POLITECNICO DI MILANO
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Master of Science Thesis in Management Engineering

EXPLORING THE OPPORTUNITIES PROVIDED BY EMERGING TECHNOLOGIES: EVIDENCES FROM THE DRONE INDUSTRY

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Executive Summary

This thesis aims at providing a structure that can support companies in addressing new industries when exploring the opportunities provided by emergent technologies.
In order to achieve the purposes of the thesis, the chosen technology for developing the analysis has been the Drone technology. The reason behind this selection lies on the fact that the Drone industry has received growing attention in the latest years, proving to be a rapidly evolving market both in terms of investments and both regarding the possibilities that the technology can enable.
The earliest recorded use of a Drone, or Unmanned Aerial Vehicle (UAV), occurred in mid-1800 and was meant for warfighting purposes; along with this first use, subsequent models and versions of the technology have been deployed during the two World Wars. Several decades have passed until, in the early 2000, drones have then been used for few applications that fell outside of military use, like as boarder protection and search and rescue operations. Even though this might have represented a first step forward in the technological exploration, many more opportunities were waiting to be discovered.

In order to have a theoretical framework upon which to build the research, the topic of "Innovation" has been deeply investigated. What emerged from this first part of the literature review is that when addressing a technology as a driver of innovation, the widespread reasoning is that a company seeking to innovate should look for a technology substitution only. Therefore, the essence of strategic technology management is to successfully switch technologies at the point where the S-curves (Christensen, 1997) – curves representing the improvement in the performance of a product or process occurring in a given period or resulting from a given amount of engineering effort- of old and new intersect.

More recent studies seem to have discarded this idea, indeed with the introduction of the “Technology Epiphany” definition, the focus for companies has moved towards the investigation of how to achieve the discovery of the potential applications and envision new meanings within new or existing technologies (Verganti, 2009). Although this line of thinking sets the right direction for the development of the analysis, one could say that it falls short of some important elements that companies could benefit from. Indeed the Technology Epiphany is mainly referred as revealing the quiescent meanings of a technology. What one could not understand from such a definition, in being “overwhelmed” by the concept of meaning itself, is that capturing the meaning of a technology could intend being able to identify the opportunities offered by that technology. Moreover, what is not enough stressed within the literature is that opening to new opportunities could represent the best way to address new industries.
Therefore, the thesis, starting from the analysis of the Drone industry, aims at providing something that is missing from a theoretical point of view. A framework, a guideline that companies could follow when exploring the opportunities provided by an emergent technology in addressing new industries, thus tapping the technology’s full value.

In order to add an additional level of detail to the research purposes, two research questions have been identified.

