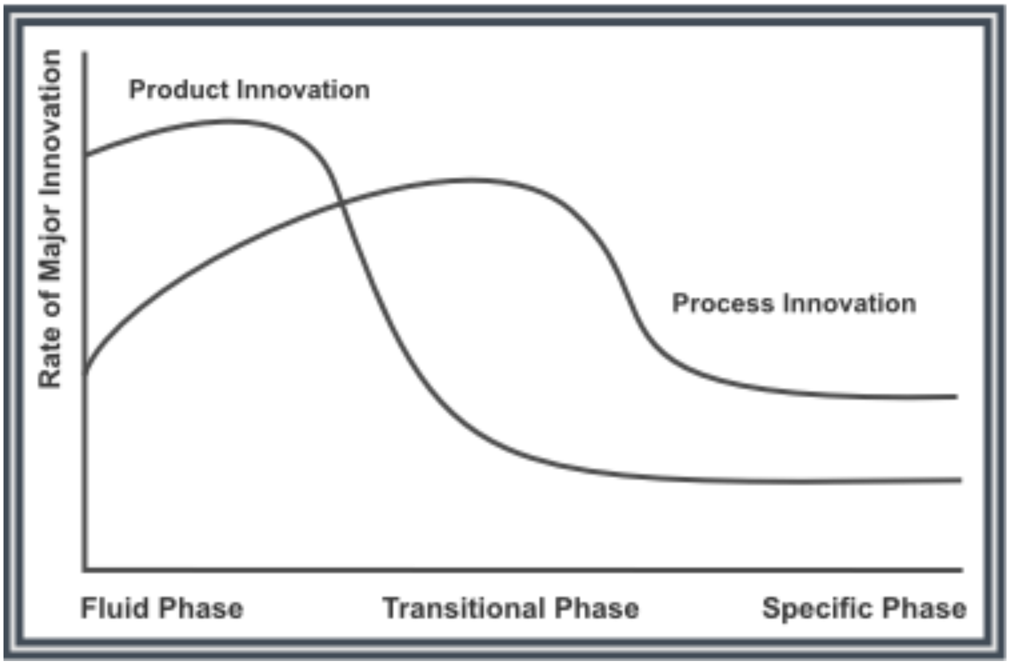


Figure 7 Product & Process Innovation Within an Industry. Source: http://www.alliance-capability.com/theories/utterback-abernathy-model/

- Fluid stage: Normally this stage represents the beginning of an industry. Starting with the radical invention theory (Jovanovic, MacDonald, 1994), when a new industry is created by a major invention, firms tend to enter the industry until expected profits are driven to zero. The entire engine is powered by a radical innovation that generates a product innovation out-flow. Competing firms invest in product R&D because these investments outweighs the benefits of process R&D (Klepper 1996,1997,2002) and they try to test a wide range of potential technological solutions satisfying the same need.

  This innovation process represents the competitive arena where several firms invest their resources to exploit better than others technological and market opportunities. In some cases product innovation is research-push, it means that we can find a linear process beginning with a scientific discovery and ending with the marketing of the new innovation. In other cases it is demand-pull, it means that behind the innovation there are users' needs asking to be satisfied (Rothwell, 1992). Rothwell also demonstrated that the importance of the research-push and demand-pull phases may increase and decrease over time considering the different phases of the innovation process.

After this short description of the innovation typologies we can move backward to the analysis of the competition in the fluid stage. This early competitive arena is characterized by an intense turbulence, given that entry, exit, and variations in market share are activities that happen on a daily basis (Beesley and Hamilton, 1984; Acs and Audretsch,1990, 1992). Entry barriers are generally ineffective while R&D and capital requirements are not a pillar to build on any competitive advantage. Competitive landscape equalizes the entire set of competitors. Therefore, gross entry, even that much higher than the final net entry, is a rampant phenomenon. Even industries with high barriers to entry (highly capital intensive) presented to previous researches impressive birth rates and consequently high mortality rates. But glancing at who the majority of entrants are, in addition to big players operating in other markets and interested in undertaking a diversification strategy from their core one, it is easy to list an enormous quantity of new and small firms, typically start-ups far away from any measure of efficiency. In the fluid stage firms enter the industry with the introduction of new products, while the market is flux and uncertain. In fact it is not really clear which technological solution will win favor in the market. Competing designs differ in terms of functional attributes and they keep on being modified with subsequent performance-maximizing product innovations in order to match customers' needs. The industrial activity is generally set in small-scale early plants while competition at this stage is centered on product performances.

Thus, in order to satisfy every single needs of the customer, customization is pretty frequent in the productive activity and production is inefficient because of the lack of the possibility to implement economies of scale.

- Transitional stage: In this later stage of the evolution, the industry stabilizes around a dominant design, which emerges because of the increasing demand for the product (Clark, 1985). The dominant design selected by the market or by a technological path-dependence (e.g. QWERTY case) may not be the best one but, as Abernathy and Utterback taught to many scholars and innovators, the emergence of a dominant design is a must happen event, it represents the keystone for the industry evolution.

  In fact, once it has emerged firms start competing in a different way adhering to it and shifting innovation from a pure product features competition to an always increasing process one, focused on high volumes, sales maximization and ability to lower production costs thanks to economies of scale. Thus we can state that the emergence of such a design allows firms to manufacture in greater batches, locking in the creation of future products and shifting their production towards the efficiency goal. In fact this step establishes the beginning of a stream of process innovations giving rise to an increasing inflexibility on the production side due to a lower customization in favor of a higher standardization. The industrial activity is centered in increasingly large-scale plants with more and more specialized equipment (Malerba, Orsenigo, 1996). Industrial concentration increases, while the entry rate diminishes drastically because of strategic entry barriers. The natural selection process starts to eliminate existing producers, which have not converged rapidly on the dominant design.

  Generally, dominant designs could be recognized only ex-post because of several factors that take places during its emergence, but it is extremely important because in the following stage it triggers a necessary shakeout that push out of the industry inefficient competitors.

- Specific stage: The final phase of industry maturity normally shows us firms focusing on incremental process innovations with the objective of cutting costs and boosting sales. We are in front of a highly concentrated industry, where competitors offer similar products and customers choose basing their preferences essentially on prices. The production side is extremely specialized and it does not allow any customization because the investments in process R&D overtake those from additional investments in product R&D. At this stage normally it is easy to recognize a shakeout in the industry that triggers many exits. After that, only few firms are left and they start merging and acquiring the ones the others. The specific stage represents the last period of an industry and it means that the industry is ready to start a new cycle after a new discontinuity appears.

2. Technology adoption process toward the selection of a dominant design

Now we try to understand what happens in the fluid phase of an industry from a different point of view, where multiple technologies addressing the same needs begin to sprout. Let us start with a basic case where just two technological solutions are available for adoption. On one side we have competitors that have developed the alternatives, and they have a deep knowledge of their own technologies; on the other side we have different players like possible partners, consumers, suppliers, distributors etc. They have to decide on which technology they should bet and consequently concentrate their efforts toward the imposition as a dominant design of the technology they have chosen. The prevailing initial feeling is called uncertainty. The true value of a technology could be learned only after a direct testing period (learning by doing) or deep study of others' experience (learning by watching) (Rosenberg, 1982; Zeira, 1986). In this case we are taking for granted that once a technology is tested by someone its real value goes public becoming part of a wider public knowledge and it benefits of a significant advantage over the other technology that has still to be tested.

The moment before someone decides to adopt one of the two alternatives is called the Penguin Effect. This definition coined by Farrell and Saloner (1986) is referred to that time when a risky decision has to be made. Using their wordings, “penguins who must enter the water to find food often delay doing so because they fear the presence of predators. Each would prefer some other penguin to test the waters first”.

This natural behavior could be easily shifted to the competitive environment. In fact, each user will prefer to wait if there is not a big evidence of first mover advantage from which he could benefit in the future.

This reluctance will persist as long as our players will fear the possibility that their choice may prove to offer lower performance. The direct consequence of this wrong adoption is to make it orphan (JP Choi, 1994).

Thus, once one of a our penguins could not resists anymore adopting a technology (let us call it technology X), X will have, at least in the short time, a strategic advantage over the competitor technology (Y). This advantage is strengthened by a herd behavior, which represents the main root of network externalities. The herd behavior could have some bad consequences for the adoption of other technologies. But let us see it from a closer point of view considering a set of predetermined data and three hypotheses to be studied.

First, let us assume there are just several players (firm A, firm B, ecc) and data for technologies X and Y are:

- Expected value of X: E(x)
- Expected value of Y: E(y)
- Real Value of X: X
- Real Value of Y: Y

Independent Technology Proposition: When all players have the possibility to choose a new technology at the same time, the first mover will adopt the one offering a higher expected value.

In the case presented us by Hypothesis I, firm A will make a decision evaluating all the features of both technologies. In this decision making process there are many influential factors playing an active role. They could be purely technological (performances, network externalities, future benefits, costs…) or behavioral (risk aversion/ risk proneness). Considering all these factors from a subjective point of view, firm A will come up with two expected values E(x) and E(y). It will make the choice that is best for it: E(x) > E (y). After that, X (the real value of X) becomes public knowledge.

Response Strategy Proposition: Once the real value of technology X is revealed, followers will consider the expected value of Y and after that they will decide among these strategies: imitating, repositioning, exiting and entering.

Now it is the turn of firm B to make a move. Basically its optimal decision relies on the confrontation between X and $E(y)_B$. Given that the expected value is a subjective measure while the real value is an objective one, $E(y)_B$ could differ from $E(y)_A$ because as stated before, there are many factors influencing the evaluation of the expected value. If Firm B will face a situation where $\mathrm{X} > E(y)_B$ then it will probably choose the same technology as firm A did. The probability depends on other key factors whose the importance could influence even more the final move. Firm B will take in consideration for example the first mover advantage enjoyed by firm A, the profit pool, the size of the market, barriers to entry and so on. At the end of this second stage analysis, firm B will decide among four possible strategies (Argryres, Bigelow, Nickerson 2013): Imitating, Repositioning, Exiting, Entering.

But first let us make an introduction to the decision moment. If an innovation discontinuity opens a scenario where multiple technologies compete to become the future dominant design, a potential “pool of revenue” is spotted out. In this competitive arena we can see two kind of players: 1) Active players, that we can associate to penguins who decided to leave the iceberg and to move at the same time plunging in different waters and looking for food (pool revenue). They compete and build networks to see their technology becoming the market standard. 2) Observers, instead of plunging in risky waters they wait on the top of the iceberg in order to analyze which one is going to be the best technology to invest their effort in. First movers, if succeed in pushing forward their solution, then they will capture a durable first mover advantage. It is clearly understandable that, once a dominant design is set and consequently a pool of revenue discovered, the initial advantage could not remain unnoticed by active competitors and potential entrants. The revelation of the technology which is desired the most by the demand side, has the power to reshapes competitors’ and potential entrants’ expectations (Argryres, Bigelow, Nickerson 2013). For rivals, in our case Firm B, failing to understand what is going on in the market after the demand information being revealed increases the likelihood of financial loss. Here below the different strategy that our Firm B could take in consideration.

- **Imitating**: In this first example, Firm B plays the role of imitator. The imitation game is a powerful strategy because it allows to catch a portion of the profit pool. Among imitators we can find potential new entrants waiting on the iceberg, and other active players that, understanding their technology was inferior, switched to the dominant design. Often innovators are not able to satisfy their entire demand, and this represents a huge opportunity for imitating competitors to play their cards and to increase their market share. Also, building strong imitation barriers (brand awareness, low-cost structure, efficient distribution channels, strong suppliers’ network) is an activity that takes time; this leaves space for competitors to undertake a counterattack strategy (Teece, 1986; Markides and Geroski, 2004). This is totally true, but imitators should intervene in the early stage of the industry, as soon as they recognize the emergence of a dominant design. The imitation game is necessary in every early industry; otherwise the innovator will gain a longer-term competitive advantage.

In our example, Firm B, showing us an analysis where $X > E(y)_B$, could choose to imitate. The imitation strategy in an early stage industry, where a dominant design is not really well defined, strengthens the herd behavior. It means that probably Firm C will consider $X > E(y)_C$ even stronger, because already two players have adopted it. This network externality will almost automatically drive the choice of Firm C toward the adoption of X.

- **Repositioning**: If firm A has already accumulated a big first mover advantage, Firm B may decide to avoid direct competition and to reposition in a market niche not really close to the dominant design influencing area. The more successful turns out to be the dominant technology the more aloof might be the repositioning strategy. In our case Firm B, if still not in the competitive arena, could choose not to enter. If already in, after having studied the impossibility of implementing an imitation strategy and after having identified the existence of a not satisfied residual demand in alternate market could go for the repositioning strategy.

- **Exiting**: This is the choice that should be made when there is no possibility to capture profits. Who is not able to build his own advantage is selected out. When in nature a dominant species comes up, other species develop a set of characteristics to keep on surviving and competing, if necessary, against the dominant one. As well, in a competitive environment those players, which decide to compete in the industry, should be able to put in action economies of scale and scope, network externalities, effective pricing strategies. The tighter the competition, the higher the exit rate for those players unable to develop their own strengths (Barnett, 2008).

- **Entering**: Firms that usually operates in related industries, after discovering the value of technology X may decide to enter because their resources and capabilities are mighty and fungible enough to compete with the innovator of the dominant design. The newly discovered pool of revenue may attract even firms operating in other industries. This is the case of a cross-sectorial diversification strategy. However, even if reduction in demand uncertainty leads to a higher entry rate, it should be suborned to the size of the first mover advantage and to the quickness the leader achieved it. If big and quickly captured it deters new entries.

Obviously firms will not respond as soon as they become aware of the information shock. In every industry we can observe different degrees of inertia characterizing each firm. This inertia, associable to factors like size, age and prior knowledge, could be considered as the inverse of adaptation speed (Amburgey, Kelly, and Barnett, 1993; Barnett and Freeman, 2001; Carroll and Hannan, 2000; Dowell and Swaminathan, 2000; Hannan and Freeman, 1984). In fact the greater the inertia affecting an organization, the longer will be the process for this player to move forward implementing a new core strategy.

Inertia could also derive from the comparative adjustment costs. These are to be divided into financial costs and strategic risks of switching from an already existing and working strategic position to a newer one. From a practical point of view these costs are (N.Argyres; L.Bigelow, and J.A Nickerson, 2013):

1. **Internal resources, abilities, know-how and knowledge**. This category includes the financial power of each firm. It is clear that organizations financially stronger have greater survival chances than those facing capital limits. In fact these firms can easily switch from an ineffective strategy to a better one. They can incur losses in the short term due to their capability to financially absorb them. Also technological knowledge is important among the internal resources. The broader it is the lower the adjustment costs will be. The process of incorporating this precious knowledge

suffers from information asymmetry, which makes quick learning infeasible (Caves, Crookel, and Killing, 1983). New knowledge could be achieved by acquiring competitors, suppliers or distributors, or through powerful relationships with other players operating in the environment: firms, universities, and institutions. The geographic location as well plays a key role in terms of ease of access to the knowledge pool. To sum up with this topic, the more distant is the firm's knowledge from the necessary one, the greater are the adjustment costs it should be able to face.

2. **Internal organization structure and incentives**. As we stated before older and larger firms normally could feed their existence from financial resources allowing them to survive for extended periods of difficulties, even if their adjustment costs are considerably high. However, these firms most of the times present structures highly rigid and hierarchical. They unlikely will opt to go for new ventures, reallocating resources and changing the governance arrangements. They suffer from structural inertia and this is the reason of the high adjustment costs they face.

3. **Relationships with other stakeholders and external parties**. In many cases, if long-standing relationships with key players are built on trust and norms of reciprocity, they might be important in reducing adjustment costs. On the contrary, if based on regulatory contacts or legal-contractual commitments, they could be a hindrance to the repositioning shift.

Public Technology Proposition: If the real values of both technologies are already revealed, every player will adopt the best technological solution at the same time.

If firm B comes up with an evaluation decision where $X < E(y)_B$, it will probably decide to opt for the implementation of technology Y. As previously taken for grant, the direct consequence of this decision is that the real value of Y goes public as well. This is the classic case where two technological solutions emerge competing to become the dominant design. Both firms, A and B, consider their strategy better than the competitors' ones while other key players, knowing the real value of both technologies can decide whether to adopt one technology instead of the other.

What is pretty evident after this digression is the vital role of a strategic choice while considering alternative strategies. Managers are expected to be smart enough to recognize some key features of innovation shock designs and to be visionary enough to understand which one could become the next dominant designs and the environmental conditions which are necessary to pave the way for it to establishing itself as the market standard.

3. Dominant design: Definition and reasons for it to emerge

When a dominant design emerges, we are in front of a creative synthesis of innovations related to technological solutions, which have a broader appeal if compared to other solutions. Anderson and Tushman(1990), defined it as "*a single configuration or a narrow range of configurations that accounted for over 50% of new product sales or new process installations and maintained a 50% market share for at least 4 years" (page 620)*. It is not always the best technology but for sure it is the best technological compromise in the set of different functional characteristics presented by an innovation. Several prior studies centered their focus on defining what a dominant design is and on identifying its emergence. In fact, an innovation turns out to be a dominant design after a determined timespan in which several competitive factors play a fundamental role. The according point is that a dominant design, once emerged, changes the rules in the competitive arena and it continues to be present until there will not be customers anymore for that product class (Suarez, Utterback, 1995). The main characteristic of market standards is that it could be recognized only in retrospect (Anderson, Tushman, 1990) when sometimes is too late for competitors to adjust their innovation strategy. From this point of view, the real challenge for managers is to spot as in advance as possible the upcoming dominance and to try to influence its advent.

Among the reasons at the basis of the selection of a technology as dominant we can find:

- **Economies of scale and economies of scope**. Thanks to this standardization, firms can start earning something on what they have invested in during the product innovation phase (Klepper, 1997; Hounshell, 1984). There is a shift from a system of “made-to-order” products to a standardized system based on mass-manufacturing (Abernathy, Abernathy&Utterback, 1978).

- **Network Externalities**. An explosive factor that could tremendously accelerate selection of a technology to be locked-in as dominant is the one connected to network externalities (Wade, 1995; Baum, 1995, Rosenkopf and Nerkar, 1999, Frenken, 1999; Hagedoorn, 2001). A technology presenting a positive effect generated by a wide network is supposed to have a higher value than other technologies, which however could be better performing in terms of technological results. Positive network externalities appear when a potential user is forced by a strong incentive to choose the technology that is already adopted by many other users (Katz & Shapiro, 1986). For example, Apple has set up a mechanism through which an Iphone user could maximize her customer experience and join a greater value if, instead of buying a Windows PC, she opts for a Macintosh one. Thus, the greater the network externalities the stronger the installed base. A strong installed base in fact, enlarges the range of a user’s network and makes the technology appealing to developers of complementary technologies (Choi, 1994; Katz & Shapiro, 1986). A technology whose the quantity of compatible and complementary innovations is high, has a greater possibility to impose itself as dominant design avoiding any risk of being locked-out by other technologies. This is due to a virtuous cycle, whereby a strong installed base attracts developers of complementary technologies, while the increasing number of complementary technologies triggers an exponential enlargement of the installed based (Hill, 1997). Network effects are able to enlarge the value-pie that a customer can join by simply deciding for a technology. With a greater pie, the slice for the user will be greater too, even if the quality of the ingredients is not the top one.

- **Strategic Maneuvering**. To explain this point, it could be useful to cite the technological battle between Betamax and VHS. This is the typical example that shows a sub-optimal technology dominating the market. Cusumano (1992), Liebowitz and Margolis (1995) analyzed that through several tools like coalitions, R&D collaborations, pricing and licensing the selection process of a dominant design can be piloted thanks to the astute installation of specific rails by competing firms. In the middle of '70s it happened that JVC planned a very powerful strategy starting a licensing relationship with many other electronic players. When Sony understood the strategy, it tried to build its own alliance, but it was too late. Thus, the main raison behind the success of the VHS technology is that JVC started a self-reinforcing process that strengthened the VHS position on the market, turning out to be the dominant design even if the Betamax used to offer better performances and even if Sony had started to commercialize it before JVC introduced the VHS one. This point is quite important if we consider market dynamics.

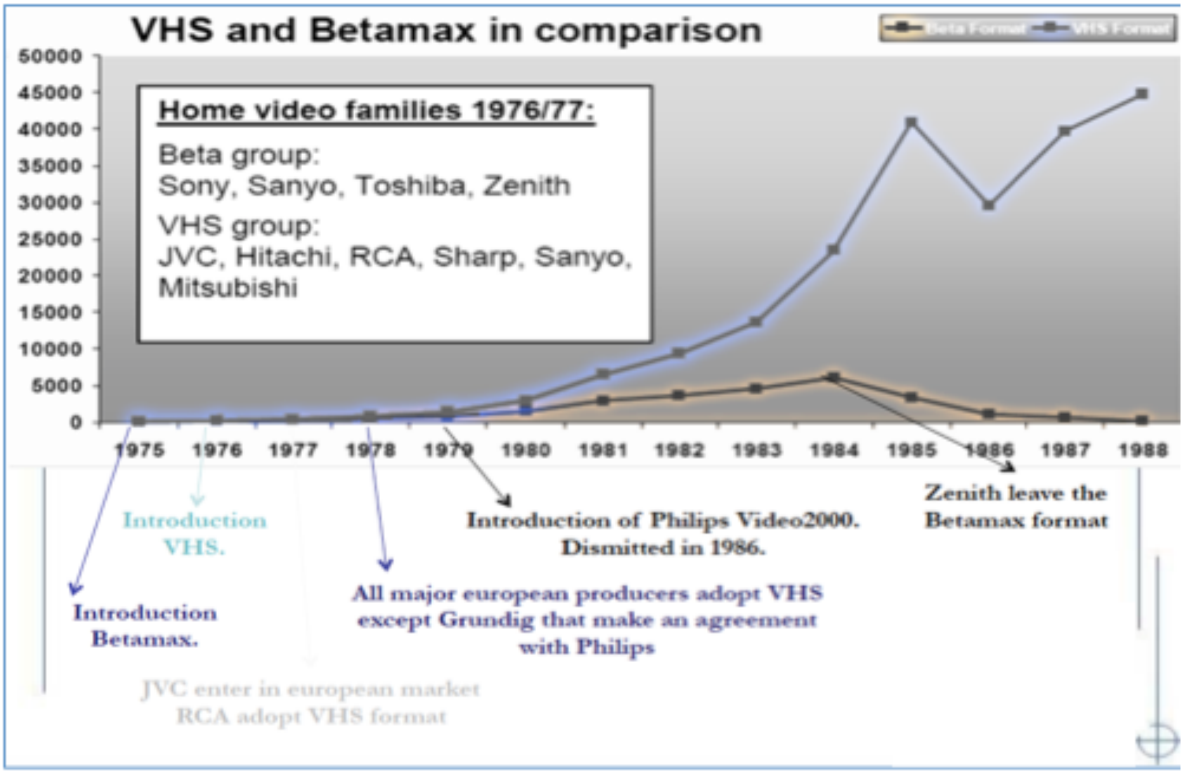


Figure 8 BETAMAX vs VHS. Source: Management of Innovation University Materials

- **Entry Timing**. As already stated, when a single technology that match a set of criteria satisfying distributors, suppliers, customers and other stake-holders emerge, although the general landscape offers several alternatives aiming at addressing the same need, we have a dominant design (Anderson & Tushman, 1990; Arthur, 1989,1994; Economides, 1989; Farrell & Saloner, 1985; Garud & Kumaraswamy, 1993). Taken for granted the possibility that this dominant technology might not be the cutting edge one (Arthur, 1994; Lee, O'Neal, Pruett & Thomas, 1995), we should analyze if it is at least the first one appearing on the market place. It is necessary to highlight, if any, the relationship between the entry timing and the dominance.