***RQ1**: How do companies explore the opportunities provided by emerging technologies when addressing new industries?*

***RQ2**: Which are the peculiarities characterising the first adopters of emerging technologies in new industries?*

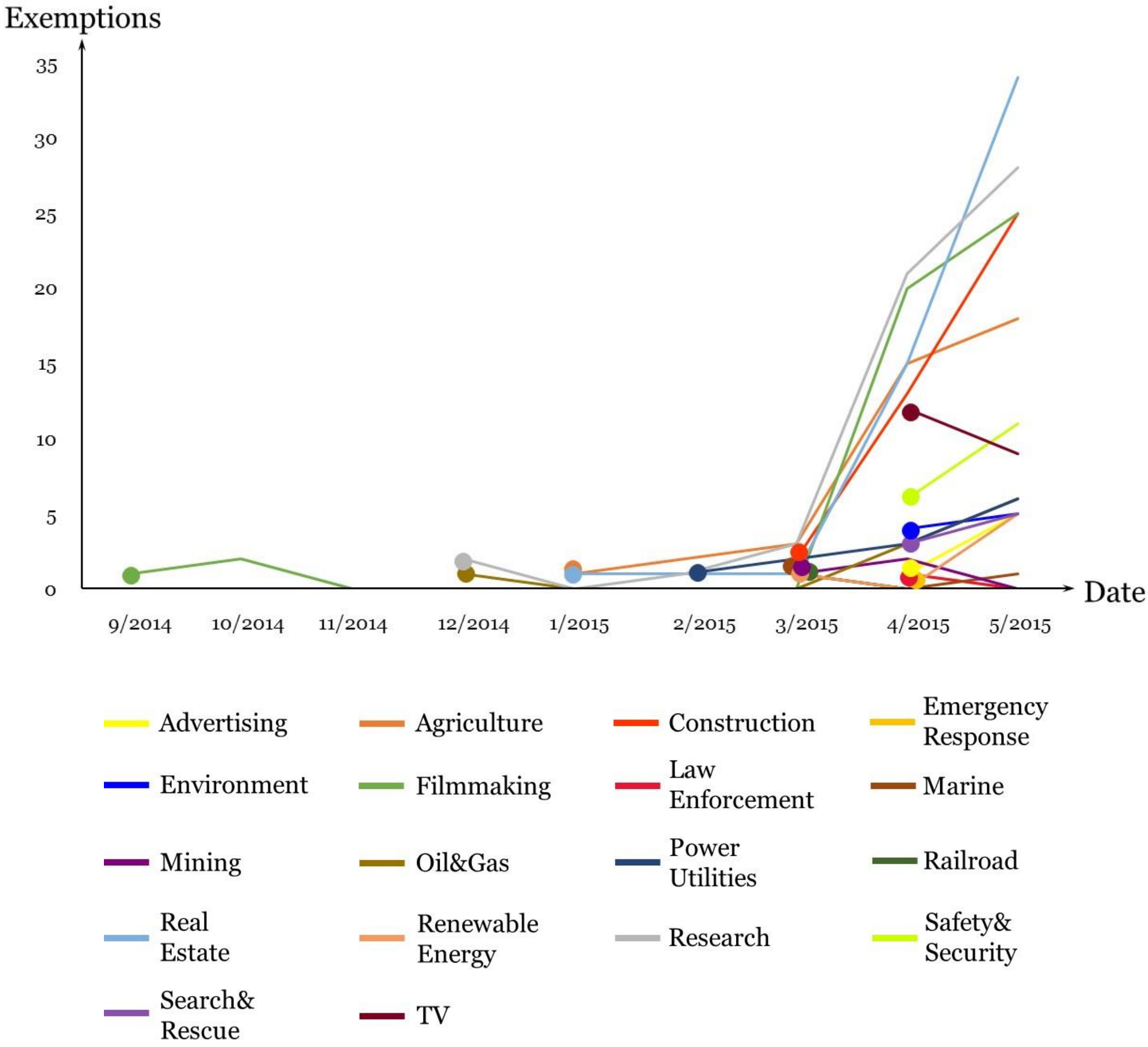
After having outlined the precise research objectives, the definition of a research methodology and a research environment have followed.
For the purposes of the thesis, considering the investigation of a small number of firms that were able to understand that the drone technology had huge opportunities to offer, the study of each of the cases seemed to be the most suitable choice.

Therefore, the “Case Study” approach has been followed. Case study research indeed has a level of flexibility that is not readily offered by other qualitative approaches such as grounded theory or phenomenology.
Together with this, the case study's distinctive strength is its ability to deal with a full variety of evidence-documents, artefacts, interviews, and observations-beyond what might be available in a conventional historical study. Therefore, this approach is also preferred when examining contemporary events (Yin, 2009) as in the case of this research, thus making it the best methodology to adopt.
After having defined the methodology, the proper research environment was needed. Even from the very early researches, the US market appeared to be the most suitable setting for the research objectives for two main reasons. Firstly, because it is generally considered a high-velocity environment where demand, competition and technology are in constant and accelerated change (Wirtz *et al.*, 2007). Therefore, the process of adoption could be observed and results analysed over a reasonable time span where performance data are available, that is indeed the second reason for choosing it.

Regardless of the fact that the harsh regulations put into place in the US market could represent one of the major obstacles for drones’ exploitation, for the purposes of this thesis the regulatory framework has represented the most valuable source of data. When dealing with the regulations in place within the American context, the Federal Aviation Administration (FAA) represents the major actor. In order to enable the nascent drone industry to grow, Congress wrote provisions into the 2012 FAA Modernization and Reform Act (FMRA) that authorized the FAA to allow certain non-recreational drone operators to begin flying low-risk operations. Under Section 333 of the Act, the FAA developed a process to review, on a case-by-case basis, petitions from individual operators wishing to be exempted from standing rules that ban the commercial non-recreational use of drones. This temporary measure became known as a “333 exemption,” and it is the principal mechanism by which non-recreational commercial drone users are taking to the skies.

As previously mentioned, the objective of the research is in providing a framework for the exploration of the opportunities provided by the drone technology when addressing new industries. In following the development of this technology, it has been stated that the military use represented the very first application ever. After several decades, new opportunities emerged, but representing just the first step in the explorative process of potential applications of the drone technology. The Section 333 becomes the tangible proof of the full value embedded within the UAV technology, which was just waiting to be seized.

The Section 333 database, along with other data, provides information including a short description of the activities that the exempted has received permission to engage in. This information was essential in order to develop a detailed picture of the types of missions that non-recreational drone users carried on.
However, since the research is focused on understanding how companies could address new industries, a categorisation was needed in order to even out the available information and to make a more proficient use of it. Starting from the description of operations provided in the database and in using several key words, 18 homogeneous categories, corresponding to specific industries that petitioners indented to address, have been identified.
Thus, in having a more structured categorisation of industries of all granted exemptions, as well as the exact day in which these have been granted, the identification of the “first adopters” with respect to each industry became straightforward, as shown in the figure.



First Adopters with respect to each industry

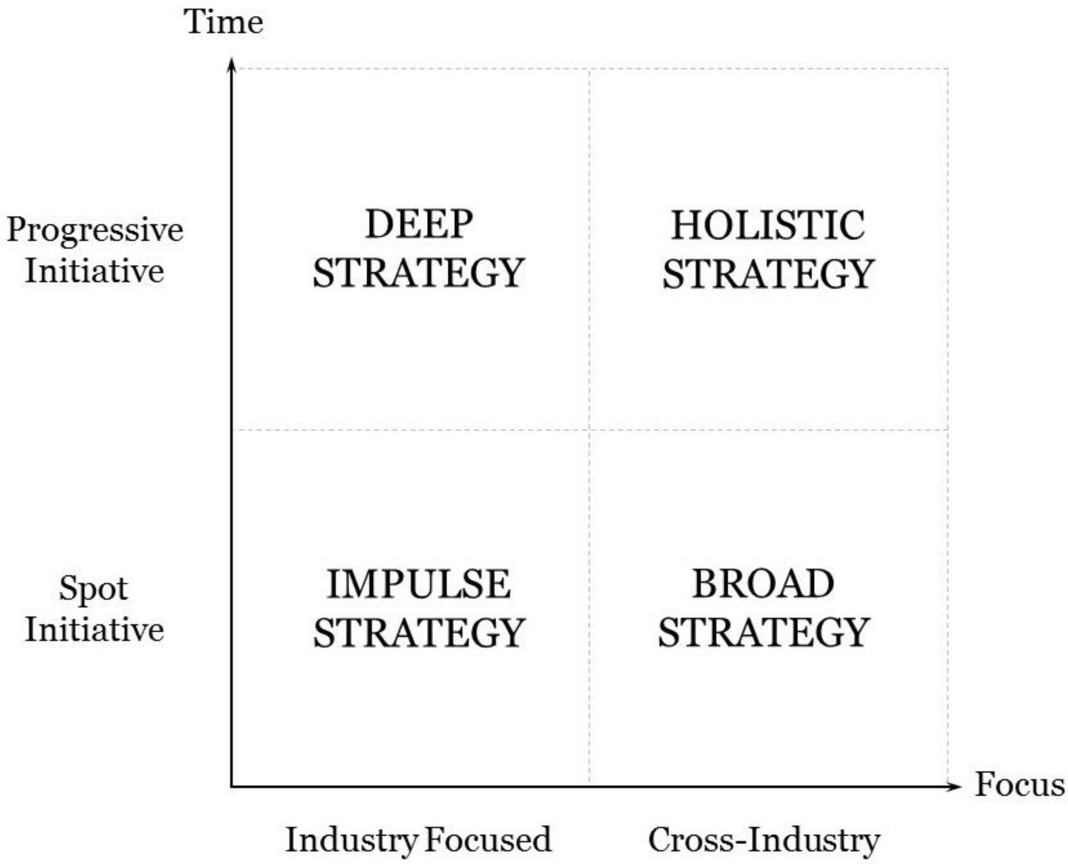
After having identified the industries of interest, as well as the petitioners that firstly adopted the UAV technology within each of these, all the available and relevant information about these first adopters has been collected. The exemption letters together with the FAA's Section 333 database provide information including the date of the exemption, the name and location of the exempted, a short description of the activities that the exempted has received permission to engage in and a list of unmanned aircraft systems that the exempted would be using for said operations. Through secondary resources, information regarding the age of the companies, the main business in which they operate and the decisions regarding the implementation of the UAV technology has been gathered.