  Timing is a crucial variable to study and not to miss, if a firm wants to impose its own technology as a market standard and to force other players, which have bet

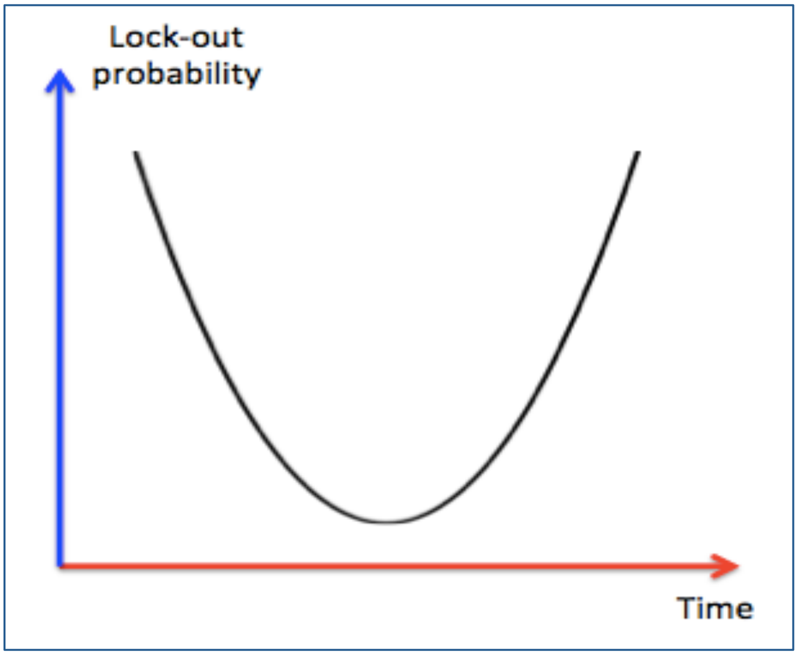


Figure 9 U-Shaped relationship between entry timing and lock-out probability. Adpted from Schilling, 2002

on another technology, to switch to it (Tegarden, 1999). There is a silent "time to market" rule that should be respected and generally this time coincides with the full emergence of complementary technologies and customer needs (Choi & Thum, 1998; Christensen, 1998; Regibeau & Rockett, 1996). Missing this time to market increases the possibility for a technology to be locked-out of the market, where technological lock-out is to be viewed as a situation in which a firm faces the impossibility to push its own products on the market because of the dominant design barriers (Schilling, 2002). Schilling hypothesized a U-shaped relationship between the entry time and the probability of being locked-out, and it perfectly makes sense. Let us discuss more deeply about it while keeping an eye at the graph.

If a firm decides to anticipate the concurrence, the risk it will face is to be too early and to incur in heavy financial losses. A practical example could be the model

Panda Elettra launched by Fiat in the early 90's. Nowadays, players like Renault, Nissan and Tesla are struggling to create a market for electric cars, it means that almost thirty years ago the situation was even worse: costumers were not ready to accept an electric vehicle, the technology at the base of the battery was heavily backward (low performances, huge dimensions), and there were no availability for complementary technologies or infrastructures to support the full deployment of that product. The result was a total disaster for FIAT whose the echo reverberates until today. In fact, even if most of the automotive players are introducing technologies to compete in the rising eco-mobility market, FIAT refuses to re-enter the competitive arena and keeps on insisting on sustaining technologies. The worst scenario for the Italian producer is to stay locked-out for the second time in thirty years, the first time because of being too early the second one because of being too late. However the advantages of being an early mover may allow a firm to establish a leadership, especially if the key assets to delivery a given technology are scarce, the technology is protected by a patent, and the firm is able to build up in a short timespan a powerful wall: buyers' switching costs (Lieberman & Montgomery, 1988; Spence, 1981). Switching costs are a huge leverage to exploit aiming at locking-in a technology as a market standard. They represent a virtuous circle, which trigger a self-reinforcing process of the dominant position (Arthur, 1989, 1994). If switching from a technology to another is too costly for a customer, she will prefer not to switch. On the other side, we have deterrents to entry a market too early. For example, the second mover could capitalize every effort made by the first one in terms of investments and services developed. The follower will behave as free rider. Golder and Telli (1993) stated that in order to cut down the failure rates, the strategy to be implemented is the "early leaders" one. They are not pioneers nor late entrants, but players who have decided to surf the innovative wave at the right time.

4. Diffusion of innovation (Roger)

The last model that we have to pass through if we want to have complete view of the general adoption process of a technology as market standard, is the one proposed by Everett Rogers (1950). When a new technology is launched, as shown in the diagram, there is a low level of awareness; after that, the curve start rising because of the increasing number of users and popularity. Finally, we can find a decreasing period as the market has reached its maturity and saturation.

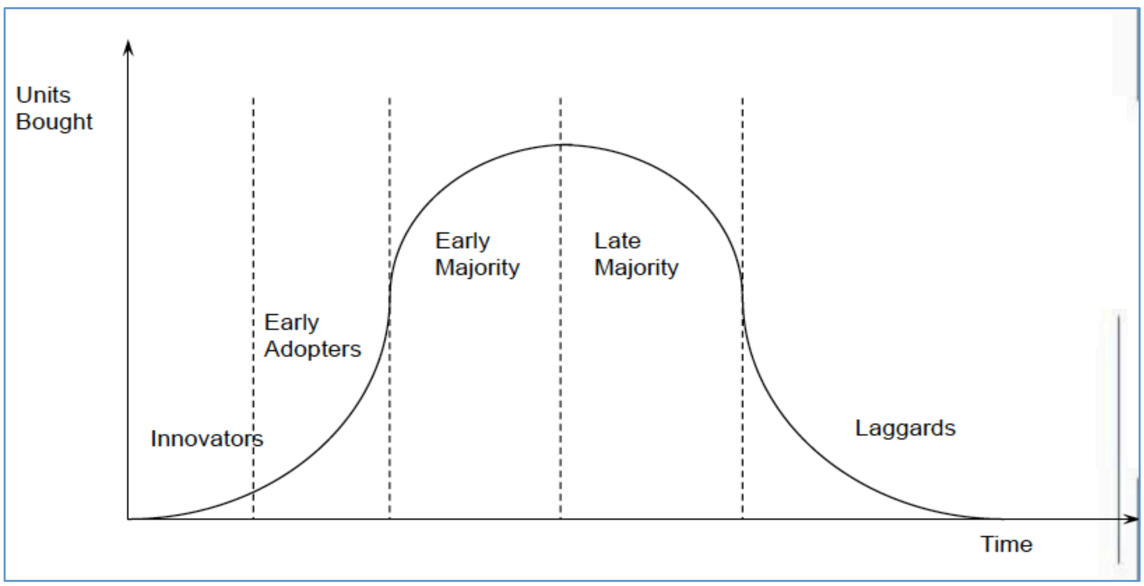


Figure 10 Roger's adoption cycle. Source: http://theory.isthereason.com/?p=35

The entire model is not a stand-alone variable but is strictly connected to what has been said before, when we talked about breakthrough innovations, discontinuities and market standards. In fact, when a new technological paradigm is set and several technologies start competing among each other, the competition is all about triggering the model we are considering in this paragraph. To conquer the dominance in fact, it is necessary to activate the process before the competitors or at least to be the first in addressing the Early Majority.

In addition to this graph, Rogers presented five elements that a technology should posses in order to increase its possibilities to be adopted:

1. **Relevant advantages**. It is quite easy to say that, if a technology presents characteristics better appreciable by customers and other stake holders, it will more likely adopted as mainstream innovation. Also the rapidity of adoption will be influenced by this feature, because the better a technology satisfies a need the faster it will be appreciated and adopted.

2. **Trialability**. The adoption process passes also through this keystone variable. Many users, especially innovators/early-adopters of new technologies, in order to be convinced in adopting a technology want to test it. Some technologies do not offer the possibility of being used before they are adopted and this could negatively influence the future adoption of the technology. This step is crucial because if innovators and early adopters are impressed after testing a new technological solution they turn into opinion-makers and influencers of a wider community.

3. **Observability**. It concerns the ease with which the relative advantages offered by a studied technology could be highlighted after a trial period. If they are relevant and easily recognizable, then the adoption process presents an acceleration.

4. **Complexity**. The easier the better. This is a general rule for innovation to augment its chances to be adopted. In fact, a technology, which is the results of different systems, could negatively influence the final adoption of it.

5. **Compatibility**. Quite evident in terms of network externalities, when a technology is compatible-friendly it probably will conquer market share. It is the case of the

software Microsoft Office and its compatibility with the operative system installed on Apple's Macintosh. Taking a look at the whole story, and taking for granted that Microsoft Office is the market standard, both Apple and Microsoft were suffering the lack of communication between the two technologies. The former because many potential customers facing a buying decision for a new PC, often used to opt for a competitor one equipped with a Windows operative system and incorporating Microsoft Office. The latter, because was locked-out of the Apple world and thanks to this compatibility found the key to open the competitors' doors.

CHAPTER II

The importance of innovation ecosystems

This second chapter introduces a general overview on what we are going to mean with the word: ecosystem. In fact, as we will say later, each innovation ecosystem is composed by two sides. The first one is an exogenous variable, while the second one is a firm-specific variable. At the end of the this chapter, we will suggest modified versions of the graphs we have studied in chapter one. This is due to the fact that we are going to include within them the influence of the ecosystem.

1. A general perspective

It could be interesting to start by highlighting an evident linkage between innovation and "The Nature of the Firm" written by R.H. Coase. This connection has been thought by Hwang and Horowitt during their studies about the ecosystem present in the Silicon Valley, and it is very useful to perform in a right way the analysis this article is to supposed to drive.

But let us proceed step by step. Ronald Coase in his tremendously famous article explains the reasons underlying the creation of a firm. Practically, introducing the theory of "transaction costs" he evidenced that a firm is the natural consequence of a bunch of individuals who, in order to cut off their costs of doing business among each other, found that partnering up into a single firm was a good way to make those costs exponentially decline. The Coasean model extends its influence to what happens in what we know as clusters. In this example, transaction costs are reduced between people who work geographically close to each other, and who, thanks to this proximity, have developed solid relationships based on trust and informal contract. The last step concluding the evolution of the Coasean structure is represented by innovation ecosystems. It means that after the maximum expansion of the theory boundaries like geographic barriers, social networks failures, cultural differences and lack of trust will not exist anymore, and the innovation will take off. (Hwang, Horowitt, 2012).

Unfortunately efficient economic ecosystems, as like as natural ones, sprout only in specific areas and are not easy to replicate somewhere else. In order to better understand what is an ecosystem, it could be useful to take as an example the French capital, Paris, during the years between the end of '800 and the First World War. The city used to be one of the most important European artistic hubs. The importance that surrounded that ecosystem was not due to the presence of thousands of artists, but instead to that network of players orbiting the artists. To make it brief, there was a virtuous circle where artists were supported by an active network of dealers who were connected to an even broader network of possible wealthy buyers. The presence of art-loving buyers started to attract much more artists who in turn enhanced the quality of the art offered in Paris.

After this brief digression concerning the meaning of ecosystem, we can make a comparison with the most valuable innovation ecosystem in the world: the Silicon Valley. What is going on out there is pretty much the same that happened in Paris. We can find all the necessary ingredients: brilliant ideas, valuable people, innovators, entrepreneurs, infrastructures, educative system, a strong network of angels and a flourishing Venture Capital industry. But to explain what triggered the innovation virtuous circle we borrow professor Annale Saxenian's wordings, who wrote the book "Regional Advantage: Culture and Competition in Silicon Valley and Route 128:

"Drawn together by the challenge of technological and geographic frontiers, the pioneers created technical culture that transcended firm and function. They developed less formal social relationships and collaborative traditions that supported experimentation. They created firms that were organized as loosely linked confederations of engineering teams.

Without intending to do so, Silicon Valley's engineers and entrepreneurs were creating a more flexible industrial system, one organized around the region and its professional and technical networks than around the individual firm"(Saxenian, Regional Advantage, page 30).

In the modern Innovation area, ecosystems are vital for firms to succeed. They technically play an active role in selecting in and out firms, in helping one firm to succeed instead of another and even, as this paper would like to demonstrate, to influence the retention of a technology as dominant design. In other words, innovation ecosystems hold the reins of technological innovation and competition. To highlight this assumption, it could be useful to quote the case history of ProFusion, better known as the Anti-Google (Hwang, Horowitt 2012). That is the story of a cutting hedge technology expected to become a dominant design among the search engines. Developed in the early 1990s' by two professors, Susan and John Gauch, ProFusion became almost immediately the best technology in the world for information searching. Their valuable metrics after a couple of years were: 1million active users per month, property of a dedicated server, leading technology of an exponentially growing market (WWW). Google, the nowadays universally recognized leader, used to be helped by ProFusion to drive traffic to its own platform. However, something went wrong in terms of business deals, contracts and investments. Yahoo! for example were able to raise 36.8 million from investors, who valued more a second or third alternative then the leading company. This depended on the playground where the commercial match was being played at that time and it shows how the equation interesting technology equal to successful business it is not direct and proven. The main failure factors, despite being partially compensated by a strong technical talent, are completely to connect to the distance from any regional cluster and they could be summarized in the following bullet points:

- Lack of experienced people helping the Gauches to drive their business
- Lack of confidential business deals
- Lack of a powerful network based on trust and reciprocity
- Inefficiency in the commercial domain (partnerships, marketing, HR)

On the other side, Yahoo! succeeded in a massive fund raising activity, and was able to capture entrepreneurs, managers and innovators bringing experiences, expertise and talents. Yahoo! and Google won the battle because they were growing in a boosting ecosystem and because they were able to compete after assembling their own ecosystem. In fact, on one side ecosystems are important as external variables, on the other they are firm specific too; a firm should exploit the external one through the right implementation of its own. Thus, modern competition is not anymore a firm specific problem but it concerns the whole ecosystem of players surrounding the firm. Technological competition shifted from a firm-versus-firm basis to an ecosystem-versus-ecosystem one, the stronger the players in a given ecosystem the greater the possibility for a technology to succeed. For example, Yahoo! at that time had already built its own ecosystem acquiring companies like RocketMail, ClassicGames.com and Yoyodyne Enterteinment, in order to enlarge its user basis and to generate revenues.

To sum up, an ecosystem is a two-sided coin that would be better analyzed later on. The first side is a variable, which is external to the firm. It is composed by all those characteristics that could influence the way a firm competes, changing the rate of success. The second side is strictly connected with what a firm is able to build to better dominate the competitive arena.

ProFusion, even if top rated technology, was not able to efficiently compete because of the low quality of the external ecosystem and because of the inability to assemble from scratch a firm specific ecosystem, an armor, with which entering the arena. The result has been the same that could be figured by imaging Claude Monet growing up and painting somewhere else than in Paris, for example in El Cairo. Probably today, there would not be any Monet in our art book nor a "technological paradigm" like the impressionism.

2. The ecosystem as an external framework: The innovation habitat

Generally path-breaking innovations are heavily promoted by start-ups. This is due to their entrepreneurial spirit, often missing in big corporations affected by the incumbent inertia. Start-ups do not fear the risks of betting on a wrong technology because that technology is the only one they have. On the contrary they strive to exploit in the right way the innovation habitat where they are born. Sometimes also big incumbents invent disruptive technologies but rarely they decide to leave a technology, which is safer in terms of future revenues in favor of a risky one. Behaving as entrepreneurs, large companies risk to lose a large slice of their market share and to be overcome by their historical competitors.

This is the case of Kodak and the digital photography we have already presented. Kodak invented that technology but preferred not to commercialize it (Tripsas, Gavetti, 2000). It means that incumbents normally face two kind of selection. Firstly the external ecosystem one, which could even accommodate new technologies playing the role of a fertilizer for them to sprout. Secondly, they deal with a stiffer corporate selection. Therefore new technologies are introduced only if a general market acceptance is a priori demonstrated (Walrave, Van Oorschot, and Romme, 2011).

Start-ups, enjoying the lack of the corporate selection, are in contrast incentivized to develop and to launch new technologies. However, in order to see their work recognized and appreciated they should operate in an efficient innovation ecosystem feeding them with the right tools to better deliver their technology, and protecting them if the disruptive technology they are about to launch risks not to reach the market. It could happen because incumbents or social players generate frictions due to the threat they feel. Start-ups are more comfortable with modern times of continuous disruptive wave, they are more flexible and this elasticity allows them to disrupt industries that someone used to consider as forever stable (Blank, 2012). Big corporation have to deal with this rough sea composed by several disruptive waves. Starting with these assumptions is now good to begin presenting the results coming from the Startup Ecosystem Report 2015,

	Ranking		Performance	Funding	Market Reach	Talent	Startup Exp.	Growth Index
Silicon Valley	1	◂	1	1	4	1	1	2.1
New York City	2	▲ 3	2	2	1	9	4	1.8
Los Angeles	3	◂	4	4	2	10	5	1.8
Boston	4	▲ 2	3	3	7	12	7	2.7
Tel Aviv	5	▼ 3	6	5	13	3	6	2.9
London	6	▲ 1	5	10	3	7	13	3.3
Chicago	7	▲ 3	8	12	5	11	14	2.8
Seattle	8	▼ 4	12	11	12	4	3	2.1
Berlin	9	▲ 6	7	8	19	8	8	10
Singapore	10	▲ 7	11	9	9	20	9	1.9
Paris	11	◂	13	13	6	16	15	1.3
Sao Paulo	12	▲ 1	9	7	11	19	19	3.5
Moscow	13	▲ 1	17	15	8	2	20	1.0
Austin	14	NEW	16	14	18	5	2	1.9
Bangalore	15	▲ 4	10	6	20	17	12	4.9
Sydney	16	▲ 4	20	16	17	6	10	1.1
Toronto	17	▼ 9	14	18	14	15	18	1.3
Vancouver	18	▼ 9	18	19	15	14	11	1.2
Amsterdam	19	NEW	15	20	10	18	16	3.0
Montreal	20	NEW	19	17	16	13	17	1.5

elaborated by Compass.

Figure 11 Global Startup Ecosystem ranking. Source: Compass

The report is based on a Global Ecosystem Index, which ranks the top 20 startup ecosystems around the world. As we can see from tableXXX none of the Italian ecosystems appears in the special ranking, and after having explicitly asked for it, it could be added that there is no trace of it not even among the top 30. Coming back to the index, it has been built using 5 different measures of ranking.

- **Performance:** This measure verifies the quality of the funding activity and the total amount of exits within an ecosystem. An efficient ecosystem is able to give birth to a large number of start-ups showing a high survival rate after 2 years. This is not a banal metric because the higher the numbers of surviving firms, the higher the number of jobs generated. A well-performing ecosystem gives birth to a virtuous turnover in jobs positions.

- **Funding:** This metric highlights the amount of the investments verified within a given timespan. It is a measure of capital flows that feed the start-ups. The funding activity, in order to be considered efficient, should happen rapidly after the investment opportunity has been spotted out. Aligned with this point of view, the report takes in consideration the time necessary to raise capital.

- **Talent:** An ecosystem should not be something isolated from the rest of the world, but it is supposed to attract talents with different skills, qualities and backgrounds.

- **Market reach:** It is calculated basing the analysis on the size of the local ecosystem's GDP and on its ability to reach international markets.

- **Startup Experience:** As will be shown later on with a practical example, start-ups founded by people who have already developed experiences in founding companies, launching spin-off or simply developed new business within a larger mother company, have bigger chances of surviving and to connect with other businesses.

A brief comparison between ecosystem has to be made just to highlights some results generated by a thriving innovation habitat. The two ecosystems taken in consideration are the global tech mecca (Silicon Valley) and Tel Aviv (Tech-Aviv)

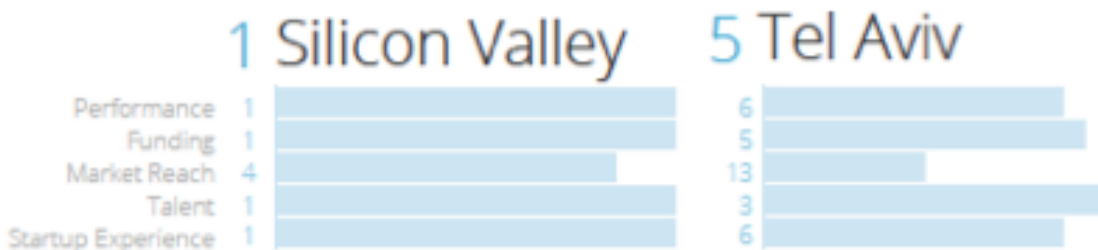


Figure 12 Comparison between Silicon Valley and Tel Aviv Ecosystems. Source: Compass

Silicon Valley

The Californian ecosystem is the top ranked one, and shows astonishing results. It has launched 19,000 startups in which are employed 2.2 million high-tech workers. It has always been a gravitation center for founders and talents. In fact immigrants create more than 50% of new startups. Looking at its history several successful stories took place in this environment. Apple, Facebook, Google, Uber and are just example of the Silicon Valley impact worldwide, and considering together their market values we can almost reach $2 trillions. In terms of observable exits Silicon Valley is able to generate an amount of exit value as the combination of the value generated by all the remaining ecosystems ranked.

Tel Aviv

The Israeli ecosystem (#5 in the global ranking) is one of the most influent in the international landscape. With 4,200 active high-tech start-ups, nourished by well-structured resources and governmental programs, it presents the higher start-up density (1 every 1,844 citizens). It is the heart of what it is now everywhere recognized as the Startup Nation.

Startups in Tel Aviv traditionally focused on areas such as enterprise IT, security and networking technology. Thanks to the Yozma project, launched in 1993 with the aim of attracting foreign VC to invest in Israeli start-ups, Tel Aviv reached a strong international reputation amongst investors and funding institutions (47% of all investments comes from foreign channels), add nowadays it shows an investment level 2.5 times higher than the Silicon Valley one and 30 times higher than the European average one. It has become really attractive for high-tech talents, especially coming from Russia, and these features represented a booster for the ecosystem to wake up. In fact an efficient ecosystem should enhance diversity of people and talents in order to create a valuable melting pot. Today Israel is proudly the second country for number of firms listed on Nasdaq stock exchange. But this is not the conclusion. There are other crucial factors that actively contribute in shaping the ecosystem engine, and which hardly ever are explicitly taken into account. Let us analyze them from a closer perspective.

Proximity

The concept of proximity has been developed and deeply analyzed by Broekel and Boschma (2012). They considered proximity a powerful tool to encourage knowledge sharing, social relations, business linkages and innovative co-operation. However, there are 3 shadows of proximity, which show different degrees of impact on the innovation generation proliferation (Frenkel, Israel, Maital; 2015)

- *Geographic Proximity*: This is the index, which has been investigated the most in recent years. In fact, the underlying idea of the metric is that knowledge sharing is strongly stimulated by face-to-face relationships. Thanks to a short distance between key actors on innovation stage, clustering properties are exalted. A cluster is a geographic concentration of firms, entities, institutions and stakeholders which are ultra-connected among each other and which operate in the same industry (Porter, 1998). The main feature of clusters is that they incentive at the same time both competition and cooperation.

  Competitors cooperate to enlarge the pie they can conquer later on. Behaving this way the efficiency, effectiveness and elasticity of a given industry in a given geographical area are enhanced toward a common goal. Competition is shaped by cluster features showing results like a higher production rate of the competitors based in that cluster, technology path set up for future innovations, and a broader nativity of new businesses. This last point generally is verified when new ventures are the result of a spin-off from existing firms. The spin-off ventures generally opt to stay in the region of the mother firm because in this way they can exploit previous connections (Fritsch, 2005).

  This assumption is confirmed by the case of RAD, Israeli start-ups that gave birth to 129 spin-off start-ups (Frenkel, Israel, Maital, 2015), strictly interconnected among them, operating in the same fields and showing an incredibly low failure rate (27%). Today, thanks to globalization and new technologies, physical distance is not a big obstacle to communication anymore, however an optimal degree of proximity is desired to play a positive role in shaping information networks and interdependencies among firms (Balllan 2012; Hardeman, 2012; Balland 2013).

- *Cognitive Proximity*: Cohen and Levinthal (1990) defined this kind of proximity as the degree of overlap related to the information, knowledge and skills of two individuals. As we know, in a competitive landscape, companies tend to interact among each other. They learn from others' expertise, they exchange knowledge to reach a common goal. Generally, to exponentially increase the innovation proliferation, a certain level of diversity is desired.

This cognitive distance (Noteboom, 2000) should be balanced by the right level of cognitive proximity, because the first is required to push forward the innovation progress while the second is necessary for other players to understand and absorb the new knowledge generated by innovators. According to a previous study performed by Cohendet and Lerena (1997), there is an inverted U-Shaped curve describing the relationship between cognitive distance and probability of innovation to happen.

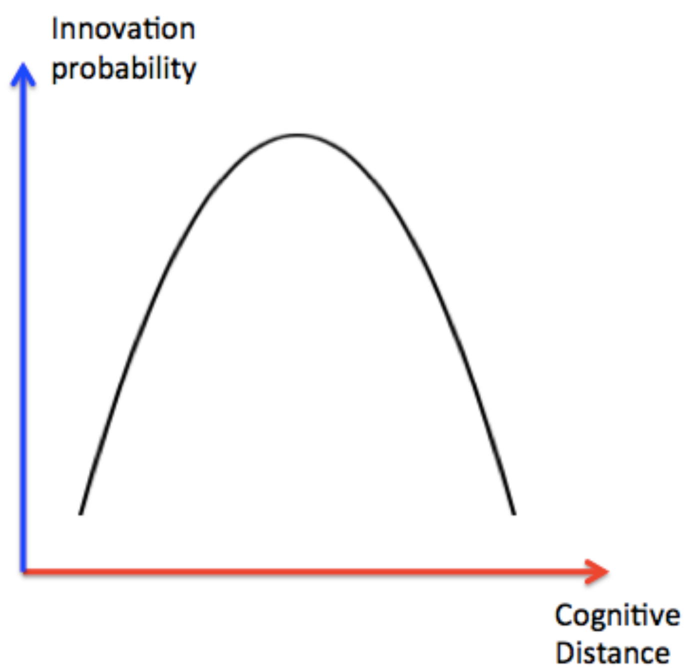


Figure 13 Inverted U-shaped relationship between cognitive distance and probability of innovating. Adapted from Cohendet and Lerena (1997)

Evidently, excessiveness is not a required feature both case of cognitive distance or cognitive proximity (Noteboom, 2007; Boschma, 2009; Boschma & Frenken, 2010).

- *Social Proximity*: To start this topic we cannot not to talk about trust. Trust is the main feature on which agents base their social networks, because thanks to trust knowledge and information are shared much easier than without it. Sometimes interpersonal relationships are the keystones of social networks, and the latter are powerful to generate co-operation and collaborative networks. For example, colleagues normally remain friendly even after their work experiences are not linked anymore to the prior organization (Buenstorf, Fornhal, 2009). They keep on helping each other, like in the RAD case, where the 129 start-ups generated by RAD showed a huge networking among each other and especially with the mother firm. In fact a common background plays a vital role for further exchanges of knowledge and further investments. However, a too strong social proximity is not a good trigger for innovation, in fact the risk is of ending up with a closed community, which nobody else is allowed to join.

  Trust is not that easy to build, it should be built by showing it first. It is a social investment that will permeate the collaborative culture for many years in the future. The right point of view is not the "business is business" one, we are not sharks. There are social pillars that should be respected to be part of a community: fairness, pay it forward, and trust. We have already seen the latter one, while for fairness we mean agreements where nobody tries to take unfair advantage from the other. If the contrary happens, it will destroy the trust pillar. The "pay it forward" philosophy is something that generally happens in thriving ecosystems like the Silicon Valley one. Entrepreneurs, managers, investors and whoever else, help each other without asking for something in return. They know that when they will need help, there is going to be someone offering it for free. These measures will enhance trust, which is the basis for social proximity to be developed. Distrust is an avoidable social cost and in this case is good to borrow Fukuyama's wordings

(Social Capital, 10 chap.2, n.33) who highlights the importance of trust in all human schemes.

"The economic function of social capital (read TRUST) is to reduce the transaction costs associated with formal coordination mechanisms like contracts, hierarchies, bureaucratic rules and the like…No contract can possibly specify every contingency that may arise between the parties; most presuppose a certain amount of goodwill that prevents the parties from taking advantage of unforeseen loopholes. Contracts that do seek to try to specify all contingencies-like the job-control labour pacts negotiated in the auto industry that were as thick as telephone books-end up being very inflexible and costly to enforce."

One might say that in the end, an individual could try not to respect the trust pact in a community and to take advantage of other players. However if the community is strictly committed to their trust rules, there is a chance to exclude who took advantage and to destroy him, economically speaking. In fact, none of the other players will trust him again, and this is an important loss to make business. Trust is able to shape social culture, and it could be immediately recognized in regional innovation systems. For example in Silicon Valley everyone trust the other and they are willing to share their knowledge during an informal conversation, while in the Route 128 (Boston Area), even if it is a technology hub, its entrepreneurs and innovators tend to distrust the others (Pydynowski, 2011).

To conclude this paragraph about social proximity and trust, it is good to remember that trust is often based on past-shared experiences. In particular we have to mention the "frontier culture". To make an example, we can quote the gold rush where thousands of gold hunters moved from the east side of the U.S to the west side. During the dangerous journey, the only possibility to survive was to trust strangers. Get along with the community or die alone; this was the basic philosophy. This frontier culture has been developing through time, and its direct projection is the culture we can find in the Silicon Valley.

To the previous features a good ecosystem is expected to show, we can add institutional structures (universities, research centers, incubators, funding industry etc) and actions that a national innovation system should offer to support the innovative process and some initiatives policy makers should undertake to boost the innovation proliferation.

National Innovation Systems:

Nations, Regions and even better Cities should be considered as complex relational frameworks in which everyday companies, public organizations and other actors connect to work societal problems out. Given that, we are not simply in front of physical areas representing the ground on which business are run, indeed they are business ecosystems composed by a dense network of contacts, relationships and knowledge sharing between companies, residents, suppliers, customers and institutions based in the national territory.

Starting from this assumption, governments have the responsibility of efficiently managing the ecosystem. It means that a local government should provide necessary infrastructures (universities, research centers, incubators, accelerator, funding industry etc), organize involving activities and events for the interested players, and deliver services to coordinate the economic life of players operating in that area. Government should play an active role in accommodating the innovation activities, especially because it happened in the past that path-breaking technologies, which succeeded to impose their ability against possible competitors and which obtained agreement, alignment and commitment in their ecosystems (Adner, 2012), failed because they faced a too fierce social resistance originated by the old generally accepted socio-technical regime (Geels, 2004; Geels and Schot, 2007; Nelson and Winter, 1982).

Often disruptive technologies fail because they undermine without the right support the foundations of a socio-technical regime, which on the contrary is reinforced by the savage opposition of incumbents, organizations, lobbies and social networks (Geels, 2004; Kemp, Loorbach, Rotmans, 2007). Thus, governments and national institutions should intervene to influence these subsystems underlying a socio-technical regime, in order to accommodate a new upcoming technology (Nelson and Winter, 1982; Raven, 2007).

To properly face and overcome that resistance a heavy backing of key stakeholders is desired, and as well as from the governments, this kind of support could come from potential customers, new social networks, general institutions, organizations, opinion leaders, policy makers, standards-setting agencies etc. (Geels and Raven, 2006; Sharapov, 2013). Sometimes could be required that at least a socio-technical niche is protected by the public institutions in order to gradual introduce it in the ecosystems and to overturn the old regime when the niche is big enough to keep on growing alone (Schot and Geels, 2008; Smith and Raven, 2012). This is due to the fact, that disruptive innovations, without a niche, are not likely to survive the natural selection if launched in the competitive are when still immature.

Thus, the state could intervene providing tax benefits, subsidies, government grants, credits, non-monetary benefits and other kind of supports (Huijben and Verbong, 2013; Smith and Raven, 2012). Just to make some examples, policy makers could have a positive impact on an ecosystem by: creating policies which can minimize the social friction due to incoming flows of capital and talents from other countries, simplifying the tax structure or allowing start-ups initiative to easily form and easily fail without heavy bankruptcy costs. However, even if governments provide the right protection to path-breaking innovations, the overturning process normally takes time. Therefore, start-ups and firms, which try to face a solid old socio-technical environment, should take in account that they are following a long-term process.

3. The Ecosystem as a firm specific asset

To date we can count several studies concerning business and innovation ecosystems. From this point of view ecosystems are to be considered as a cobweb of highly interconnected orbiting a focal firm. (Adner & Kapoor, 2010; Iansiti & Levien, 2004a; Moore, 1996). These assumptions have many direct consequence on firms' strategic thinking; in fact when we discuss about competition we cannot see it anymore from a perspective of firm versus firm, indeed we should think about a face-off involving many other players. A competition between ecosystems (Doz & Kosonen, 2008; Gulati, Nohria, & Zaheer, 2000; Iansiti & Levien, 2004b; Iyer, Lee, & Venkatraman, 2006; Moore, 1993; Normann & Ramirez, 1993). The direct consequence is that managers should facilitate the value creation of the entire ecosystem and just strategically structured firms will be able to gain a dominant position in the market or to gain their own technology as the market standard.

The ecosystem perspective is even more important if referred to innovation, because innovation means change, and innovative changes involve multiple parties to work toward the same result. It has already been analyzed the importance of getting everything done while trying to overturn a socio-technical regime. Sometimes it is not sufficient to develop a path-breaking innovation to reach a technological success, nor it is sufficient to operate in an easygoing socio-political environment. Sometimes to succeed it is necessary to coordinate the efforts of other interconnected innovators operating in the same environment but in a wide range of different industries (Adner, 2012; Autio & Thomas, 2014). The focal firm should efficiently accompany changes, coordinating the whole set of participants to the ecosystem, which play an active role in co-creating value. (Adner & Kapoor, 2010; Autio & Thomas, 2014).

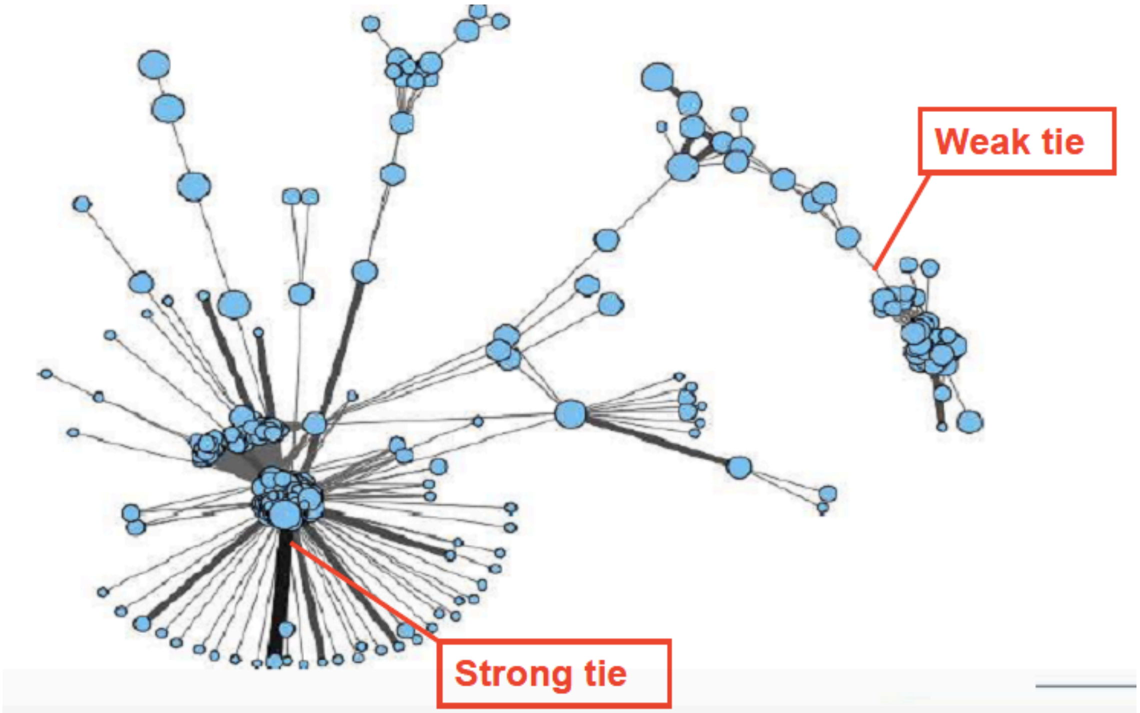


Figure 14 Strong and weak networks between suppliers and complementors. Source: Management of Innovation University Materials

Taking a look at Figure 14 is pretty evident where is the place for a business to be. If the network is composed by highly interconnected firm, whose the efforts are directed to the final value creation, that ecosystem is going to overcome the weak ones. This statement is particularly true when innovations rely on other players' ones. It means that sometimes the final innovation is the composition of several smaller innovative products, processes or services that should be implemented by other firms. From this point of view, the focal firm is embedded within an ecosystem of interconnected innovations (Adner 2006).

The strategic activity for a focal firm, which wants to deliver a technological innovation, is based on the identification of the members operating in that innovation ecosystem. The second strategic step is to work for the alignment of other parties' motivations, advantages and goals. Just through the full exploitation of goals alignment, a firm could enhance the chances of success for an innovation.

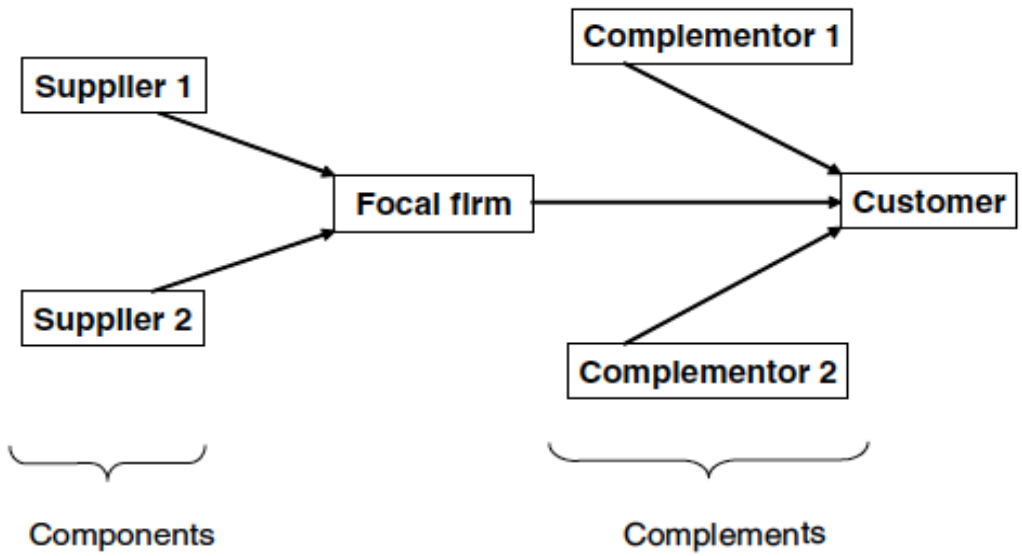


Figure 15 Generic schema of an ecosystem. Source: Value Creation in Innovation Ecosystems, S.M.J (Adner R, Kapoor R)

As we can notice in this basic scheme, innovations are the results of additional values added by many players of the industry. Without their intervention there will not be any innovation. However the larger the ecosystem of actors the greater should be the coordinating strategy of the focal firm; every single dependency, partnership, alliance, joint venture should be calculated and aligned before developing the final product. This process of common understanding toward a successful cooperation and co-innovation is a feature typical of innovative ecosystem (Brandenburger and Nalebuff, 1997; Afuah, 2000). The risk of not coordinating is to fail.

Specifically, we can assess that upstream component challenges represent a bottleneck to the value creation because they constrain the focal firm's ability to deliver the full innovation, while downstream complement challenges thwart a full value creation because they impede the customers to fully enjoy the focal firm's innovation. Now it is quite obvious that bottlenecks can arise in all levels of the innovation process and a successful firm should be able to offset them as soon as they come up. In fact other players will probably have to face and to solve their innovation challenges, and the focal firm should give them the right time without delaying the launch of the final innovation

But let us go on with the analysis of the challenges to be considered by the focal firm. Challenges in innovation ecosystems can be an opportunity to enhance the competitive advantage or a risk to destroy it. In particular, on one side we have the suppliers, which usually face challenges, which could increase the value of the final innovation. On the other side we can find the complementors, whose big challenges could destroy the entire competitive advantage previously created.

There could be lots of different sources for interdepence risk. Interconnected players could be late in innovating because of regulatory issues, development problems, misalignment of incentives, financial risks, structural changes etc. (Adner, 2006).

		External complement challenges	
		Low	High
External component challenges	Low	Internal innovation challenges	Internal challenges + external constraint on consumption
	High	Internal challenges + external constraint on production	Internal challenges + external constraints on production and consumption

Figure 16 A framework for understanding the effect of ecosystem challenges on innovators. Source: Value Creation in Innovation Ecosystem, S.M.J, (Adner R, Kapoor R)

Observing the table (Figure 16) we can assess that just in case of a low level of both external component and external complement challenges, the focal firm will be able to deliver its own innovation without any kind of dependence. Otherwise, there will always be an interconnected dependence on performances reached by suppliers and complementors. As stated, bigger technological challenges for suppliers could be exploited as greater barriers against new entrants or alternative technological solutions. The direct consequences of these challenges are barriers to imitations, and ease of access to competitive knowledge. To conclude the value creation process, we find players whose the contribution is not directly involved to create from scratch the innovation, but which are necessary to unlock the full value of the innovation. These players are usually defined as complementors (software developers, electricity distribution network for zero emission vehicles). When complementors face big technological challenges the main risk is to waste any competitive advantage deriving from previous stages of the innovative process. (Huges 1983; Rosenberg, 1972).

That is why Ron Adner introduced the concept of Minimum Viable Ecosystem (MVE). Each firm trying to innovate should plan a logic interaction with partners, and it should decide not only who is necessary to include within the process and what the partner is supposed to do, but the focal firm should also plan when the intervention of the partner is required. The main reason of the staged evolution is the necessity to create the logic of sequencing the alignment. For example, firm A would prefer to co-operate with partner B just at time t+1, because B at time t could not involve firm C and D into the innovative process.

Borrowing Adner's wordings:

"The idea of an MVE is to establish a commercial footprint that lets you manage a staged expansion, where you're adding partners over time, and with every additional partner you're enhancing the value proposition. At the end, you're at scale with a full value proposition, but your priority has been partners and value creation rather than racing to expand the single concept you had established at the pilot level." (Ron Adner, Innovation Ecosystems An Interview with Ron Adner, Conversations about the challenges and benefits of managing your innovation ecosystem, Research-Technology Management, pag.14).

This definition is particularly fitting for big corporations, which could exploit the possibility of shaping the ecosystem. The following chart could explain the basic idea. An MVE is a way to test how to trigger the adoption cycle of the innovation. It is necessary to identify risks, weaknesses and threats coming from the external environment and then building up an efficient ecosystem to offset them and to properly take part to the technological battle. This has fully put in action by Apple, which is the focal firm of at least four important industries (PC, consumers electronics, communications, IT). Apple has constantly worked to create a rich ecosystem of partners through the co-evolution. At Apple they perfectly know that if they want to innovate, their ecosystem as well has to do so.

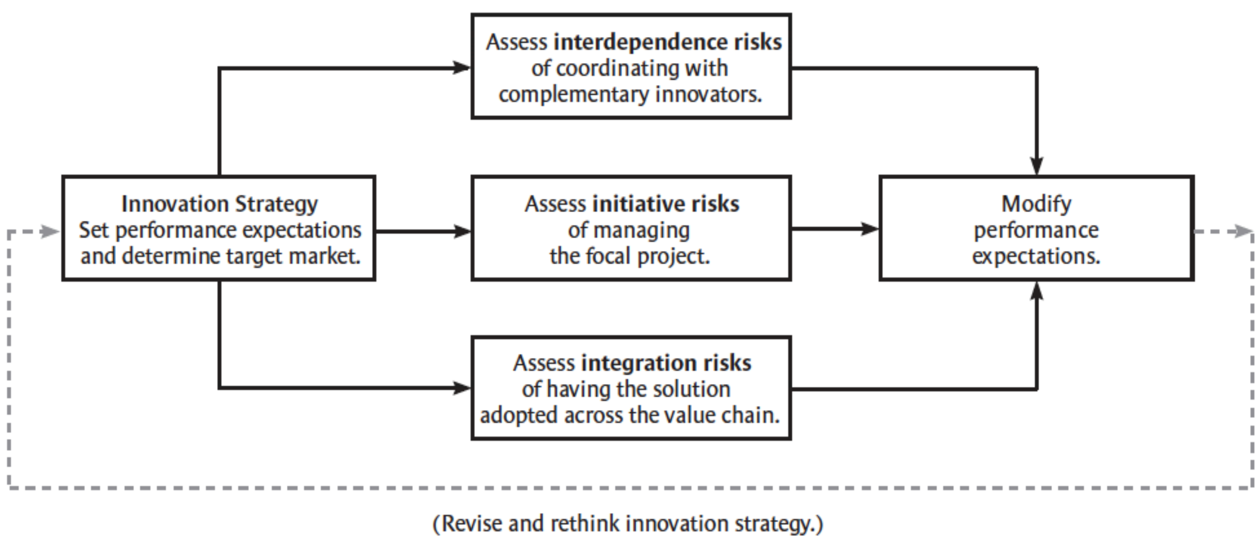


Figure 17 Innovation Strategy shaped tby taking in consideration ecosystems' risks. Source: Match Your Innovation Strategy to your Innovation Ecosystem, HBR, (Adner R.)

L.D.W Thomas and E. Autio (2015) proposed three phases of ecosystem emergence: Initiation, Momentum and Control.

- **Initiation**: This phase is recognizable because of the dense presence of early technological activities. Firms develop prototypes to evaluate the viability and feasibility of their technological solution and to test the impact on the ecosystem (Suarez, 2004). After having tested the viability, the market for the technological innovation is created and, given that the main challenge at the beginning is to capture lead customers and to find key partners, suppliers and distributors, the focal firm has to protect its innovations through a well planned strategy (Suarez, 2004). Each decision concerning standards and designs will influence the future of the whole growing industry and the ecosystem's structure if taken during this phase (Klepper & Graddy, 1990). Ecosystems start to arise in this phase and their number is relatively small, given that the whole industry is in an early-stage phase (Abernathy& Utterback, 1985), The end of the initiation process could berecognized observing a sharp rate of entry of alternative technologies provided by new competitor. (Agarwal & Gort, 1996; Gort & Klepper, 1982).

- **Momentum**: The second step of the evolution presents a huge quantity of ecosystems growing together and competing to reach an as big as possible installed base. The differential that makes an ecosystem more competitive than others is to be searched into network externalities. (Suarez, 2004). Competition is all about defeating alternative technologies satisfying the same needs, and pushing the ecosystem toward the general recognition of the technology as dominant design (Moore, 1993). From a different point of view we can say that this is a phase between the dawn of a dominant category of products and imposition of a dominant design (Suarez et al., 2014). The ecosystem strategy is characterized by moves aiming at driving adoption of the technology, at enlarging the partnership base and at legitimating the ecosystem in a dominant position (Gawer & Phillips, 2013; Moore, 1993; Sharapov, Thomas, & Autio, 2013; Suarez, 2004). At the end of this phase we can recognize a negative entry rate, almost equal to the mortality, and a stable group of ecosystems (Gort & Klepper, 1982).

- **Control**: This is the last phase of the ecosystem life. There is dominant design imposed by a dominant ecosystem, which has previously won the competitive battle (Hariharan & Prahalad, 1991; Suarez et al., 2014). Its strong position benefits from a virtuous self-reinforcement process, which is triggered by network effects, partnerships and installed base, driving to market dominance (Suarez, 2004). The competitive challenge for dominant players is, on one hand to keep on promoting their vision for future technologies in order to motivate components suppliers and complementors to innovate again together (Moore, 1993); on the other hand to firmly hold a strong bargaining power over the whole set of players of the ecosystem (Moore, 1993).