In order to answer the research questions, a critical analysis of the gathered data has represented the last step of the research process. In looking at the collected information, the first elements that emerged were both the similarities and dissimilarities regarding the choices that first adopters have made in terms of requested exemptions. Therefore, the analysis of first adopters' data has not been developed on a case-by-case basis; it became far more interesting to study these petitioners according to their choices and to understand whether these decisions were somehow related to common characteristics and objectives. Much research depends on the estimation of the similarities and dissimilarities between pairs of things (Romesburg, 1984).

Two variables have been considered in the development of the analysis. The first variable regards the industries in which first adopters have decided to focus on. "Industry Focused" refers to the case in which the company has been granted exemption(s) for only one industry, while "Cross-Industry" means that the firm filed exemption request(s) for at least more than one industry.

The second is a time variable that distinguishes between "Spot Initiative" and "Progressive Initiative". The former refers to the case in which a firm has filed an exemption request just once, while the latter concerns the case of separate exemption requests.

Is then in considering these two variables together that the answer to the question on how companies can explore the opportunities provided by the UAV technology when addressing new industries (***RQ1***) emerges. Indeed, four main strategies can be alternatively adopted.



The four identified strategies

In order to enrich this picture, peculiarities regarding the first adopters of the examined technology within new industries (***RQ2***) have been outlined, in taking into consideration the choices they have made regarding the actual implementation of the technology.

Starting from the gathered information during the data collection phase of the research, other elements have then been taken into account. More specifically, whether the adopter of the technology was already operating within the industry/industries that has/have been addressed and the role practiced within the value chain of the examined technology. Addressing this last variable means identifying first adopters as "manufacturers" of drones, "final users" and/or "service providers" in leveraging the UAV technology.

Together with this, as detailed within each exemption letter, the number of UAV models adopted by the first adopters has been taken into account.

With respect to each strategy, the following results have emerged.

Focusing on a single industry in a unique moment in time, thus adopting an "Impulse Strategy", generally means opting for a unique model of the technology in order to upgrade the performances within an already known industry. The main difference among the first adopters following first strategy is represented by the way they actually made use of the technology itself. Firms either decided to internally develop the capabilities to fly the chosen drones or opted for leveraging external competences for getting the job done. In the former case, firms have exploited the opportunities provided by this technology in offering a service to their clients, while in the latter case the first adopters made use of drones for private purposes.

When choosing to renew the commitment to a single industry in adopting a "Deep Strategy", the firm is implicitly reaffirming the leadership position that it has within that specific industry in which it has introduced the UAV technology. Thus demonstrating that behind the choice of following the same direction and sharpening the competences, strong premises are needed.

Choosing to address an extended set of industries in a unique time frame, thus following a "Broad Strategy", is usually the straightforward consequence of the purposes for which a firm has been founded. Indeed, the technology is both the pillar of the firm and the mean trough which multiple industries are explored. Thus in addressing multiple industries, these first adopters enter into fields that they have never explored before, thanks to the UAV technology.