Prior studies have often made a direct connection between the end of a technological uncertainties and the dawn of dominant designs (Utterback and Abernathy, 1975; Anderson and Tushman, 1990) and industry standards (Cusumano, Mylonadis, and Rosenbloom, 1992). The ecosystem presented above as a firm specific asset states that a main role to solve out a technological uncertainty is often played by interconnections with other players, readiness of complements, efficiency of complementors and ecosystem strategy.

4. How an ecosystem could shape technological competition

Until this point we went deep in analyzing both technological competition in all its declinations and the ecosystems' dichotomy. Now we have a general overview about what happens around the main focus of technological innovation. But there is something missing that should be analyzed: how technological competition we know, could be distorted by placing the ecosystems' lens on it.

Starting from this point several assumptions will be made, taking well know graphs previously presented and suggesting revisited versions of them.

Modified Technological Paradigm

The first graph to be studied from another perspective is the one deductible from Dosi's theory. It had two variables as inputs. The two variables were representing a trade-off that a firm generally faces when developing and delivering its own technological solutions. The outputs of the graphs were technological trajectories generated by a problem solving activity and moving inside the paradigm at different levels. The revisited technological paradigm suggests to include one more variable into the analysis.

This suggestion derives from the observation that the previous model does not give any indication about which trajectory will then give rise to a dominant design. In other words, just taking a look at the possible trajectories we never will know which one is going to be the most widely accepted.

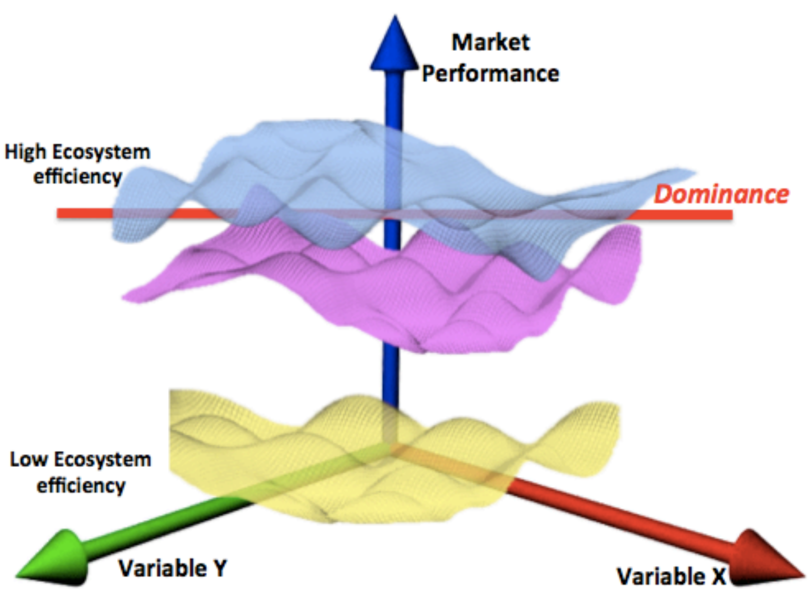


Figure 18 Modified Technological Paradigm

The new variable that we should introduce is the market performance (blue arrow) and then we should consider a plan (red line) representing the threshold for a technology to overcome to be locked-in as dominant design. Taking a look at the updated model, we can spot out three different technological plans on which technological trajectories can move. They represent three alternative technologies performing the problem-solving activity in a given paradigm. They are striving to develop an efficient technological solution to address the market. However, the path of the trajectories developing on each plan is strictly influenced by the efficiency of the ecosystem. In fact the stronger the engine thrust triggered by a good ecosystem the higher the possibility for a given trajectory to evolve toward the right goal: technological dominance.

Thus, even if a technology it is the best one in working a problem-solving activity out, it may not become as widely accepted as an inferior technology whose anyhow the propeller is tremendously active. In the example reported in the chart, just the blue plan succeeded in reaching the dominance. This is due to the fact that, even if challenged by the violet one offering a valuable solution, the blue plan were supported by a stronger ecosystem that in this case made the difference to exploit a better market performance and to gain the technological dominance.

An example to confirm this observation is the one cited above. ProFusion's business case. The real differential factor was the ecosystem, that Google and Yahoo! smartly built and exploited, while Profusion stayed blind relying on its competencies and talents. We can imagine then, Profusion followed a path like the purple plan, ending up in developing a technological solution, a technological trajectory leading to nowhere. On the other side, we can find Yahoo (orange plan) and Google (blue plan) that started a fierce competition to become the market standard. Everyone knows the result of this battle. Even if the competition took place in the same external ecosystem, fact that is important to underline because it means that none of them has received additional propulsion, evidently Google entered the ring having developed a more efficient and elastic firm-specific ecosystem.

Google's minimum viable ecosystem made the difference allowing it to being locked-in as dominant design. It is important to specify that, not being locked-in as dominant technology does not mean being locked-out of the competition. In fact, Yahoo! still exists and keeps on playing in the competitive landscape.

Modified Product and Process Innovation

The second graph that should be reviewed is the one proposed by Abernathy & Utterback. They made a distinction between product and process innovations, saying that when a technological discontinuity appears, competitors starts competing on a product basis. They try to launch alternative solutions on the market, in order to test its reactions and eventually to accelerate towards a dominant position. Then, there is a moment called shake-out when a dominant design emerges and pushes out of the industry all those players that were not able to switch to the dominant technology. The shake-out normally is verified in a phase where incremental process innovations matter more than the product ones. However the emergence of such a dominance normally takes years, sometimes decades.

To support this observation we can quote the analysis of the automotive market at the beginning of the last century performed by Abernathy (1978), Suarez and Utterback (1995). The study is centered on the introduction of the well-known Model T. Ford launched its vehicle in 1908 but evidences show that the dominant technological path locked it in only in 1923. The analysis should be adjusted considering events that happened between those years. For example, immediately after the launch, market demand for the model outweighed Ford's sales expectations, making the American automotive player unable to meet the demand and was forced to restructure its production plants.

Given that, an increasing exit rate is observable in those years, therefore we can say that the emerging dominance is observable since 1911 (N. Argyres, L. Bigelow, and J. A. Nickerson, 2013).

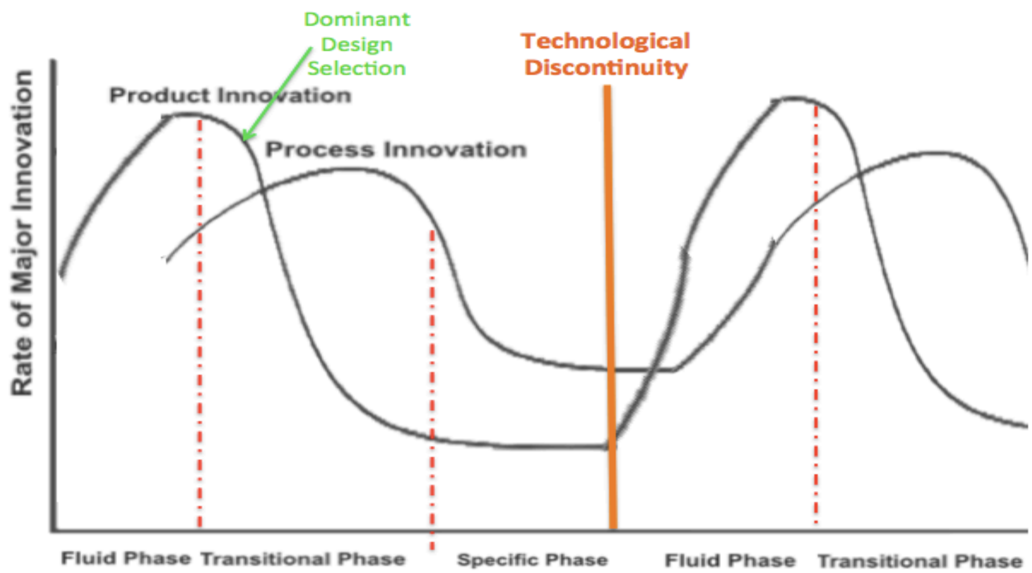


Figure 19 Modified Product and Process Innovation model

After this brief reintroduction to the Abernathy and Utterback's chart, supported by a practical business case like the Model T, we can explain the way the chart can change under the influence of an innovation ecosystem. First of all, we are now in a competitive environment deeply influenced by globalization, there are no geographical barriers behind which a firm can hide thinking to be safe. Starting from this assumption, competition has become fierce and merciless especially if we consider the field of cutting edge technologies. Today, thanks to pushing ecosystems market standards last less than they used to, they are continuously challenged by new emerging technologies, which open new paradigms. Firms whose the technological solution has reached the dominant position cannot be sure to sleep soundly.

This introduction suggests a revisited model where cycles happen much faster and in particular the shake-out moment approaches much earlier. This new early emergence of dominant designs could be studied using as example the Social Networks market. Considering that in the early 2000s' social networks started to sprout like daisies, a new technological paradigm was set up. Here below the most impactful ones: MySpace (2003), Facebook (2004), Twitter (2006), Google+ (2011).

As we can see in the following pie chart dated 2015 the social network launched by Mark Zuckerberg in 2004 became the dominant design in just 4 years.

One might say that technological dominance is strictly connected with metrics like Millennial's daily activity (almost 46%) or like the Time spent on social platforms (83%). Facebook did not become for these reasons de facto a dominant design. Recall, however, that in the literature with the word dominant design it is meant a single product architecture that is widely adopted within an industry, not a single product that becomes widely adopted (e.g., Utterback and Suarez, 1993).

Given that, it is Facebook's structures that impose its dominance, because all the previously existing social networks had been fiercely challenged to avoid to be selected out. MySpace insisted on competing with its technological solution. This strategy drove it out the industry in 2010 (it has been re-launched in 2013).

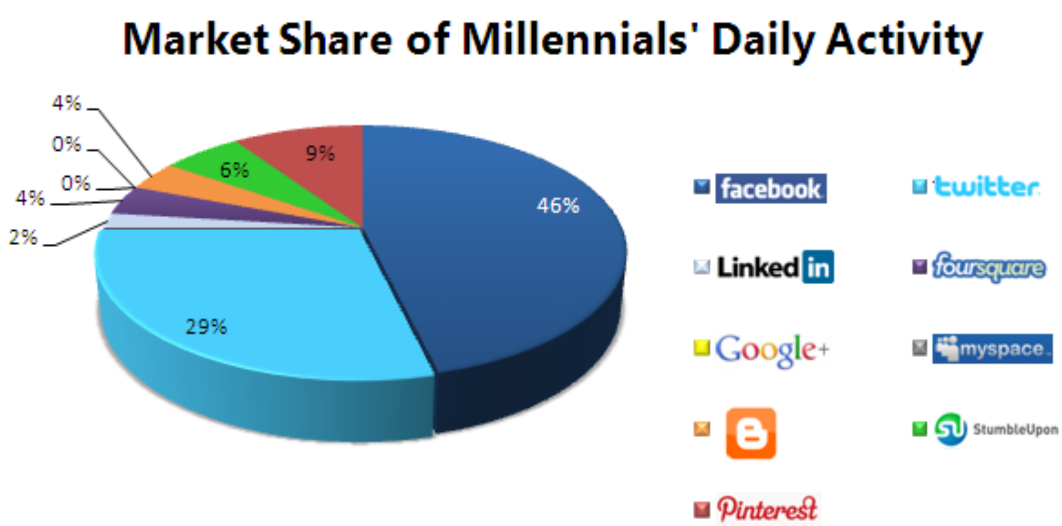


Figure 20 Source: http://www.business2community.com/social-media/a-millennials-daily-hangout-0187582

Social networks born after the market launch of Facebook, in order to survive was forced to find a niche, to be different, to satisfy another kind of need. This the case of Twitter, Pinterest and LinkedIn, whose the format is completely different from the Facebook's one. On the contrary, nowadays there still are social networks entering the industry but their survival rate is pretty low.

To conclude this point, the social network industry is almost in the specific phase, and its lifecycle has been incredibly fast. But what we can observe in the social networks example, is that the shake-out moment has been verified very early if compared to other examples and this is due to a strong influence of the ecosystem lying under the paradigm. Facebook, playing the fast-follower role, grew up rapidly, exploiting both its own ecosystem and the external one. Ecosystems have the power to accelerate and to make the fluid phase briefer, because a technological solution, which grows in a fertilizing ecosystem, turns faster into the dominant one.

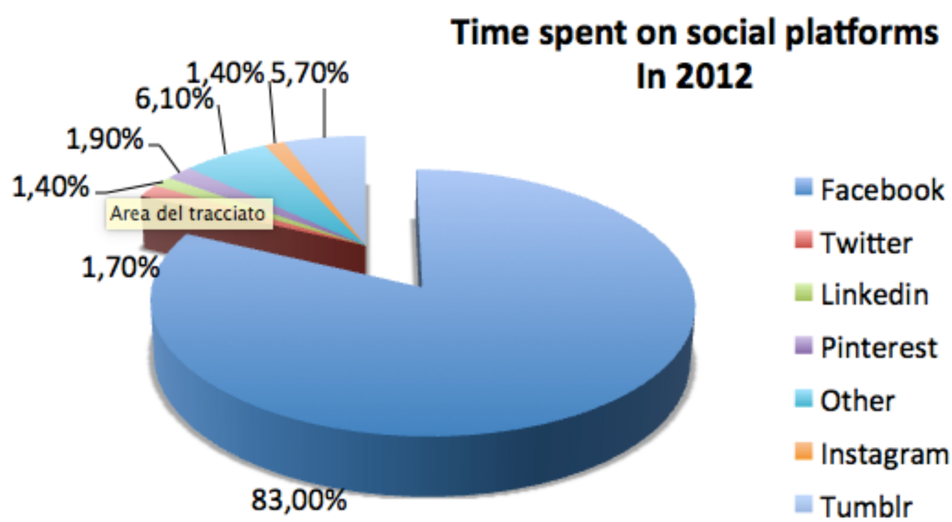


Figure 21 Source: http://wearesocial.net/blog/2013/02/comscore-2013-digital-future-focus/

Modified Entry Timing Effect

The third graph that should be adapted is the one proposed by Schilling. She said that there is a U-shaped relation between the entry timing in an industry and the probability of being locked-out of it. As already explained, what really matters is the time to market. An

innovation could fail and could be rejected even if we are in front of one of the best technological progresses.

But, this graphs does not tell the full story. Something is missing. The graph should not be a U-shaped curve based on a mathematical function like $y= ax^2+bx+c$. Indeed it should be a 3D reversed-bell curve resulting from a function like $x^2/a^2+y^2/b^2-z=0$.

A third variable is suggested to be included into the analysis and in particular we can include the ecosystem efficiency as we did in the previous studies. But let us make some

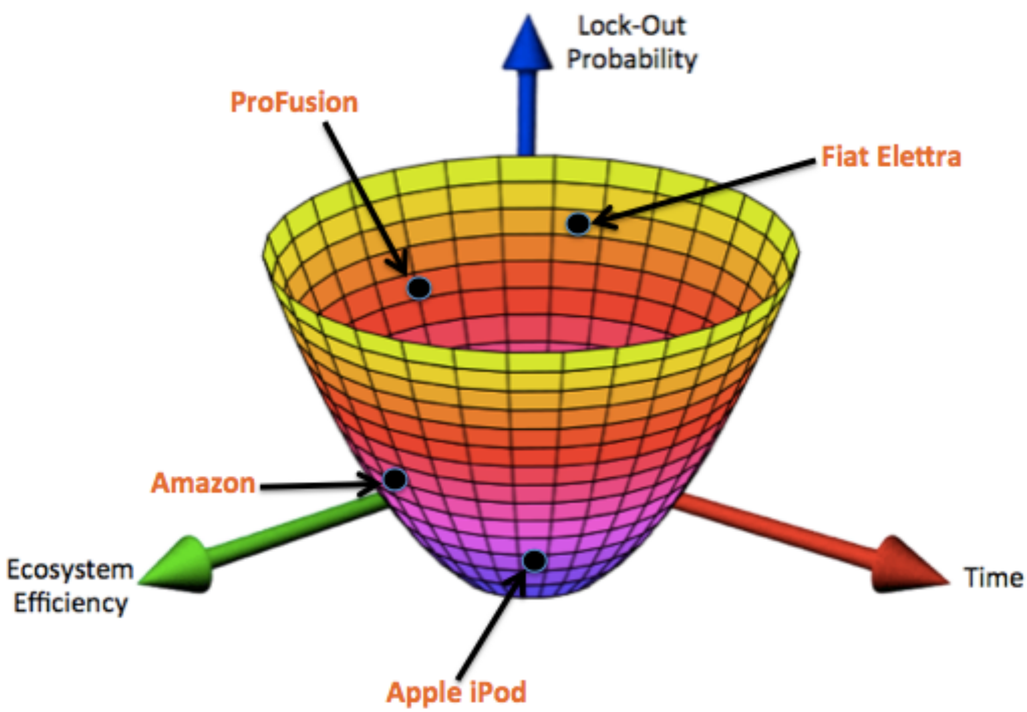


Figure 22 Modifed U-Shaped relationship between entry timing and lock-out probability

assumptions before introducing a practical business case to support this hypothesis.

Taking a look at the chart, we can imagine the following situations representing the four extremes possibilities:

- **Low Efficiency- Early Timing**. In this possibility, quite evidently, we can see that there are no the right conditions for a technology to survive. Sometimes negative effects of wrong timing could be compensated by the strengths of the ecosystems. We can re-quote the Fiat Elettra example just to make it evident. Very early technology, which has been delivered in a rejecting ecosystem. The ecosystem instead of pushing the technology toward the general acceptance and toward the right market niche, kept on insisting with the ancient technological paradigm (combustion engine).

- **Low-Efficiency-Delayed Timing**. This is an even worse case than the first one. Delaying the entry-time could be an effective strategy, but the firm should be supported by a strong ecosystem if it wants to play some important cards during the match to select a dominant design.

- **High Efficiency- Early Timing**. As practical example to prove the importance of a good ecosystem to boost the emergence of a dominant design we can quote Amazon. Its architecture has been widely adopted as market standard in the technological paradigm of the E-commerce. Every competitor strives to develop something at least similar to what Amazon did. However, Amazon started its story in 1994, a period when just farsighted people could even imagine today's vital importance of buying something using laptops, PC, smartphones and tablets. In fact we are talking about devices that in 1994 partially were just fantasies (smartphones, tablets), partially were very primordial (PC, laptops). Nonetheless Jeffrey Bezos launched its technology to achieve the dominant design status.

A major role has been played both by the firm specific ecosystem and by the external one. Amazon's managers who prepared a minimum viable ecosystem composed by several players and partners interacting among each other have accurately set up the first. The second, the Seattle's ecosystem, is one of the top ecosystems to start a new business. In fact, it has been ranked at the fourth position in the Startup Ecosystem Report elaborated by Compass in 2012 (eight position in 2015).

- **High Efficiency- Delayed Timing**. This last extreme example is to show that even if a firm decides for a late-entrant strategy but supported by a good ecosystem, could set up the basis for a dominant design. In fact, for a technology to emerge it is important just that its architectural design becomes widely accepted. This statement is partially in contrast with the point of view of previous studies saying that strategic entry timing is critical to achieve good results (Lieberman and Montgomery 1988, 1998; Mitchell 1989; Tripsas 1997; (Ahuja and Lampert 2001; Rothaermel 2001). We said "partially" in contrast because entry timing is important but not critical. In fact, as this paper highlights, entry timing is a variable that could be influenced and muffled by strong effects deriving from a strongly efficient innovation ecosystem.

  Therefore, firms entering the market launching their own technological solution should shape their entry timing strategy upon the external ecosystem efficiency and upon the firm specific ecosystem they are delivering to the market. But let us take a look from a closer angle.

  MP3 global market since its dawn has displayed a fierce competition in terms of product innovations, high nativity but high mortality too. After almost ten years of skyrocketing development, in 2007 the market value reached the amount of 18 Billion US dollars with 116 million units sold globally.

Analyzing the competitive landscape, we can observe a shift from earlier portable audio players working with exchangeable storage media (tapes, CDs) to MP3 devices designed with internal storage media whose the main advantages were lightness, aesthetics, improved storage and better portability. This breakthrough innovation, opened a new technological paradigm were firms started to compete on a product innovation basis offering qualities like higher storage capacity, more attractive designs, or higher number of functionalities. But in 2001 Apple entered the market with its iPod, and marked the beginning of a dominant design era.
Apple played as a late entrant but succeeded in making its architecture widely accepted and valued. Apple's success is to be searched into the innovation ecosystems it was born in and wisely shaped in order to boost its technology. Firstly the external ecosystem in which Apple built its powerful brand, the Silicon Valley one. We have already studied the way an external ecosystem could influence a general acceptance of a technology rather than another one. Secondly, Apple tested its own minimum viable ecosystem, which was a direct consequence of its best innovation: iTunes Music Store. The company created by Steve Jobs, created an ecosystem exploiting the fact of solving problems of legal infringements. Given that, end-users started feeling good because of the possibility to download legally while copyright companies and authors found the way to earn from a the digital channel. All the upstream and downstream industries started to consider Apple's innovation as the best choice to support. Of course the first iPod was offering valuable product innovations like an user-friendly interface, an eye-catching design and a huge storage capability; but the real innovation that set up the dominance was the ecosystem Jobs was able to built.
The evident success we are analyzing could be demonstrated by its progress in the MP3 market showed in the following table: 381,000 iPod units sold in 2002, 4

million pieces in 2004, more than 51 millions in 2007. An amount of 119 millions iPods has been sold in just six years.

Table 2: Revenues and unit sales of Apple

		2001	2002	2003	2004	2005	2006	2007
Total revenue [mil. US $]		5,363	5,742	6,207	8,279	13,931	19,315	24,006
Net income (loss) [mil. US $]		(25)	65	69	276	1,328	1,989	3,496
Net sales by product [mil. US $]	Mac sales	4,403	4,534	4,491	4,923	6,275	7,375	10,314
	iPod sales	N.A.	147	381	1,584	5,439	9,561	10,801
Unit sales [1,000 units]	Mac	3,087	3,101	3,012	3,290	4,534	5,303	7,051
	iPod	N.A.	381	939	4,416	22,497	39,409	51,360
Net sales in iPod category [mil. US $]	iPod hardware	N.A.	143	345	1,306	4,540	7,676	8,305
	Music services	N.A.	4	36	278	899	1,885	2,496

Source: Apple's Annual Reports 2001–2007 (http://www.apple.com/investor).

Figure 23 Source: Apple's Annual Reports 2001-2007 (http;//www.apple.com/investor)

Coming back to the reversed-bell chart, it is quite evident that a firm should balance its strategy in order to increase the possibility for its technological solutions to be locked-in. In particular, there are two variables strictly influencing each other that should be taken into account: entry-timing and ecosystem efficiency (resulting from an external ecosystem in which a firm is located and from a firm specific ecosystem tightly depending of firm ability to build and deliver it to the competitive arena)

Modified Technology Adoption Cycle

The last graph that should be revised considering the influence of a good or bad ecosystem is the one proposed by Rogers. As we stated previously when discontinuities appears and several technologies begin a fierce competition toward the recognition as dominant design, the one able to conquer the Early Majority will enjoy greater chances be locked-in. Competition is about who is better in triggering the adoption cycle and exploiting network externalities. After this brief reintroduction to the model, we can assess that it presents some imperfections. This is due that it considers only scenery where the adoption process is gradual, without being influenced by any external agent. But let us see how it varies when the ecosystem exerts its pressure.

In the first scenery, the ecosystem is quite efficient, the curve shifts to the left. It means that the adoption process has been accelerated and the time between the innovators' adoption and the early majority one is quite short. As obvious, when a technology has an adoption cycle like the following one, its chances to conquer the dominance are exponentially enhanced.

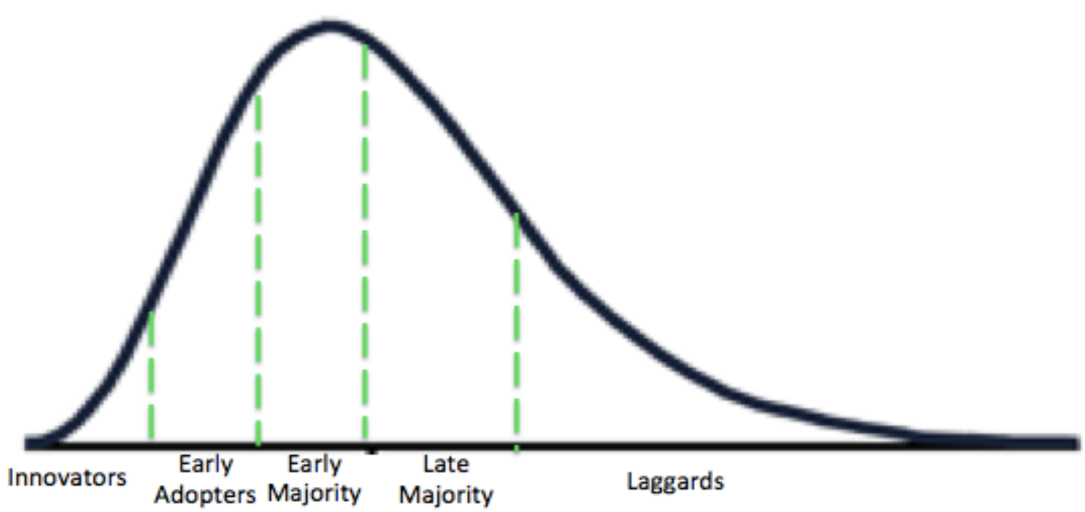
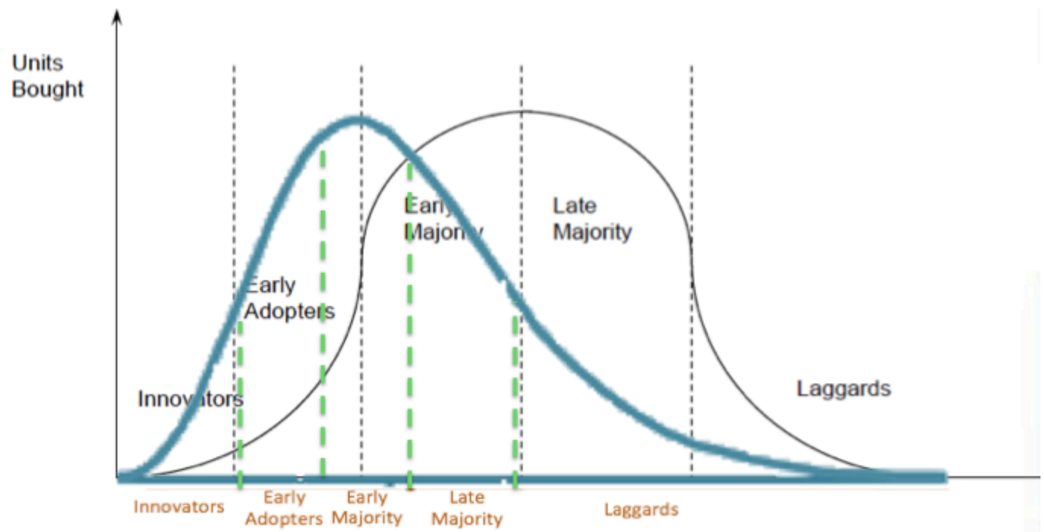


Figure 24 Modified Adoption Cycle: Accelerated Adoption Cycle

To support these hypotheses, we can quote again the iPod example and make a comparison between its adoption cycle and the MP3 one. The former shows an accelerated-adoption graph, the latter a normal adoption cycle. By overlapping the two charts, it is glaring to understand which one has conquered the early majority first and made its architecture widely accepted.



On the contrary, when an ecosystem is not well performing, it ends up being a brake instead of a booster. Everything happens later than normal, and only niches of innovators and early adopters keep on using technologies. The graph below shows us this kind of scenery. We can link this example to the Anti-Google case, where the inefficient ecosystem slowed down the adoption process, making that innovation failing while tempting to set up the basis for a dominant design position.

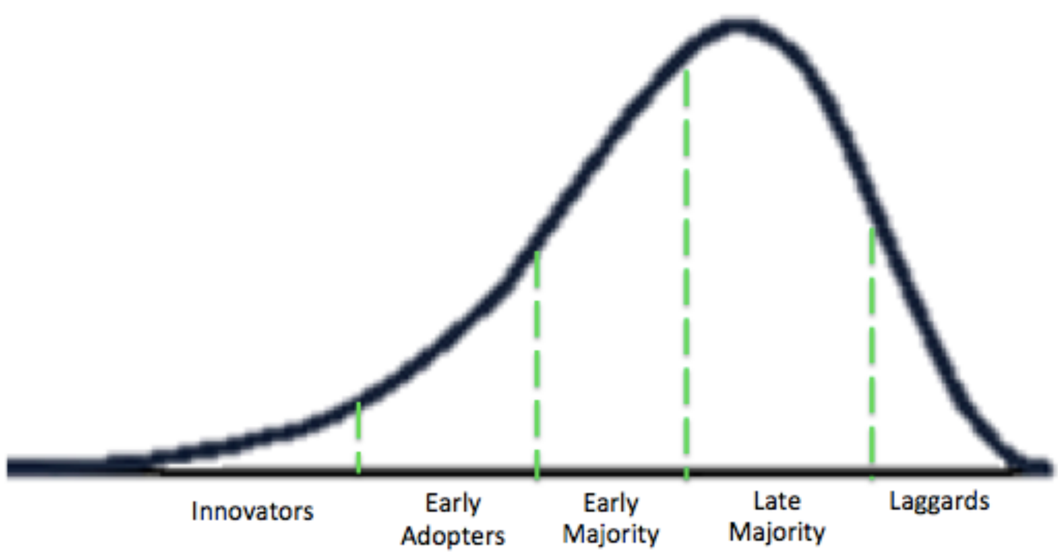


Figure 25 Modified Adoption Cycle: Delayed Adoption Cycle

CHAPTER III

Competitive Arena

This chapter presents a general overview of the competitive arena. At the beginning we will introduce the reader to the top three technologies to solve the indoor positioning: Beacons, Wi-Fi and Magnetic Positioning. To conclude we will analyze the state of the art of the technological competition toward the dominance.

1. Indoor Positioning: A technological need

Localization is the process through which it is possible to determine the right position of a given object in a given space. Humanity has always developed localization tools to exactly know positions. These tools can be basic and primitive like stars' movements, more developed instruments like astrolabe and compass, and much more specialized like the ones exploiting radio frequency, satellite signals and the Global Positioning System. Given that, humans have always considers important to use localization tools for different reasons: R&D, commercial uses, and daily usage. However, even if GPS is the optimal solution for outdoor positioning, unfortunately it does not work inside buildings because GPS signals do not have the necessary strength to penetrate building materials. In the competitive landscape, different technologies are now regularly developed to obviate the lack of an indoor localization tool, but we still cannot identify an approaching dominant design.

Indoor localization and navigation has been defined as one of the next big things because it will allow and facilitate the interaction between users and the surrounding environment. The underlying needs of interacting with the environment in a closed space could be different and they depend on the user we are considering. Hospitals, malls and museums could be interested in helping the user navigation within their spaces, while retail companies could be interested in the technology to improve their marketing efforts addressing the right information, to the right person at the right time. The Federal Communications Commission of the U.S would appreciate the advent of an efficient Indoor Positioning System (IPS) in order to promptly provide emergency services.

But let us focus on what indoor positioning could mean for retail purchases. In fact, if on one side the e-commerce is booming, on the other the majority of retail purchases still happen inside stores. People love to look and touch in first person products. Given that, and taking for grant that almost everyone has a smartphone, an integrated marketing strategy when based on indoor positioning and proximity could match shopping behavior and customer engagement. For example, a retailer could deliver discounts and promotions to customers who are most likely interested in some products or services; retailers could push the customer in a buying decision without seeming invasive.

More than 200 start-ups, after having recognized this "pool of revenue", entered the competitive arena betting on different technological solutions. For example we can find technologies based on cameras, Wi-Fi signals, Bluetooth Beacons, inaudible sound waves, LED signals and geomagnetic fields. These technologies differ in terms of costs, capabilities, precision, longevity and need of infrastructures. Then they can be classified in two main categories: proximity solutions and positioning solutions. The first ones are those like Bluetooth Beacons. It means that the user's mobile will engage with the system built up by the retailer, who can create value for the consumer through messages or push notifications. The second ones on the contrary, are more sophisticated technologies, which offer greater performances, accuracy and real-time localization. Positioning is quite different from proximity because the result will be a moving blue dot on a map (Blue Dot typically stands for You Are Here) and because it will enable several wayfinding applications, turn-by-turn solutions and just-in-time services.

2. Indoor Positioning: theoretic principles.

Before introducing singularly every technology, which aims at satisfying the indoor positioning needs, it could be useful to introduce the four different techniques on which the localization systems rely.

- ***Trilateration***. This methodology provides an estimation of the user's position basing the calculation on distances between the user and at least three reference points. Assuming that the system knows the distances between each reference point, it is possible to build a generic set of coordinates to localize the user.

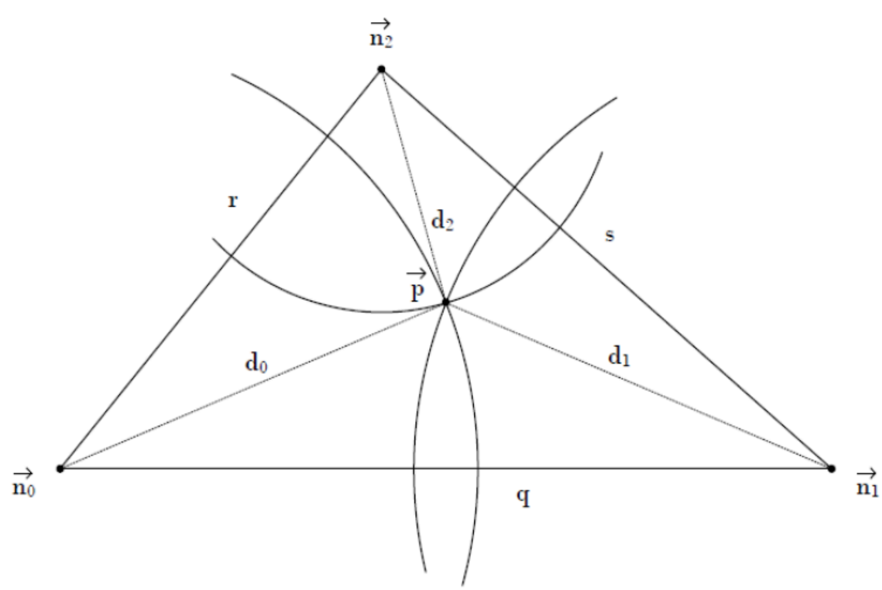


Figure 26 Trilateration System. Source: GiPSTech Confidential Material

- ***Triangulation***. This approach relies on measuring the angle of incidence (angle of arrival AOA) between the users and at least two reference points. The intersection of the lines originating by these angles is taken as an estimation of the user's position in the space. Sometimes this process could be easier if supported by a previous triangulation process.

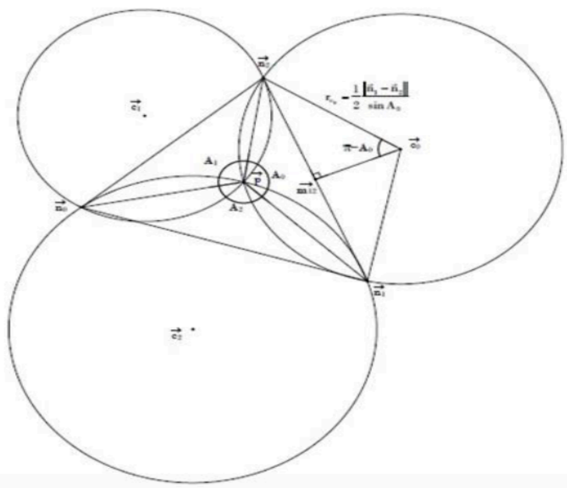


Figure 27 Trinagulation System. Source: GiPSTech Confidential Materials

- ***Context Analysis***. Before starting to use these techniques it is always required a preliminary mapping phase of the environment in which the user is supposed to be localized. Thanks to the mapping phase, information about reference points, signals and their location is collected for every single position in which the user could be. Then, every point presents a set of information defined as fingerprint and we can identify as many fingerprints as positions used during the mapping phase, and it stands as a unique identifier of each position.

When the user moves in the mapped space, it begins the tracking phase based on generating new fingerprints starting from the mapped ones and making comparisons with the fingerprints' database.

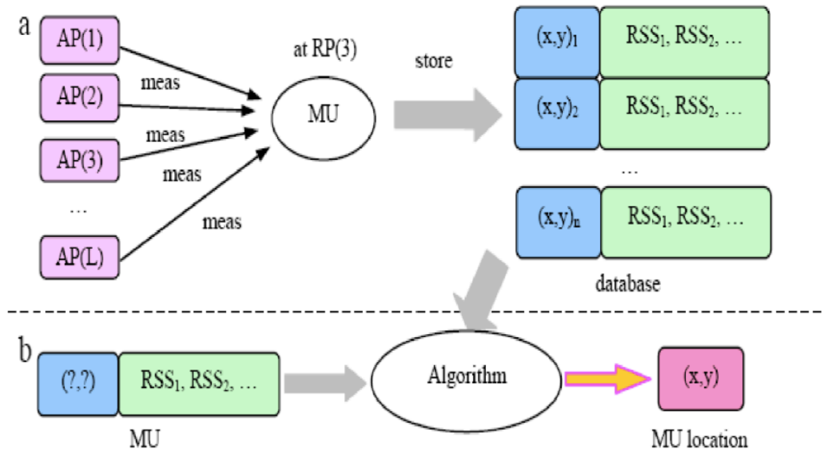


Figure 28 Context Analysis. Source: GiPSTech Confidential Material

- ***Proximity***. This principle is very often used on systems exploiting radio frequencies. In a given space we can find a grid of antennas whose the position in the space is known a priori. When the user moves, he should be equipped with a transceiver that could be identified and reached by the antennas. To estimate the position of the user, it is used the closest antenna to him.

3. Indoor positioning: different technological solutions

Even if there are several technologies that potentially could solve the problem of indoor positioning, we can distinguish three main solutions which are widely recognized as the competing ones to be locked in as dominant design: Bluetooth, Wi-Fi, Magnetic Fields.

3.1 Bluetooth and Beacons

This technology operates within the ISM (Industrial, Scientific and Medical) band. Generally the communication range is 10-15 meters, way lower than other technologies like Wi-Fi. However, Bluetooth is a generally accepted standard, which can run on all modern technologies (PCs, smartphones, tablet etc.) and it works through a constant communication between Bluetooth tags. Bluetooth technology has not been developed as a solution for indoor positioning, however in small places it can works quite efficiently depending on the number of tags that have been put in that place. Apple, via iBeacon, has popularized the diffusion of a proximity technology relying on Bluetooth signals. Beacons are small, battery-powered devices that communicate with the environment and other Bluetooth tags. The user's smartphone will recognized location signals delivered by beacons and it is supposed to reasonably estimate the distance of the user from the beacon simply by calculating the strength of the signal. This technology has received much of the location technology attention especially because of the intervention of Apple, which developed the high profile iBeacons and which is betting on that technology. Several entities are now using beacons for commercial purpose; for example Apple has installed few beacons at the entrance of its stores in order that a potential customer will receive a welcome message every time he will get into the store. inMarket has recently performed a study concerning the improvement to the customer experience deriving from the advent of beacons. Here the results: interactions with advertised items were 19 times higher when users received a beacon message, while the same users used 17 times more frequently the store app during their shopping experience. Among the advantages of this technology we can say that they are really cheap, they do communicate with a wide range of devices, they are small and they are widely diffused. On the other side, beacons can exclusively be used for notification (proximity) and not for positioning. They cannot show a moving blue dot because it goes out of their potentialities and they will not be able to provide XY or XYZ coordinates for consumers better engage with the environment. Other disadvantages of beacons are that they are highly susceptible to be removed because they are often stuck using tape and that they require battery maintenance. However to perform an accurate estimate of localization we need a large-scale installation of them and it could be costly. Even if beacons are proximity technologies non-optimally adapted to solve the indoor positioning need, Matteo Faggin, co-founder at GiPSTech during an interview said:

"If I have to identify an indoor localization technology which is most likely to reach the status of dominant design, I will say that beacons are closer to that dominance. This is due especially to their compatibility with other devices, and to the high profile support of a giant like Apple, which is widely promoting their adoption in several industries".

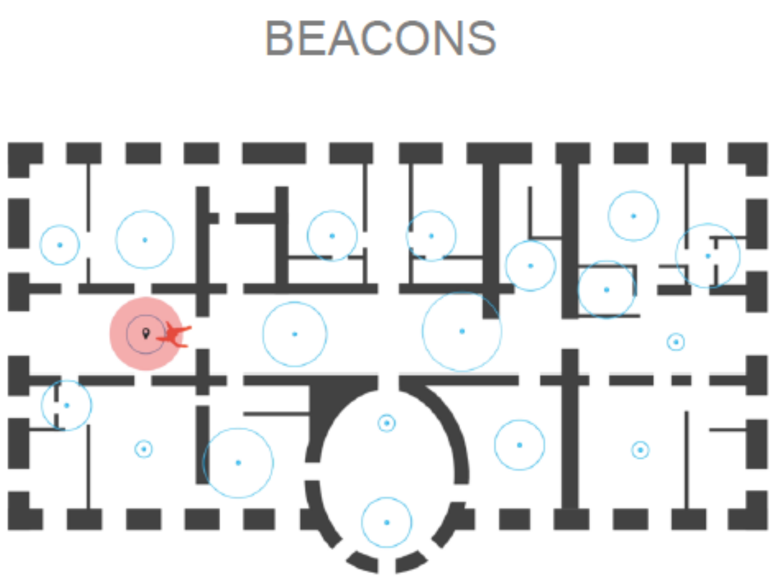


Figure 29 Source: GiPSTech Confidential Material

3.2 Wi-Fi

The Wi-Fi system works using an already existent WLAN infrastructure to address the indoor positioning needs. The IEEE 802.11 is currently the standard for wireless standards and it works exploiting RF signals in the 2.4 Ghz band. The real measuring precision oscillates between 3 and 30 meters depending on the environment conditions, while the maximum distance for this technology to work is 100 meters. The main boosters of this technology are the huge availability of Wi-Fi enabled devices and the widespread network infrastructure. Different studies have been conducted to push this technology to its limits and the results confirmed that Wi-Fi is not the optimal solution for indoor positioning. Y.C. Chen analyzed how doors, people and humidity could influence the estimation of the indoor localization. For example, if in a given space there are closed doors, the positioning error goes up to 236%, if there are people moving the error increases of 86%, while humidity rises the error of 43%. We are in front of performance degradation, which is typical of RF fingerprinting based systems and the impact of each component depends on the signal frequency: when obstacles are relatively small compared to the wavelength, their influence is quite negligible. But we have to take in consideration that the Wi-Fi wavelength is typically 12,2 cm and the direct consequence is that the vast majority of the objects in a given space have dimensions, which could not be classified as negligible. To sum up we can assess that Wi-Fi indoor positioning presents several advantages like the exploitation of an already existent infrastructure, availability of mobile devices and good precision. However the technology is affected by several limitations, which influence both precision and reliability. Here below a brief description of the main ones.

- ***Limited coverage***. Even if Wi-Fi is tremendously popular, its coverage is concentrated in office buildings and in huge urban areas. In fact Wi-Fi is still difficult to find in developing countries and in less populated areas.
- ***Interference***. The 2.4 GHz is shared by several electronic devices, like cordless telephones and microwaves ovens. Thus, these devices could actively influence the detecting precision.
- ***Energy consumption***. Generally Wi-Fi modules are characterized by a relevant power consumption (300 mW, when in energy saving modality) and consequently battery powered devices have limited functioning.
- ***Multipath***. In the wireless telecommunication sector, the multipath phenomenon in propagating a signal transforms in radio signals, which reaches from multiple directions the receiving antenna. Among the causes of multipath, we can find: the ionospheric reflection, the reflection and refraction due to water entities, terrestrial objects like mountains and buildings, walls and doors. Multipath will shift the signal and sometimes it will completely shadow it.
- ***Shadowing***. It happens when a signal passes through obstacles and it depends on time, geographic location and radiofrequency.
- ***Inflexibility to changes in network structure***. Every single time there is a change in network infrastructure, it is necessary to reconsider from scratch all the assumptions on which the localization system is based. For example, Wi-Fi localization exploits the fingerprinting technique originated in the above mentioned training phase. After each small change in the infrastructure (new access points, access point relocation, access point removal) it is necessary to restart the training phase.

In addition to these limits, it is necessary to mention the non-implementability of Wi-Fi positioning systems on Apple iOS devices. This happens because Apple does not allow developers to have access to the value of the signal power (RSSI) measured by the smartphones. By hiding this value, Apple impedes every Wi-Fi based fingerprinting localization technique. Thus nowadays, except of those cases in which there is a specific agreement with Apple, it is not possible to implement Wi-Fi indoor positioning on iOS devices.

To conclude, we can reasonably assess that rarely the Wi-Fi measuring error is lower than 10 meters, and even in the future it would not be possible to improve reduce the error. In fact drastic changes in access point might be necessary, and these changes will undermine already generally accepted Wi-Fi standards. Given that, huge costs to revolutionize the entire Wi-Fi infrastructure are not justifiable and sustainable. In addition, as already stated, this technology could not work on Apple devices, which on the contrary have an enormous installed base. For these reasons, it easy to understand that Wi-Fi is not an optimal solution to satisfy the indoor localization need.

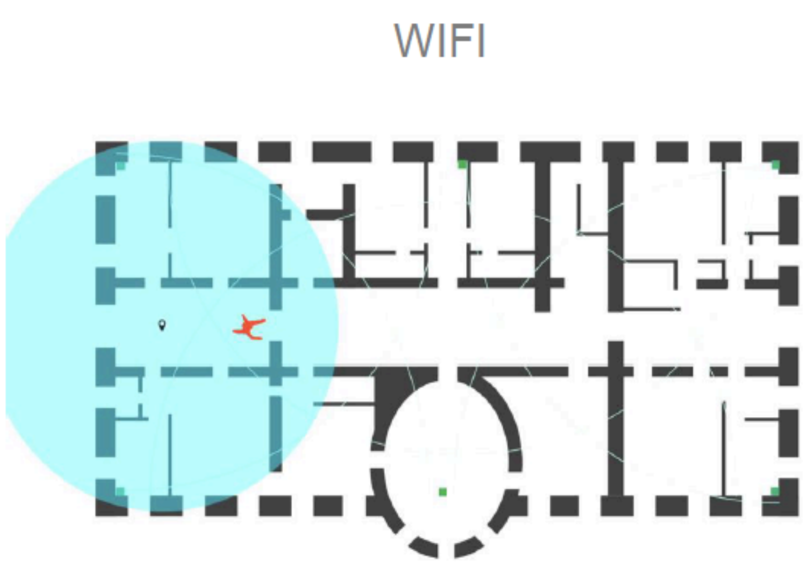


Figure 30 Source: GiPSTech Confidential Material

3.3 GiPSTech and Magnetic Positioning

Magnetic positioning works taking inspiration from animal wayfinding system in nature (e.g., birds, bats, bees, etc.). Animals exploit Earth's magnetic fields to understand their position and to identify the right direction to reach their destinations (e.g. seasonal migrations). Likewise smartphones are similarly able to identify and interact with magnetic field alterations inside buildings. Indoor positioning technology provides performances whose the accuracy in indoor environments oscillates between one and two meters maximum.