When approaching different industries in subsequent moments, through a "Holistic Strategy", a firm tries to capture the full potential embedded into the technology. In order to do that, along with an amplified selection of versions and variations of the technology, manufacturing competences are developed. Indeed, when having to provide a service in multiple applications, first adopters have never decided to narrow the number of adopted models, preferring to have a broader available set for adaptations and eventual changes.

The provided framework represents a valid reference when exploring the opportunities of a technology for addressing new industries and the proper outset for future researches. Indeed, one can say that this structure could have a two-sided reading, either starting from the strategies to the examined variables, or in the other way round.

In closing the thesis, main limits, like the choice of such a narrow focus for developing the research, have been identified. The ongoing process of regulations' definition and the availability of data, has almost forced the choice. Nevertheless, in a non-distant future the regulatory environment would certainly be more stable, in making the information gathering more complete and precise and the realised framework even more consistent.

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CHAPTER 1
PROBLEM SETTING

This chapter aims at identifying the focus of the research by firstly defining the problem setting. In order to stress the relevance of the object of study, market researches will be presented and a quick digression about the main barriers to adoption will follow. In the end, the research scope will be outlined in presenting a case study taken from another industry.

1.1 Unmanned Aerial Vehicle Technology

The IT revolution, started during the 80's, definitely reshaped the modern economy by allowing firms all over the world to re-engineer their operations. Nowadays, a comparable disruption in terms of scale is happening as Unmanned Aerial Vehicle technologies overturn business models and reframe industry environments ranging from real estate to television.

An unmanned aerial vehicle (UAV), commonly known as a drone, as an unmanned aircraft system (UAS), or by several other names, is a pilotless aircraft, which is flown without a pilot-in-command on-board and is either remotely and fully controlled from another place (ground, another aircraft, space) or programmed and fully autonomous (from the 35th Session of the International Civil Aviation Organization Assembly, 2004).

A UAV is capable of controlled, sustained level flight and is powered by a jet, reciprocating, or electric engine. In the 21st century, technology reached a point of sophistication that the UAV is now being given a greatly expanded role in many areas of aviation.

1.1.1 Military Use of UAV Technology

The earliest recorded use of an Unmanned Aerial Vehicle was for warfighting and occurred on August 22, 1849, when the Austrians launched some 200 pilotless balloons against the city of Venice. The balloons were armed with bombs controlled by timed fuses, Austrians also affirmed to have used fuses electrically activated via signals fed up trailing copper wires. This is, by most accounts, the first recorded action of its type.

Later on, the first pilotless aircraft was built during and shortly after World War I. Leading the way, using Archibald Montgomery Low's radio control techniques, was the Ruston Proctor Aerial Target of 1916 (see Figure 1.1). If developed further it was to have been used against Zeppelins. Soon after, on September 12, the Hewitt-Sperry Automatic Airplane, otherwise known as the "flying bomb" made its first flight, demonstrating the concept of an unmanned aircraft. They were intended for use as "aerial torpedoes", an early version of today's cruise missiles.