During the interview, Matteo Faggin (GiPStech's co-founder) told the GiPSTech history. The two inventors were trying to make drones flying inside buildings, then they perceived that the compass installed into the drone were suffering for abnormal alterations. It was not pointing the right North. Starting from this event, they understood that each building or structure has a unique magnetic fingerprint, which depends on the way building materials affect and warp the persistent geomagnetic field. In fact, buildings are erected with materials that influence the readings on a smartphone's compass. Earth's magnetic field is disrupted by the presence of steel beams, wall studs, doors and other materials, and it is detectable through the use of magnetometers, which are normally present on the vast majority of smartphones. Thanks to magnetic positioning software, these fields are mapped and coupled with points on a floorplan in order to allow indoor positioning services. Given that, magnetic positioning, by enabling smartphones' compasses to detect the individual within an already fingerprinted location, exploits the Earth's geomagnetic fields to locate individuals within indoor spaces with an extremely accurate precision. Thus, smartphone owners (iOS and Android) can then be accurately located inside retail stores, hospitals, malls, airports and other indoor spaces.

GiPStech has developed a new technology, which exploit the MLC algorithms' functions. MCL algorithms can be considered as "brute force" because they perform an exhaustive research that addresses specific problems systematically developing, a set of possible candidates for each iteration and then trying out whether these candidates can represent a feasible solution to the problem or not. When after N iterations there is only one remaining candidate, that one is the solution. Contrariwise, the algorithm aims at disrupting the set of candidates, and then it expands again generating new possible candidates and releasing only the best candidates to reiterate the whole process. The basic idea on which GiPStech technology is based is to use as inputs signals for the MLC the map of the geomagnetic field of the building coupled with key signals elaborated by a proprietary inertial module used to develop the entire system. Starting from the assumption that geomagnetic field is locally constant because it is a natural phenomenon of our planet, GiPStech technology intervenes in closed environments, where the phenomenon's constancy is not realized due to presence of ferromagnetic materials (cables, pipes etc.) that alter the value of the field and its effects. This alteration is exploited by GiPStech to locate the user.

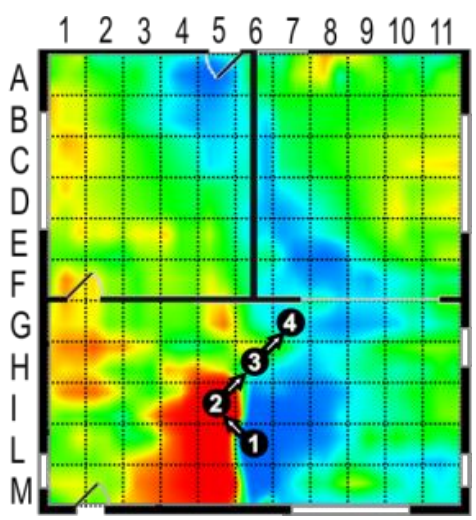


Figure 31 - Magnetic map of building 1,
Source: GiPSTech Confidential Material

The plan in Figure 31 presents a typical closed space, integrated with an ideal grid. Different colors show us different values of the geomagnetic field in order to detect anomalies originated by the presence of ferromagnetic objects. Areas with the highest field strength are red, while areas with a lower intensity are blue. While performing the iterations of the algorithm-driven inertial system, if we prefer candidates that not only do not break geometric constraints (collisions with walls, leaving the perimeter of the building etc.), but also are characterized by an intensity of the magnetic field on the map quite similar to the one previously measured from the user's smartphone to localize, then we will have the opportunity to improve the operation of MCL. This improvement could be possible because at each iteration the process will exclude many more particles than in the case of just using the map without having measured the intensity of the magnetic field in advance.

Just to show the way the technology works, let us assume that an individual wants to be localized is in the position 1 (cell L-6) of the map in Figure 31. Then, he decides to move from position 1 toward positions 2 (I-5), 3 (H-6) and 4 (G-7). At the beginning, for the localization system, the user's location is unknown. With reference to Figure 32:

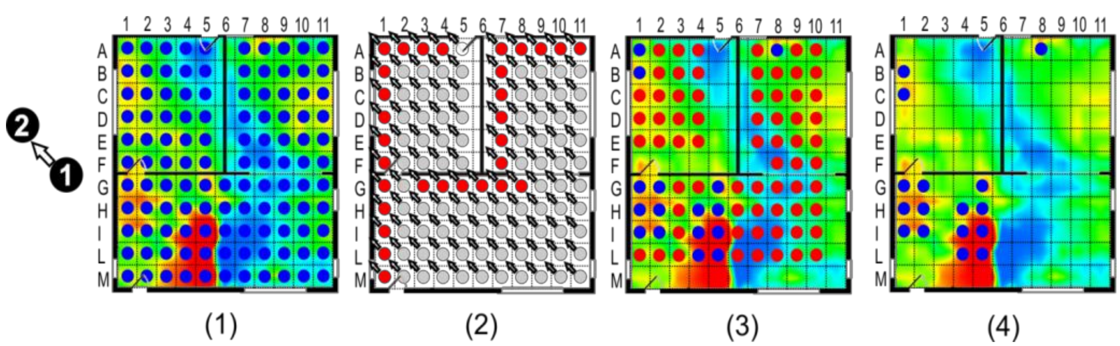


Figure 32 First Iteration Localization Algorithm. Source: GiPSTech Confidential Material

- The system set up the procedure by placing the particles in each grid cell of the map (Figure 32 - 1).

- When the individual moves, he perturbs the particles, which moves in the same direction. Few of them are eliminated from the set of feasible solutions because with their displacement they collides with the walls inside the buildings. These collisions are represented by the red dots in Figure 32-2.

- Surviving particles (red and blue) are then processed and sorted. This step is performed in accordance with a probability function that relates the value of the geomagnetic field of the cell occupied by a particle with the one measured by the user's smartphone. In the example the user goes to cell I-5, and this cell when measured by the smartphone, presents a very intense geomagnetic field (red). Thus, we can delete from the map all the particles whose the field has an intensity very different from the one measured by the user.

- The process will eliminate red particles and just blue particles (Figure 32-4) will survive the first iteration.

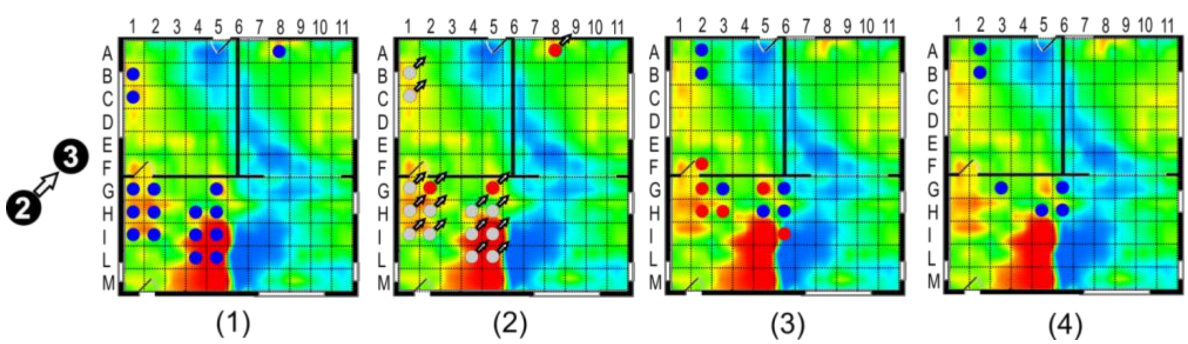


Figure 33 Second Iteration of The Algorithm Localization. Source: GiPSTech Confidential Material

After that, taking in consideration subsequent movements of the user, the algorithm iterates the calculation and in two steps (Figure 33 and Figure 34) it will correctly locate the user in the cell G7.

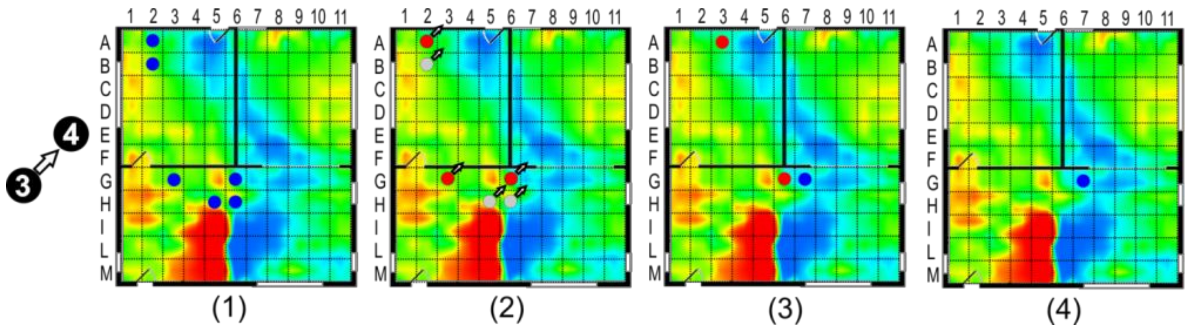


Figure 34 Third Iteration, User location in G3

As previously described, the localization system requires efficient input signals to properly work. Thus, it is indispensable to have the right measures in order to estimate the user motion length and direction and to drive the iterations of the location engine. Starting from literature, we know that it is possible to use an inertial measurement unit (IMU) to estimate the direction of a moving individual. The IMU normally is composed by accelerometer, gyroscope and compass, it is firmly attached to the moving object, and it publicly shows the offset in alignment between the reference system of the IMU and the reference system of the moving objects. These techniques could be applied in modern indoor positioning technologies because the smartphone will substitute the IMU and it is supposed to be attached to the user.

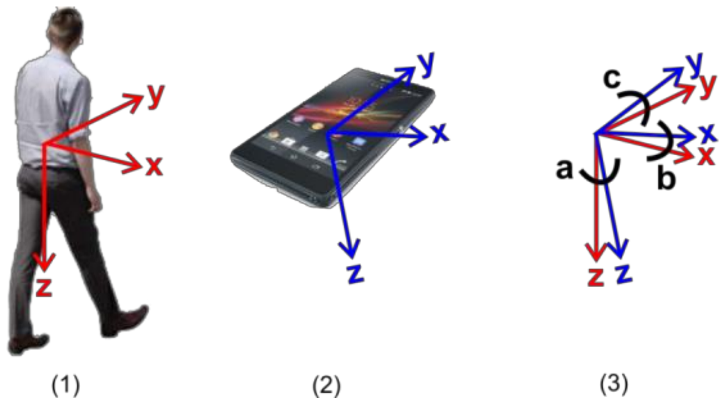


Figure 35 Reference Systems and smatphone user. Source: GiPSTech Confidential Material

If these assumptions were verified it would be possible to use known techniques, for example to calculate the angle which expresses the user's direction of travel with respect to the reference system fixed to the map (Figure 7, angle Ψ) and the other two angles of pitch and roll.

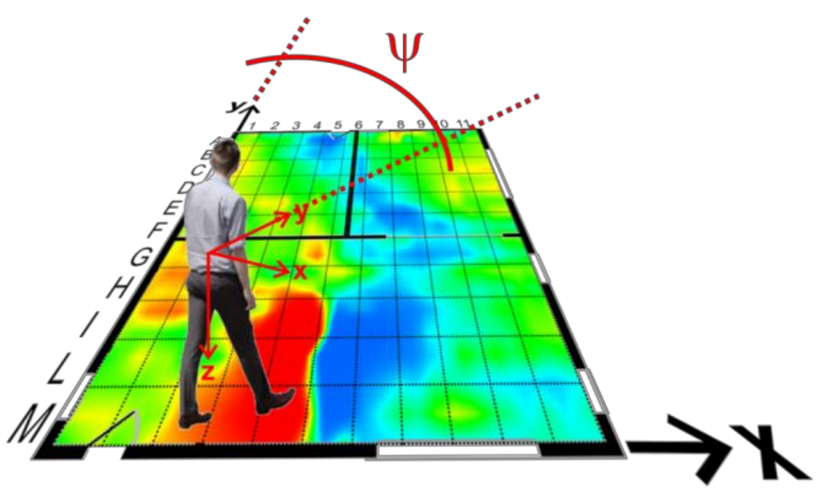


Figure 36 angle reprentative of the direction of movement of the user. Source: GiPSTech Confidential Material

Generally the user that would like to know his location has the smartphone in his hands and he tends to move it while walking. The direct consequence of the smartphones' movements is that it will impossible to know the offset angles a,b,c of Figure 6 relying on a static model.

The inertial engine, implemented in GiPStech technology, uses a proprietary technique to solve this problem. In fact it succeed in estimating the moving direction angle (angle of yaw) without constraining the relative orientation of smartphone and user. Moreover GiPStech's engine uses a proprietary technique for the estimation of the angles of pitch and roll.

The other input signal required by the localization engine is the distance that the user travels in his displacements, for example between two consecutive steps. In this case as well, there are various techniques available in literature, which allow determining the space covered by the object that moves if it is firmly anchored to the IMU and if the offset of alignment between the two reference systems is known in advance. In reality, because of drifts and errors present on the accelerometer measures, calculating the distance through this simple formula causes errors of the order of a few meters per minute of use, and therefore is not usable.

Then, magnetic positioning techniques should face a second problem: the determination of instants of time in which the user moves and those in which the user is stationary. If the smartphone was fixed, for example to the user's foot there would not be any problem in measuring acceleration. In this example (Figure 8) it would be really easy to recognize both the instants of time and to calculate the distance traveled.

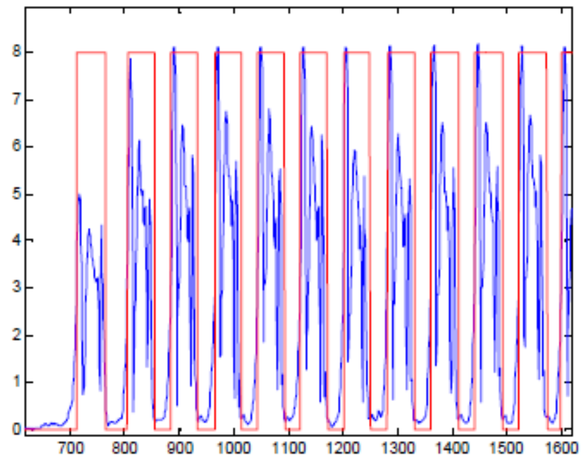


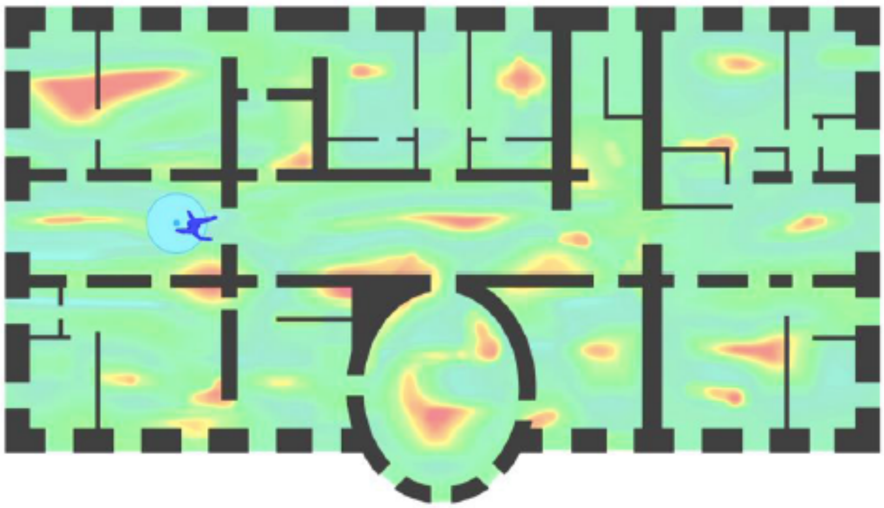
Figure 37 Measurement of acceleration during walking user

In reality, the smartphone is not attached to the user and this in turn does not allow to use the readings of acceleration to simply discriminate the state of motion and still, as the user dynamic is measured coupled with other effects introduced by the absence of the bond of attachment (relative movements between user and smart phones during the walk).

GiPStech has developed a proprietary technique that overcomes these problems and allows the technology to determine the times when the user is moving and still, and the distance traveled.

These estimates calculated by GiPStech's inertial engine (moving direction, instants when the user is stationary and still, distance traveled) are then taken as input signals for the location engine.

GIPS TECH



	WIFI	BEACONS	GIPS TECH
PRECISION	5 to 15 meters	3 to 5 meters	1 meter
NAVIGATION	Not meaningful	Jumping	Fluid
INFRASTRUCTURE	Wi-Fi Emitters	Beacon Emitters	What is already there
SETUP COST	High Depending on type and number of APs	Medium Depending on numbers of beacons	Low If any, we require less than 1/10 emitters
PROS	WiFi infrastructure can be used for other services.	Integration with iOS (iBeacons)	Reliable, using "natural" signal and leveraging any RF already present
CONS	Unreliable as infrastructure is unreliable	Unreliable, dedicated installation. Precise only with lots of beacons.	None

Figure 38 and Figure 39. Source: GiPSTech Confidential Material

Thus, the ideal indoor-location technology would be one that requires no additional hardware to be installed in buildings or added to mobile phones. In other words, GiPStech provides the optimal solutions, but for some reasons it does not mean that magnetic positioning will be the dominant design.

4. The way to dominance: state of the art

Until this moment we have deeply studied the three main technologies, which solve the indoor positioning problem. It seems pretty logic that the technological solution developed by GiPSTech is the closer to the condition of optimal solution. However, the vast majority of players are betting on the other technologies. As we already stated, when it comes to decide on which technology it is worth to focus innovative efforts, many players go for the less risky one. In fact, technologies like Wi-Fi and beacons are widely used on a daily basis. Today every building is equipped with a Wi-Fi connection, while many retailers have already started to use beacons as a marketing leverage. Wi-Fi is a general technological standard for Internet connection, but it is not a standard to perform localization. It is quite imprecise and there are no margins for future improvements. Anyhow, big players still rely on this technology, forcing it to do the job of other technologies. For example, Apple has recently acquired for $20 Millions a startup (Wi-Fi Slam), which developed a Wi-Fi indoor localization system, while InvenSense has acquired, other two Wi-Fi positioning startups: Movea and Trusted Positioning. Apple exploiting its leadership made a predatory announcement to the rest of the players, it clarified which technology they considered the most valuable, and probably this move triggered a powerful herd behavior among smaller players. Apple is also betting, for marketing purposes, on the beacons technology by having endorsed iBeacons. However, even if we previously specified that beacons are good for proximity purposes and not for indoor positioning, when a big influencing corporation as Apple opts for that technology, it could happen that it becomes so popular that it is then exploited to solve different problems. Nowadays beacons are so diffused that if we have to decide which technology is the closest one to be the next dominant design, it would be obvious to choose beacons.

On the magnetic positioning side there are two main players: GiPStech and IndoorAtlas. These are two startups that are struggling to find the right partners to build their firm specific ecosystems and to set the pillars for a future dominance of magnetic positioning. IndoorAtlas, is a Finnish startups (spin-off from the University of Oulu) which has already disseminated strategic bases in the Silicon Valley and in Asia (Japan, Korea, China). These bases helped them during the fund rising activities, and now they can leverage their financial power to develop their magnetic positioning solution. GiPStech is an Italian startup, which is the result of a spin-off from the Università di Calabria. GiPStech technology is a bit better than the one provided by IndoorAtlas, contrariwise it is having lots of problems in finding the right capital power and the right boosters to promote its technology.

Here comes the purpose of this study. We want to understand what are the hidden factors that decide over the life of a given technology that somehow is better than the one selected as dominant design. But first things first, after the emergence of an indoor localization need a new industry has been set up. The very distinguishing feature of this industry is that just one technology has been developed from scratch: magnetic positioning.

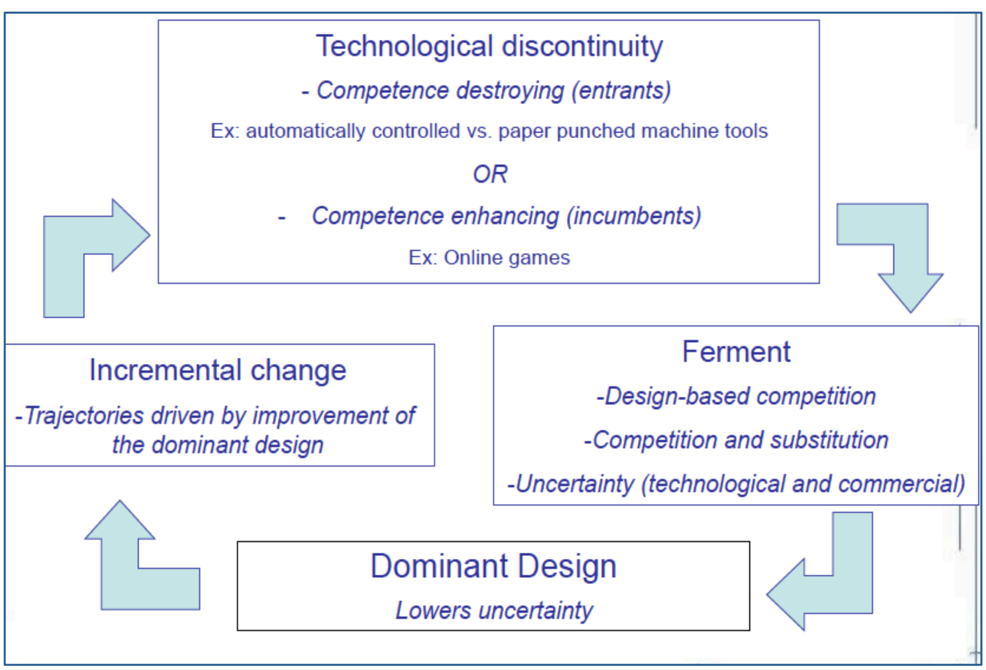


Figure 40. Source: Management of Innovation University Materials

In fact, it should be highlighted that technologies like Wi-Fi and Beacons exist to address other needs. Those technologies operate in other industries, however they can, at least in part, provide an acceptable technological solution to address indoor positioning needs. Then, taking a look at the previous graph, we can say that Wi-Fi and beacons are competence-enhancing technologies, while magnetic indoor localization is a competence-destroying one. This is due to the fact that, the first two are following evolutions of already existing technologies, they have been improved since their creation and still they will. On the other side, magnetic positioning is an innovation that partly destroys those competences developed by already existing technologies.

Just the future development of the industry will show which of the technology will be selected as dominant design, but today we can assess that magnetic positioning is a potential disruptive technology which has the possibility to undermine at the right moment many sustaining technologies. It should be specified that the use of potential as adjective to classify the technology we are analyzing has been selected on purpose; in fact, we cannot state for sure that magnetic positioning will disrupt the indoor localization industry, however it is pretty evident that this technology presents the necessary characteristics to be disruptive.

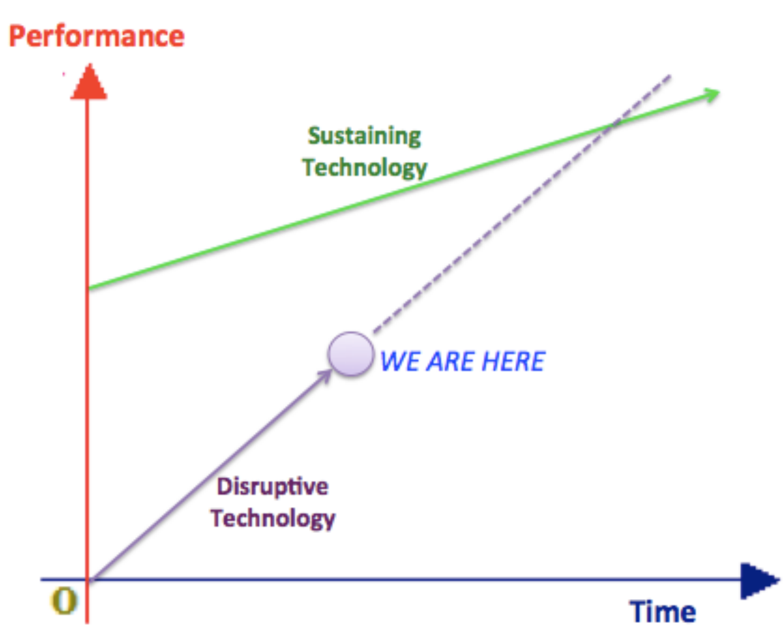


Figure 41 Dirsuptive Technology. State of the art.

There are many obstacles to be overcome from within the industry. It has already been said that Apple has heavily invested in Wi-Fi positioning and in endorsing iBeacons. It means the huge Corporation from Cupertino, will not accept to see its investments easily burned. And like Apple many other players will keep on pushing Wi-Fi and beacons positioning by fiercely protecting their competitive positions.

What is happening right now is that Apple, when it came to decide on what technology to bet, opted for a safer technology (Wi-Fi) because it presented a higher expected value if compared with magnetic localization solutions. In fact, as we analyzed while presenting the penguin effect, Apple's optimal decision relied on the confrontation between X (Wi-Fi technological value) and $E(y)_{Magnetic}$. While the real value of Wi-Fi was already part of the public knowledge, the evaluation of magnetic positioning was based on risky and subjective expectations. Probably Apple judged $X > E(y)_{Magnetic}$ and its managers decided to invest in Wi-Fi. However, behaving in this way, Apple made a predatory announcement. It means that a big player clearly specified its competitive position and it can exploit its awareness as an influencing tool to push other players deciding for a less risky herd behavior, and putting in action an imitation strategy. The bigger the corporation the stronger the influence of the announcement. In fact Firm B will face again a situation where $X > E(y)_B$, and the value of X is even reinforced by the choice made by firm A.

Thus, apart from developing a cutting edge technology GiPStech should find a strategic big player to insert among complementors in its own firm-specific ecosystem. It needs to be supported by a predatory announcement in order to enhance the possibilities for other players to recognize the disruptive potentialities of magnetic positioning. Paradoxically speaking, for GiPStech will be a good result if IndoorAtlas find a strategic partner. In fact at this stage of the industry, the competition is among technologies not among competitors to gain market share. Starting from this point of view, IndoorAtlas and GiPStech are allied towards the selection of magnetic positioning as dominant design. They are struggling to enlarge the pie they will compete over in the future. If they do not cooperate now, there will not be a pie tomorrow.

Today, Apple relatively risks that magnetic-positiong pioneers will dominate the new market protected by well-structured barriers to entry (patents, copyrights, loyal customer base, suppliers etc.). In that case, Apple, instead of trying to offset new technology's advantages, might accept that previously made investments in Wi-Fi positioning turned out to be sunk costs and consequently it should start investing in magnetic positioning before it will be to late. Normally big corporations enter an industry by acquiring smaller well performing start-ups.

Going back to the industry analysis, the technological paradigm that characterizes the technological development of different solutions is based on two main variables: Infrastructure unnecessity and precision. The first one is important because, it means that the detection system is independent from any kind of complementary structure. GiPStech's technology does not need any previously installed infrastructure, while Wi-Fi and beacons do. This is a huge technological advantage to be leveraged.

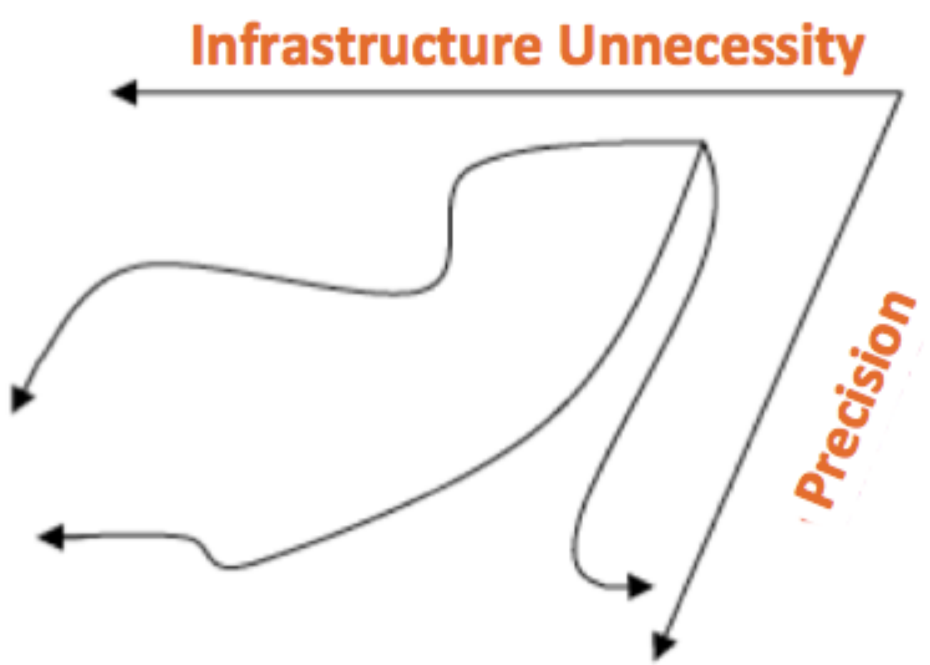


Figure 42 Technological Paradigm and Technological Trajectories applied to our case study

The second variable is the precision in localizing an individual inside a building. In the case of Wi-Fi and Beacons there is a direct correlation between the number of infrastructural devices and the precision rate. It means that the higher will be the number of Wi-Fi hotspots or the number of beacons the more precise will be the localization system. In the case of magnetic positioning, this relation does not hold. Even without any sort of infrastructure the magnetic positioning will perform almost perfectly. This is due to the fact that magnetic positioning exploits magnetic fields, which are a natural ever-lasting force.

After having specified which is the technological paradigm behind technologies we are taking in consideration, we can move to the industry analysis using the model developed by Abernathy and Utterback.

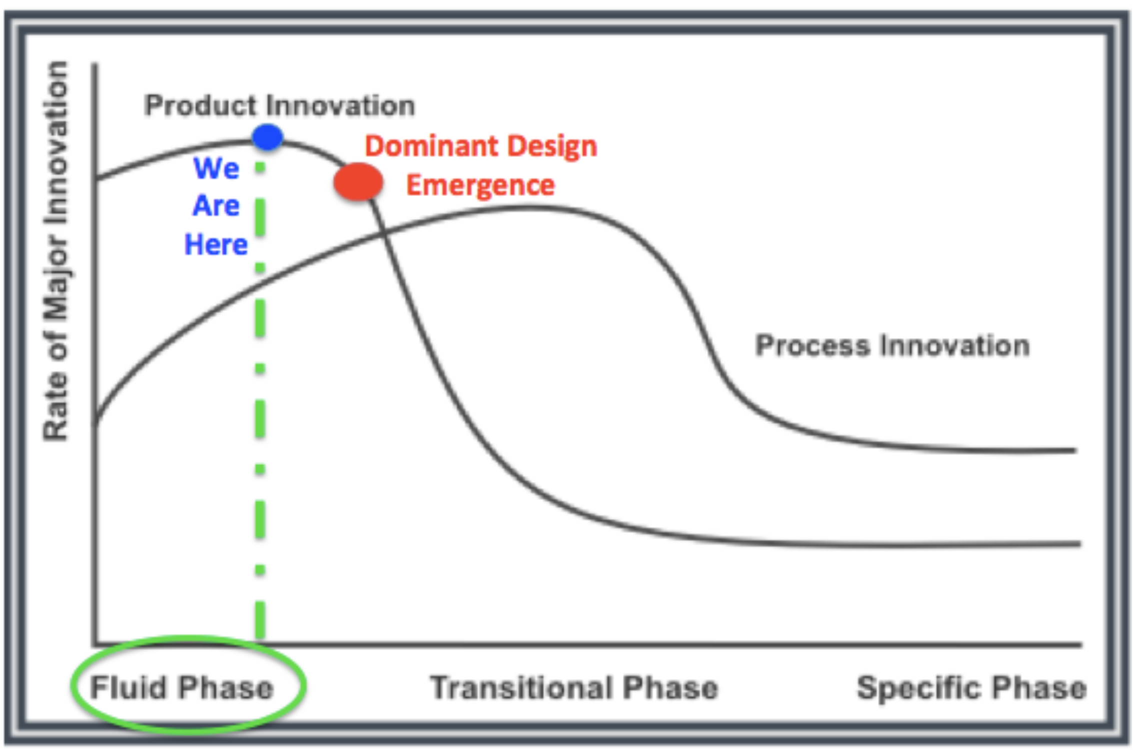


Figure 43 Produtc and Process Innovation. State of the art

As we can see we still are in the fluid phase. It means that several technological solutions to solve the indoor positioning problem have been developing since the industry birth. Many players are entering the industry providing their solutions and keeping on improving it. Everybody tries to make his solution as precise as possible in order to push it towards the recognition as dominant design. However, even if we can assess that at some point there will be the fateful lock-in of the dominant solution, we still do not know how far in the time that moment is. There are many variables to be taken into account, strategic variables strictly related to the technology and to the firm, and ecosystems' variables whose in next chapter we are going to demonstrate the incidence over the dominant design selection.

CHAPTER IV

Methodology and Results

1. Methodology

Theoretically, we have assessed that ecosystems are two-sided variables. In fact, in order to study the whole distortion caused by an ecosystem to an industry, we can break down the ecosystem in two variables: the first one is an exogenous one, while the second should be understood as a firm specific asset. These variables, when combined, have the power to shape the technological environment, its industries and its dominant designs. In chapter 2, we have revised some graphs from literature with the aim of including in the ecosystem variable and to make assumptions about its consequences, both positive and negative, over the evolution, development and adoption of a given technology. The main aim of these studies was to put in evidence that technological evolution needs to be included in efficient ecosystems of other proactive and complementary factors.

To come up with the set of assumptions, we have firstly identified several case studies that we previously mentioned, and then we tested them with the GiPStech's case study supported by several interviews. In order to have a general overview over industry dynamics, we started with a deep understanding of industries' and ecosystems' evolution literature. After having collected a sample of evidence from prior case studies, we elaborated a set of new graphs and assumptions, and we tried to predict what kind of ecosystems' factors could play a crucial role during the selection of a technology as a dominant design. The importance of this study relies on the fact that managers and entrepreneurs should include these variables in their strategies. As we know, ecosystems play a fundamental role in driving a technology to success and business strategists should handle it with care. Given that, if managers and entrepreneurs understand how to efficiently set their technological trajectories up, they will exponentially increase the chances for their technology to be locked in.

To test the assumptions we have formulated in chapter 2, five interviews have been conducted with 5 industry experts with different backgrounds, skills and visions. The five interviewees came from different roles within GiPStech. In particular, they are two engineers, two investors with a deep technological understanding and a Sales&Marketing Manager. Each interview was semi-structured, in order to follow an inquiring path but at the same time to leave the interviewee free to analyze several aspects of the business and technology. The interviews were preceded by a general introduction about literature, technical wordings and about the aim of this thesis, and they lasted 40 minutes on average. At the end of the interview, the new graphs have been shown to the interviewees asking for a comment. They all agreed on the importance of including ecosystems as a strategic variable that must be studied while running a business.

Sixteen questions have been asked to the interviewees, and they could be divided in two main blocks:

- **Technology and Industry**: This block of questions is crucial to understand GIPStech's team capacity to analyze market's signals and its evolution over time. It was important to see whether they consider the dominant design emergence imminent or not. In fact, starting from the assumption that it is imminent, we could then moved to the analysis of ecosystems' influence and then to see how they are struggling to implement an effective strategy to avoid to be locked out. In particular we wanted to analyze if they perceive the competition more competitor-based or technology-based. The fact that they all considered it as technology-based, confirmed the assumptions that we still are in a fluid phase and developers of the same technology support themselves hoping for the recognition of the dominance of their technology.

Technology and Industry
1) Taking a look to my three propositions, how did you appear on the competitive landscape? I mean, have you previously studied the entire set of available technologies, which try to solve the indoor positioning problems or have you developed your technology from scratch, independently from other technologies?
2) Like many rising industries, the indoor positioning one is now going though a Fluid Phase, where lots of competitors appear on scene, offering different technological solutions. How are you feeling this competition? Are you trying to deliver a more efficient technology by improving its qualities? Are you trying to change it? Have you ever changed it? Are you trying to make it compatible with other technologies?
3) At some point, one of the competing technologies will be chosen as dominant design. How are you approaching that moment? Do you think it is far away in time or more imminent?
4) In case Gipstech were not chosen as dominant design, which factors would you judge having made the difference in favor of other technologies?
5) When giant corporations like Apple clearly bet on an alternative technologies of yours, they make a predatory announcement to the competitive arena (Apple recently bought Wi-Fi Slam for 20$ Millions). What kind of signal do they deliver to the market? How did you feel this announcement?
6) IndoorAtlas is your most direct competitor in magnetic positioning. At this stage of the industry is it more important to compete against them or to support them while competing against alternative technologies in order to drive the dominant design selection towards magnetic solutions?

The aim of this first block was to understand the strategy they are undertaking and to verify if they have considered the ecosystem as an active variable when they developed their strategy. The strategy resulting from the inclusion of the ecosystem variable in the strategists' thinking is a dynamic strategy whose the flexibility is the main feature.

- **Ecosystem**: The second block was more focused on their opinions about the ecosystems. First of all, we began by asking to identify in the external ecosystem some variables, that could have a strong influence over a technological lock-in and especially they were supposed to clarify how those variables could actively distort the dominant design emergence. After this brief introduction about the external ecosystem's influence, we then focused on the Italian ecosystem because of the GiPStech's origins. To perform this study we were supported by some data provided by Compass, in which there was no trace of any Italian city among the top 30 ecosystems on a global scale. These questions have been very helpful to verify if they have experienced the above-mentioned delay of the Italian ecosystem while trying to run their business, and to understand their future strategy. As we expected, the short-term strategy shows a migration to the Silicon Valley and we had to analyze why they are going there and what they are looking for. Afterwards the analysis moved to scan their opinion about the ecosystem as a firm specific asset in order to understand if, within a firm, it is known that the competitiveness of a technological solution provided by a focal firm relies on several actors' ability to innovate. Finally, we concluded this second block of questions with a question related to the adoption cycle of a new technology. The goal of the last question was to verify if they agree on the fact that ecosystems have the power to accelerate the adoption of a technology and consequently to decide over the life and the death of other solutions powered by less efficient ecosystems.

Ecosystem
7) How do you think the Ecosystem (exogenous variable) could influence the technological lock-in of a given technology? (external ecosystem= culture, country, institutions, policies etc.).
8) What do you think about the Italian ecosystem? Could it be a booster for Italian startups and SME or is it too late when compared to other international ecosystems?
9) Compass has just published a report, which ranks the Top 20 global ecosystems. There is no trace of any Italian city in the ranking. While working on GiPSTech have you experienced this ecosystem delay?
10) How much do you consider important for start-ups to compete exploiting an efficient ecosystem?
11) Now, considering the ecosystem as a firm specific asset. What is the importance for a firm to compete having previously built its own ecosystem? (Components and Complementors)
12) Can we assess that instead of a competition among firms, we are now in front of competitions against ecosystems?
13) How are you interacting with your ecosystem (internal and external). Are you trying to involve different strategic players to finally deliver your technology? What are your competitors doing?
14) Which proximity do you consider the most important in order to better built relationships and effective networks in a given ecosystem?

15) Why did you open a branch office in the Silicon Valley? What are you looking for? Partners? Customers? Investments? A more efficient ecosystem?
16) What kind of role does the ecosystem play during the adoption cycle? Can it somehow influence it? For example can it make the adoption cycle faster?

Thus, it was crucial to interview a group of people directly involved in developing one of the technology in order to understand how they are changing their strategy according to changes in the ecosystem. One of the most important goals of the conversation with them was to understand what they think about dominant designs and technological lock-in. Previously, it has been said that dominant designs can be recognized only ex-post, however players can exploit the weapons the ecosystems offer to them to get locked in. Ecosystems are waves that technology developers should surf; it is just a matter of waiting the biggest wave and surf it with the right surfboard.

2. Results

After having interviewed the 5 GiPSTech members we can now contextualize and validate the set of revised charts that we have already introduced at the end of chapter 2.

The first step was to understand how they decided to bet on the magnetic positioning technology, in order to match their strategy to one of the propositions introduced when talking about the "penguin effect". In this case study the proposition which better describes the birth of GiPSTech's technology is the first one:

Independent Technology Proposition: When all players have the possibility to choose a new technology at the same time, the first mover will adopt the one offering a higher expected value.

In fact, as Gaetano D'Aquila (CEO at GiPSTEch) explained, in 2010/2011 they were working on developing a completely different technology to address another need. However they experienced some problems while trying to develop it. The sources of those problems were magnetic fields, which interfering with the technology, used to falsify final data. Just after this experience they understood that they could turn the source of problems into a pillar for a future technology. They understood the real value of that technology starting from scratch and without any comparison with other priory developed technologies. After that episode, while developing their technological solution they started to keep an eye on alternative technologies, and they realized at that time there was no trace of Bluetooth-based solutions but just Wi-Fi and Laser (M.Faggin, Sales & Marketing Manager, 2015).

Given that, we can set 2010 as a hypothetical birth year for the indoor positioning industry. Therefore, starting from that year, several players entered the industry with alternative technological solutions and the global entry rate of the industry quickly increased.

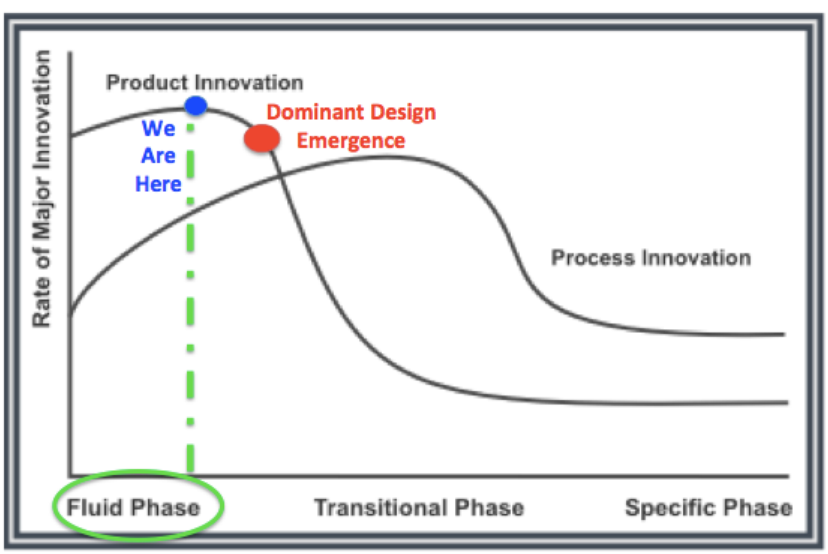


Figure 44 Accelerated Product and Process Innovation Model. State of the art.

Thus we can state that what happened does not match with any other proposition:

Response Strategy Proposition: Once the real value of technology X is revealed, followers will consider the expected value of Y and after that they will decide among these strategies: imitating, repositioning, exiting and entering.

Public Technology Proposition: If the real values of both technologies are already revealed, every player will adopt the best technological solution at the same time.

In fact at GiPSTech they explained that what push them to innovate is their passion to solve problems, and not their willingness to get rich. Given that, independently from any other available technology, they wanted to develop the best solution they could and to do this they chose the technology whose the expected value was the higher for them. This behavior does not fit either with the Response Strategy Proposition because they did not take in consideration other technologies and other players from the beginning, nor with the Public Technology Proposition because just the real value of the Wi-Fi technology was already part of the public knowledge, while magnetic positioning and beacons still were not born.

After five years we can assess that we are where the blue point is. We have almost reached the X moment when a dominant design will emerge. That moment depends on the market evolution. In fact, when all the potentialities of indoor positioning will be clarified the dominant design selection will be verified in few months (G. D'Aquila, 2015). According to D'Aquila in maximum five years a new dominant design will be the fulcrum of the industry that today is rising. It happened almost the same thing with the GPS technology, which was powered by the US Minister of Defense. At that time was almost impossible to forecast that today we would have had the technology installed in almost every device, and that several industries would have centered their products and services on that technology. GPS took almost 20 years to become as essential as it is today.

"Today the presence of an efficient ecosystem is quite crucial to impose the dominance of a given technology. The more efficient the ecosystem is pushing a technology, the shorter is the time for other technologies to build their own ecosystem. In few years we will see which technology is going to be the market standard" (Simon Ardiss, Investor and member of GiPSTech's board 2015).

Ardiss stated the importance of exploiting an ecosystem as a propeller and confirmed the closeness of the dominant design emergence too. This conviction upholds the accelerated model elaborated by Abernathy and Utterback that has been presented above. It means that, when technologies are supported by efficient ecosystems while competing toward technological dominance, the elapsing time between the birth of a given industry and the recognition of a dominant design within it will be much shorter. This particularly happens when industries are characterized by a high technological turnover.

However at GiPSTech, they do not believe that once a technology will be locked in, the others will be locked out. In fact today there is no trace of a technology that could respond to all different needs at the same time (Faggin, Ardiss, Cutrì, 2015). According to Ardiss we are not in front of an equivalent VHS-Betamax case study, because starting from the mismatch between specific needs and specific technologies, even if the market will chose a technology as the dominant one, the others will keep on existing in order to address different needs. Giuseppe Cutrì (Co-Founder and CTO at GiPSTech) is quite sure that in the end, more than one technology will continue to satisfy more than one sector. In his opinion even if magnetic positioning will be the next dominant design, solutions like Wi-Fi and Beacons will still solve some of the indoor localization problems. It means that the direct consequence of a dominant design will be a less impactful shake-out period characterized by a not so evident exit rate.

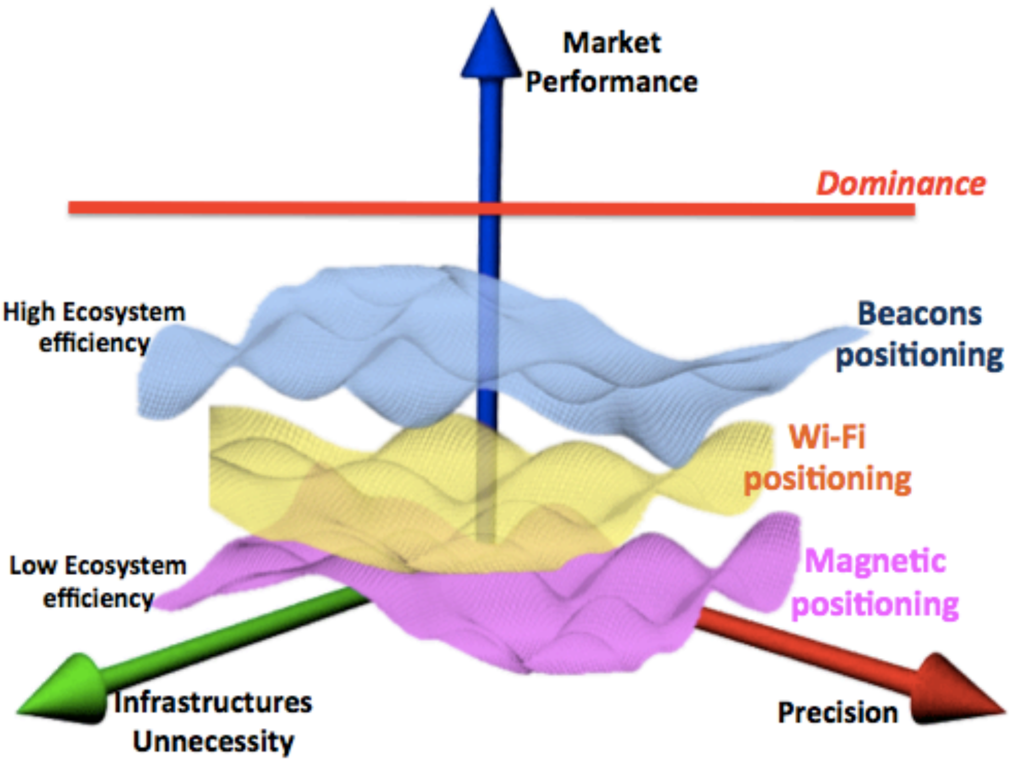


Figure 45 Modified Technological Paradigm applied to GiPSTech case study

From a graphic point of view, as we will discuss later, it is quite obvious that technologies like Wi-Fi and Beacons are being pushed forward more efficiently than magnetic positioning technologies. Starting from three variables, which are precision, unnecessity of infrastructure and market performance, on the pink plan we can find essentially two players which try to plot alternative trajectories to develop magnetic localization solutions: GiPSTech and IndoorAtlas.