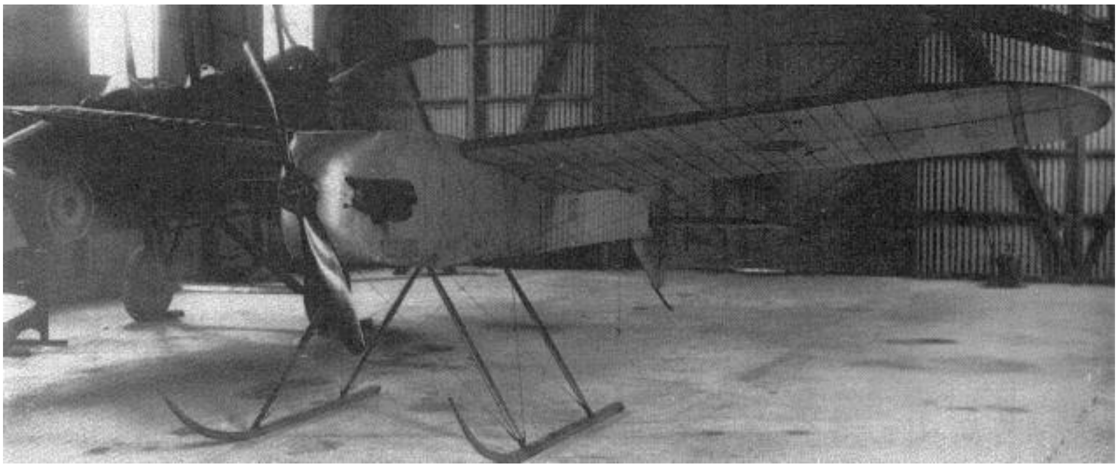

Figure 1.1 Ruston Proctor Aerial Target

The first large-scale production, purpose-built drone was the product of Reginald Denny. Together with his partners, he won an Army contract for their radio controlled RP-4, which became the Radioplane OQ-2 (see Figure 1.2). They manufactured nearly fifteen thousand of these target drones for the army (which means realised for hitting a target) during World War II.

Figure 1.2 Radioplane OQ-2

In the post-World War II period, the first target drone converted to the battlefield unmanned aerial photo reconnaissance mission was a version of the MQM-33 conversion for the US Army in the mid-1950s designated the RP-71, later re-designated the MQM-57 Falconer (see Figure 1.3). Reconnaissance unmanned aircraft were primarily used to gather intelligence and explore outside an area occupied by friendly forces to gain information about natural features and enemy presence.

Figure 1.3 MQM-57 Falconer

At the same time, early steps were being taken to use them in active combat at sea and on land, but battlefield Unmanned aerial vehicles (UAV) would not come into their own until the 1980s.
The attitude towards UAVs, which were often seen as unreliable and expensive toys, changed dramatically with the Israeli Air Force's victory over the Syrian Air Force in 1982. Israel's coordinated use of UAVs alongside manned aircraft, allowed the state to quickly destroy dozens of Syrian aircrafts with minimal losses. Israeli drones were used as electronic decoys, electronic jammers as well as for real time video reconnaissance.

1.1.2 Civilian Use of UAV Technology

According to a 2006 Wall Street Journal report "after distinguished service in war zones in recent years, unmanned planes are hitting turbulence as they battle to join airliners and weekend pilots in America's civilian skies. Drones face regulatory, safety and technological hurdles, even though demand for them is burgeoning. Government agencies want them for disaster relief, border surveillance and wildfire fighting, while private companies hope to one day use drones for a wide variety of tasks". The U.S. Customs and Border Protection agency has experimented with several models of UAVs, and has begun in late 2004 purchasing a fleet of unarmed MQ-9 Reapers (see Figure 1.4) to survey the U.S. border with Mexico. "In more than six months of service, the Predator's surveillance aided in the arrest of nearly 3900 arrests and the seizure of four tons of marijuana" border officials say.

Figure 1.4 MQ-9 Reaper

In August, 2005, after Hurricane Katrina tore through the Gulf Coast, military and local officials urgently requested unmanned surveillance planes for search and rescue missions. The drones were delivered, but aviation authorities kept them on the ground out of concern about mixing drones with manned aircraft in the crowded skies over New Orleans. "A lot of lives might have been saved had we been able to use [drones]," says David Vos, whose Athena Technologies Inc. makes navigation systems for unmanned planes. "In Iraq, drones track the enemy, but we weren't able to track our own people in trees or on roofs to save them." However, some experts are concerned that drones pose safety hazards to manned flights, and want rules in place to govern their use. "Technology in this area is moving way ahead of regulations," says Richard Healing, a former member of the National Transportation Safety Board.

Nonetheless, on May 18, 2006, the FAA issued a certificate of authorization, which allowed the M/RQ-1 and M/RQ-9 aircraft to be used within U.S. civilian airspace to search for survivors of disasters. The Predator's infrared camera with digitally enhanced zoom has the capability of identifying the heat signature of a human body from an altitude of 10,000 feet, making the aircraft an ideal search and rescue tool.