At this stage of the industry, we can consider the competitive arena as powered by a competition among technologies more than by a competition among direct competitors. In fact, Massimo Vanzi (Investor and advisor within the GiPSTech's board) stated that the presence of IndoorAtlas is a godsend, even if they are more developed than GiPSTech. Thus, according to him, IndoorAtlas is a tank that could be exploited to make inroads in the market. In fact, GiPSTech could enjoy several benefits from

IndoorAtlas because they are sensitizing the market opinion; they are shifting the perception of the market to the importance of exploiting magnetic localization systems.

In any case, today the current situation is the one presented in the prior graph and confirmed by M. Faggin saying:

“If I have to identify an indoor localization technology which is most likely to reach the status of dominant design, I will say that beacons are closer to that dominance. This is due especially to their compatibility with other devices, and to the high profile support of a giant player like Apple, which is widely promoting their adoption across several industries”.

However, even if Beacons are really appreciated among the public opinion, they give birth to expectations, which constantly are unfulfilled. This is due to the fact that beacons are proximity tools that are forced to solve positioning problems (Faggin, 2015). Starting from this assumption GiPSTech is developing its own strategy leveraging two key characteristics: complementarity and compatibility. In fact, if on one side the technology provided by GiPSTech could exploit other technologies in its favor in order to increase its performances and its efficiency, on the other side they are developing a technology, which is able to be run on the widest possible number of devices. Faggin clearly presented the strategy they aim at implementing:

“Today none of the technologies has the potentialities to perfectly perform in all environmental conditions. At GiPSTech, after having built up our core proprietary technology (geomagnetic), we are now focusing on including other technologies in our solutions in order to exponentially increase our performances“ (Faggin, 2015).

Indeed, according to G.D’Aquila, the most important key to develop a competitive technology is to make it compatible with the widest number of already existing devices. G.D’Aquila and his team identified these devices in the smartphones, and they developed a technology that could run on every smartphone.

At this point we can introduce the importance of developing a strong firm specific ecosystem. Taking a look at the following graph, we can imagine GiPSTech as the focal firm, smartphone producers as suppliers (components) and retailers as complementors. The focal firm should be strong enough to disclose the importance of an innovation like magnetic positioning to the whole innovative chain and we will analyze how GiPSTech is trying to assemble an efficient Minimum Viable Ecosystem, including strategic players and changing them when not functional for the final goal.

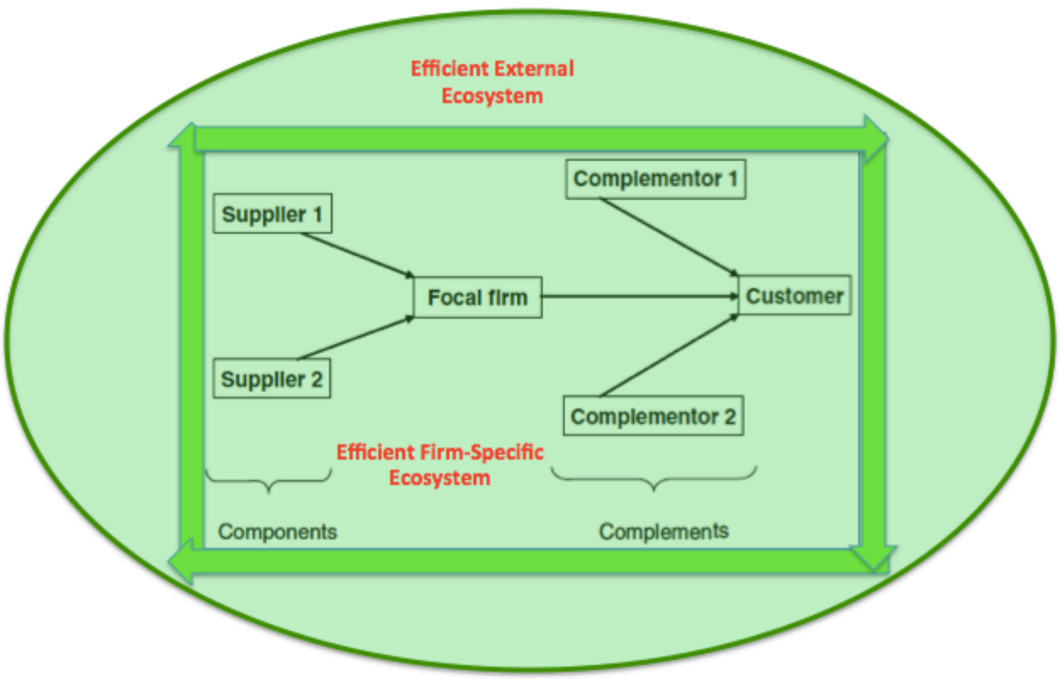


Figure 46 Efficient Firm-Specific Ecosystem within an efficient External Ecosystem

About the left side we can state that suppliers play a critical role in GiPSTech technology. The better the smartphone the higher the quality that GiPSTech would be able to deliver. The main challenge is to convince suppliers to shape their future benefits on GiPSTech vision. Today smartphones are provided with low quality magnetometers, which are good enough to satisfy current needs; however just after the proven evidence of an indoor localization need, smartphone producers will start to provide them with high quality magnetometers This is the real challenge for GiPSTech: to proof that evidence.

About the right side, it could be said that nowadays for GiPSTech, it represents the greater obstacle while assembling a Minimum Viable Ecosystem. We already studied that greater difficulties in the suppliers' side drive to a greater competitive advantage thanks to higher barriers for imitators. However greater difficulties in complementors' side could be dangerous for the competitive advantage that a firm has previously built. If complementors are not aligned to deliver a technology, that technology is likely to die before entering the market. Thus the focal firm should aim at enlarging the value-pie to be split among the innovative chain and at orchestrating the whole innovative process because the innovative ecosystem could not make the difference without an intrinsic strength of the focal firm. In fact, we can say that nowadays is more frequent to observe competition between ecosystems instead of just between firms, but we should consider that when an ecosystem collapses, just the focal firm fails (Faggin, 2015).

Now, it could be helpful to introduce the importance of a powerful external ecosystem, which has been confirmed by the interviewees when asked about the reasons behind the opening of a branch quarter in the Silicon Valley. First of all, GiPSTech is moving in the US in order to find bigger investments that could not be found in Italy. According to M.Vanzi, the Italian ecosystem is quite efficient for seed investments but is really far from top ecosystems in generating Series A and Series B investment rounds. Having understood this point of view, it is seems reasonable to move where a firm can attract the necessary amount of capitals to pursue a sustainable development. S. Ardiss confirmed that an efficient ecosystem could simply be recognized by taking a look at the amount of circulating capitals, and it tried to explained the delay in the Italian funding industry by using cultural differences:

"In Italy there is a fantastic entrepreneurial environment, from my experience I can state that here we can find a huge quantity of entrepreneurs. However, this is not sufficient to generate startups and consequently exits. This is due to the fact that

Italian entrepreneurship is conceived as a lifestyle business because people want to create firms and then pass them on to their children. This peculiarity does not match with investors' exigency to reach an exit and consequently to earn on previous investments. In USA, entrepreneurs are serial entrepreneurs. In fact they launch a startup, they run their business for a while and then they sell everything to start again from scratch. This cultural characteristic is the main obstacle to an efficient development of the funding industry." (Ardiss, 2015)

The second reason to move to the Silicon Valley is to encounter the benefits generated by those proximities we have already presented in chapter 2. In particular M. Faggin highlighted the importance of being present in an efficient ecosystem because all the players they are interested in speaking with, are concentrated in that area, and for a startup, whose the budget is not enormous, it is quite expensive to continuously go there and then come back. Thus geographic proximity is perceived as a key factor to build up efficient networks and consequently to assemble a well performing firm specific ecosystem. G. Cutrì agreed on this necessity, adding that in Italy they cannot start negotiations with semiconductor firms in order to convince them to integrate GiPSTech technology into their one. The second proximity that GiPSTech is looking for is the cultural one. The interviewees explained the same idea saying that the Italian culture is less open to innovate. Key complementors do not fully understand the potentialities of new technologies, while in the US every player immediately aligns on the same vision. In addition, a light and rapid bureaucracy does not support this innovation adversity, because every single procedure lasts months, and this huge need of time is not compatible with a startup life. S.Ardiss perfectly explained it stating:

"Bureaucracy is a big brake to innovation. For example, here in Italy, even opening a bank account could take several weeks. Launching a startup, especially when it is a high-tech one like GiPSTech, is a speed race. If we have to take part to an obstacle race while our competitors go for the 100m-speed race, it is quite obvious who is going to win. In the US there is a completely different background ecosystem, which is able to

influence the growth probabilities for new technologies. Culturally speaking, they are innovation prone" (Ardiss, 2015).

Considering this statement, GiPSTech members agreed on the fact that if they were born in the Silicon Valley, at this time they would have been more advanced in deploying their technology (D'Aquila, Faggin, Cutrì). This opinion should be read from a market point of view. In fact, according to them Italy is an excellent place to start to work on new technologies.

"Italian engineers are top level engineers. However, what is missing in Italy is a bridge able to connect the R&D galaxy to the market place." (Ardiss, 2015)

This choice is confirmed by GiPSTech's strategy to leave their R&D department in Italy, and to open just a branch office in the Silicon Valley in order to intercept the huge capital flows, which characterize the start-up Mecca.

To conclude the topic of the ecosystem importance, GiPSTech is looking for a big player to insert among its complementors, and this big player could be found just in an efficient ecosystem. M.Faggin assessed that they need that a huge player bet on them in order to demonstrate the goodness of a technology like the magnetic positioning one, because at the moment it is quite difficult for them to convince leading players like Google. Google in fact has heavily invested in internally developing Wi-Fi and Beacons solutions, and top management is not willing to change course because a small Italian startup developed a technology, which has still to be accepted by an important player. Given that, moving to an efficient ecosystem (green area in the previous chart) is strategically crucial to find key suppliers and complementors in order to assemble a boosting Minimum Viable Ecosystem (Green arrows in the previous chart). This strategy would be the main pillar to consequently deploy a competitive technology, supported by efficient ecosystems both Firm-Specific and exogenous.

Next graph, whose the validity has been confirmed by the interviewees, presents the current situation of the competitive arena. Let us analyze each technology keeping an eye at the reversed bell graph. In relation to the magnetic positioning solutions, IndoorAtlas is competitively in advance when compared to GiPSTech. IndoorAtlas benefited from huge capital investments coming from different countries, however GiPSTech should look at IndoorAtlas not as a competitor to fight against in order to get a greater market share, indeed GiPSTech should exploit the market attention IndoorAtlas is trying to attract to impose the magnetic positioning technology as the dominant one. In fact, if a big player acquires IndoorAtlas, the probability for GiPSTech to be acquired by another player will immediately increase (M. Vanzi, 2015). They entered the market almost at the same time but IndoorAtlas is supported by a more efficient ecosystem. This situation is represented by the two black points, among which the IndoorAtlas one is closer to the origin of the bell.

On the contrary, Wi-Fi and Beacons are fully exploiting their own ecosystem. They are both supported by technological leaders. In particular, it is quite evident how the Beacons' entrance delay has been offset by an efficient ecosystem, which since the technology birth has being been able to push it down toward the technological dominance, represented by the origin of the bell.

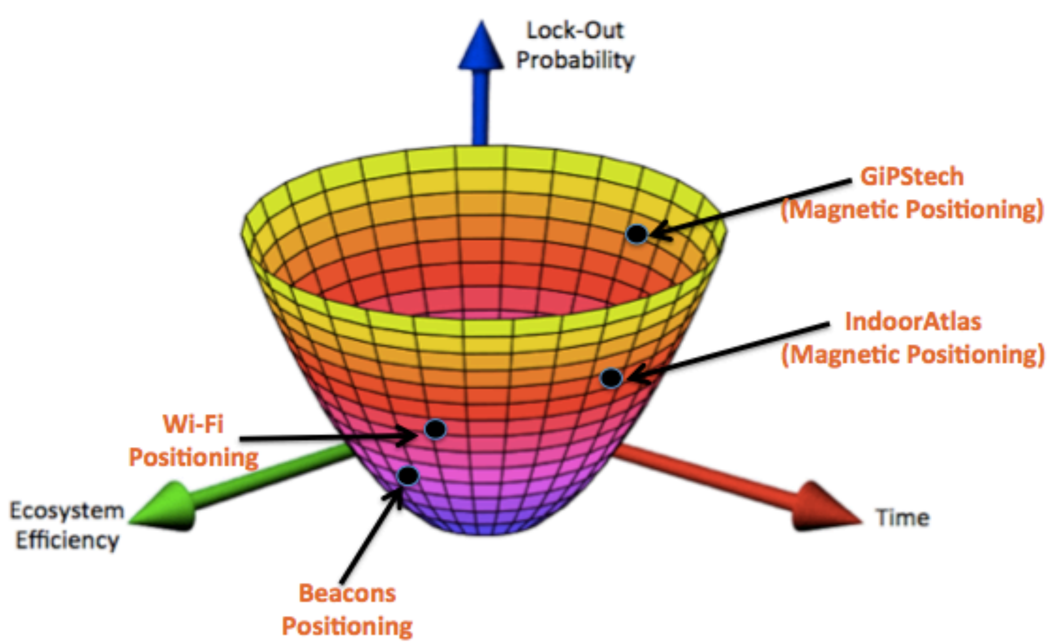


Figure47 Modified U-Shaped relationship graph applied to GiPSTech case study

The last hypothesis that has been confirmed by the interviewees' opinions it the adoption cycle one. As we said before, when influenced by a strong ecosystem the adoption cycle bell shifts to the left. It means that the adoption process has been accelerated and the time between the innovators' adoption and the early majority one is quite short. As obvious, when a technology has an adoption cycle like the following one, its chances to conquer the dominance are exponentially enhanced.

According to M.Faggin the movement of the bell relies on the cultural aspect of a country. When there are many early adopters the traction supporting a new technology is quite evident and the bell shifts to the left. This point of view is supported as well by G.Cutrì who stated that when people are hungry for innovation the ecosystem is more efficient. The result of this efficiency is an accelerated adoption cycle whose the direct consequence is to increase the probabilities of a technological lock-in.

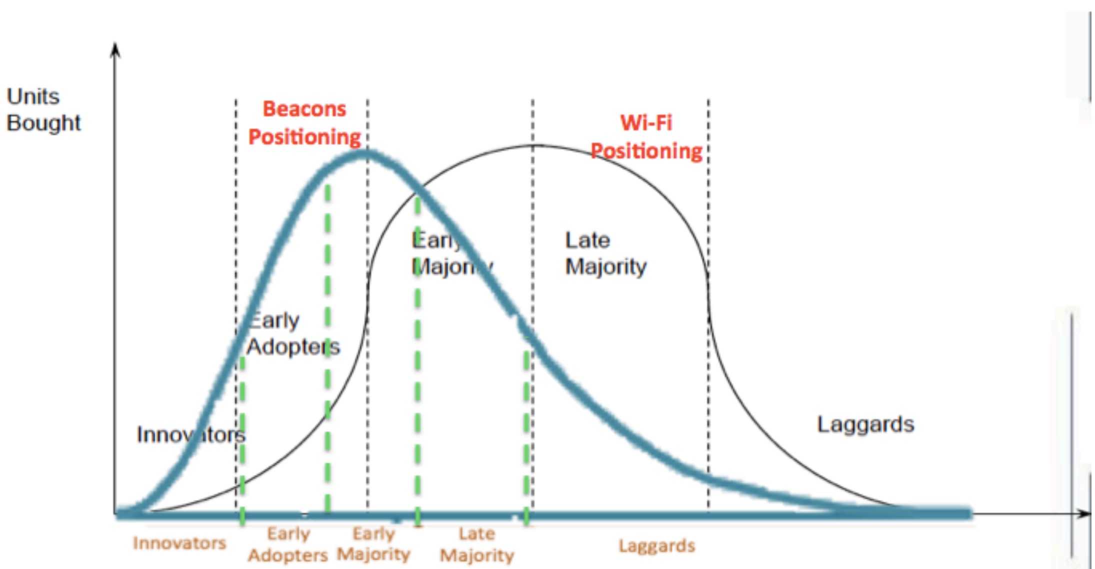


Figure 48 Accelerated Technology Adoption Cycle applied to GiPSTech case study

G. D'Aquila as well has the same opinion about the adoption cycle evolution. He affirmed that in Italy the bell is located at the right side of the time line, it means that everything is delayed and there is no hungry for innovation. The direct consequence of this assumption is that we can spot out a lack of innovators and early adopters. He then stated that for this technology, while in the US we are already in the Early Majority area, in Italy we stick on the innovators' one. This is due to the fact that here, it is really difficult to identify who the early adopters could be.

"Of course the ecosystem plays a crucial role and the firm should shape its strategy starting from a complete analysis of it. Ecosystems have the right of life and death over a startup and in particular over a technology. If the ecosystem is not efficient, every single problem that arises could stop a technology or its deployment. Otherwise if it is efficient, the speediness to reach a critical mass of adopters is strongly amplified" (Ardiss, 2015).

To these last assumptions we can connect the description of the two modified graphs. Starting from the first one, we can see that Beacon technology is supported by an efficient ecosystem that is pushing it toward the technological dominance. In fact Beacons are now widely adopted and used in several domains. For example, several marketing agencies use them as unconventional proximity marketing tools. It means that once a handful of players started to use the Bluetooth technology we are analyzing, and demonstrated the power of that technology, a huge herd behavior has been generated and it is now reinforced by effective network externalities. That's why M.Faggin affirmed that if there is a technology that is closer to the technological dominance, it could be recognized in the Beacons' one.

In the second graph, we are in front of the Italian innovation ecosystem. The market is not hungry for innovation and when a technology is developed in Italy the elapsing time between the launch of the technology and the adoption of the Early Majority lasts forever. To be strongly competitive a new technology should be validated by its ecosystem, but if the ecosystem is not efficient the technology risks to die. These assumptions over the current situation are confirmed by GiPSTech's strategy to move to another ecosystem. Basically, in addition to what we stated before, they are looking for early adopters that could generate a powerful market traction to validate their technology.

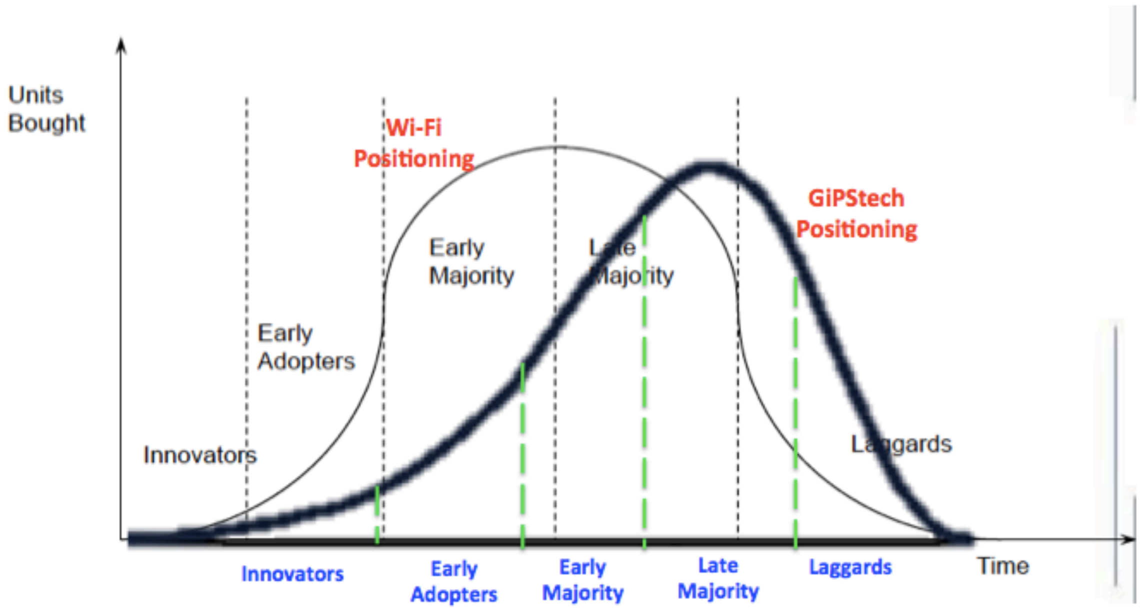


Figure 49 Delayed Technology Adoption Cycle applied to GiPSTech case study.

Conclusions

With this study we wanted to verify how the selecting process of dominant design often depends on the efficiency of the underlying innovation ecosystem. Starting from a deep observation of past technological battles, it was necessary to understand why several times top technologies did not succeed in reaching the technological dominance. Given that dominant designs can be recognized only ex-post, it could be too late for managers and innovators to adjust their own strategy. For this reason, we wanted to demonstrate the importance of taking in consideration the innovation ecosystem since the beginning, in order to properly shape the innovation strategy and to influence the following technological selection.

The analysis started with a full understanding of previous literature related to dominant designs and technological competition around them. As we saw innovations become dominant just after a given period in which lots of competitive variables by interacting with each other, boost technologies towards the dominance. We found many prior analyzes related to dominant designs and technological competition, however less attention has been devoted to examine the critical influence generated by innovation ecosystems during the selection of the dominant technology.

Thus, starting from the main pillar of our analysis, which was characterized by a huge literature confirming that the end of technological uncertainties within rising industries is the direct consequence of the emergence of a dominant design, we showed that efficient innovation ecosystems represent a crucial variable because they actively contribute in solving that technological uncertainty, and consequently in helping one technology to become the dominant one.

To perform an accurate analysis of that crucial variable, we presented innovation ecosystems as a twofold variable, where on one hand we considered them as an exogenous variable by taking in consideration key factors like geographic proximity, cultural adjacency and institutional supports, while on the other hand we compared innovation ecosystems to firm-specific assets because in this case their efficiency strictly depends on the innovating firm. These two faces of innovation ecosystems, when combined, are so potent that they can influence and shape technological environments, multi-sectorial industries and the selection of dominant designs. This ecosystem perspective is particularly relevant if connected to innovation because innovation means shake-ups in already established technological paradigms, and these shake-ups need to be orchestrated by a strong cooperation between players operating in efficient ecosystems

At the end of chapter 2 we introduced a set of modified graphs, which had been elaborated starting from prior widely accepted studies. We modified these charts by introducing the above-mentioned crucial variable of ecosystem efficiency, and we consequently tested them through GiPSTech's case study. Our business case examined an Italian start-up operating in the indoor positioning industry, and which, even if it is offering the best performing technological solution (magnetic positioning) it risks to be overcome by Wi-Fi and Beacons that are widely accepted and utilized all over the world. To test the validity of the modified charts, we have interviewed five GiPSTech's members with a deep technological and industrial background. At the end of the interviews they all agreed on the importance of taking in account innovation ecosystems as critically strategic variables to be studied while running a business.

Anyway, this study aimed at proving the importance of analyzing industry dynamics by using the ecosystem's lens. This practice will allow us to plot several sceneries that could be useful to realize how different technological solutions are striving to approach the selection moment in a dominant position. The importance of taking in consideration this new ecosystem perspective relies on the fact that innovation ecosystem is a variable that could be actively shaped by competing players. In fact firms can strategically assemble their own firm-specific ecosystems and even if they cannot influence the external ecosystem variable, at least they can search the optimal ecosystem for their technology to emerge and consequently move there.

Of course this study presents several limitations both general and methodological. Firstly it considers only those innovation ecosystems operating in highly technological industries. The direct consequence of this first critical issue is that, the model that has been elaborated may not be generalizable to all industries. Secondly, among methodological limitations, we can highlight the very restricted sample of interviewees, who in addition were belonging to the same start-up. On the contrary it could have been useful to interview more individuals from the same industry but supporting competitor technology and from complementary industries. Future research should keep on analyzing the ecosystems interaction within industries and providing other supported-by-data business cases to reinforce the results provided by this paper.

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