After having described the first uses of the UAV technology, some initial insights emerge, allowing the focus of the research to be identified. The first evidence coming from the UAV industry regards the fact that after the initial application of the technology in the military field, the shift towards a civilian use of the examined technology took several decades to happen. In other words, one may say that the opportunities enclosed in the UAV technology started to be explored until not many years ago. Moreover, illustrating the first civilian use of the technology meant giving just a glimpse of the potential that this technology could offer. Therefore, the research is focused on the understanding of how to explore such opportunities that are provided by this emergent technology.

Before detailing the research objectives, some forecasts regarding the UAV market will follow, in order to justify the choice of studying this technology and to stress its significance. Together with presenting the relevance of the UAV technology, a short digression on the barriers to its introduction is presented.

1.2 Market Trends

In order to endorse the importance of studying the development of UAV technology, several studies and forecasts will be presented in this paragraph.
Within "The Drones Report" Business Insider (BI) has forecasted that the military sector will continue to lead all other sectors in drone spending ,during the forecast period (as shown in Figure 1.5), thanks to the high cost of military drones and the growing number of countries seeking to acquire them.

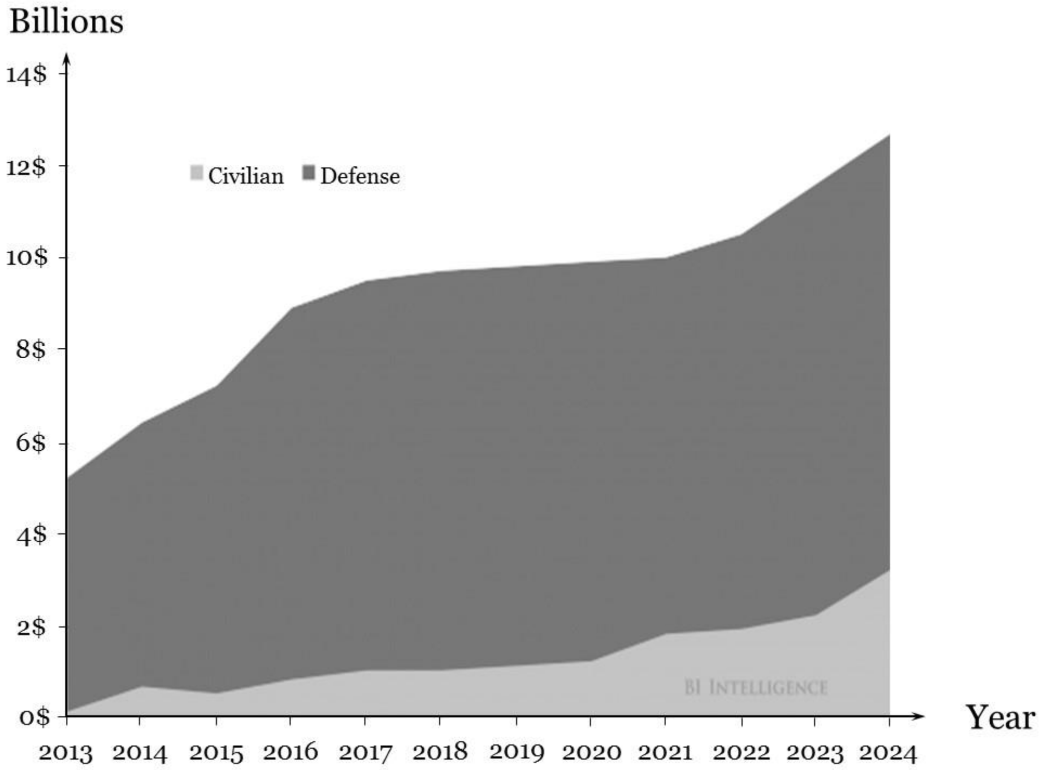

Figure 1.5 Global Aerial Drone Market (Source: Teal Group, BI Intelligence Estimates, Michael Toscano, 2016)

BI also projected revenues from drones sales to top $12 billion in 2021, up from just over $8 billion of 2015. Shipments of consumer drones will more than quadruple over the forecast period (as shown in Figure 1.6), fuelled by increasing price competition and new technologies that will make flying drones easier for beginners.

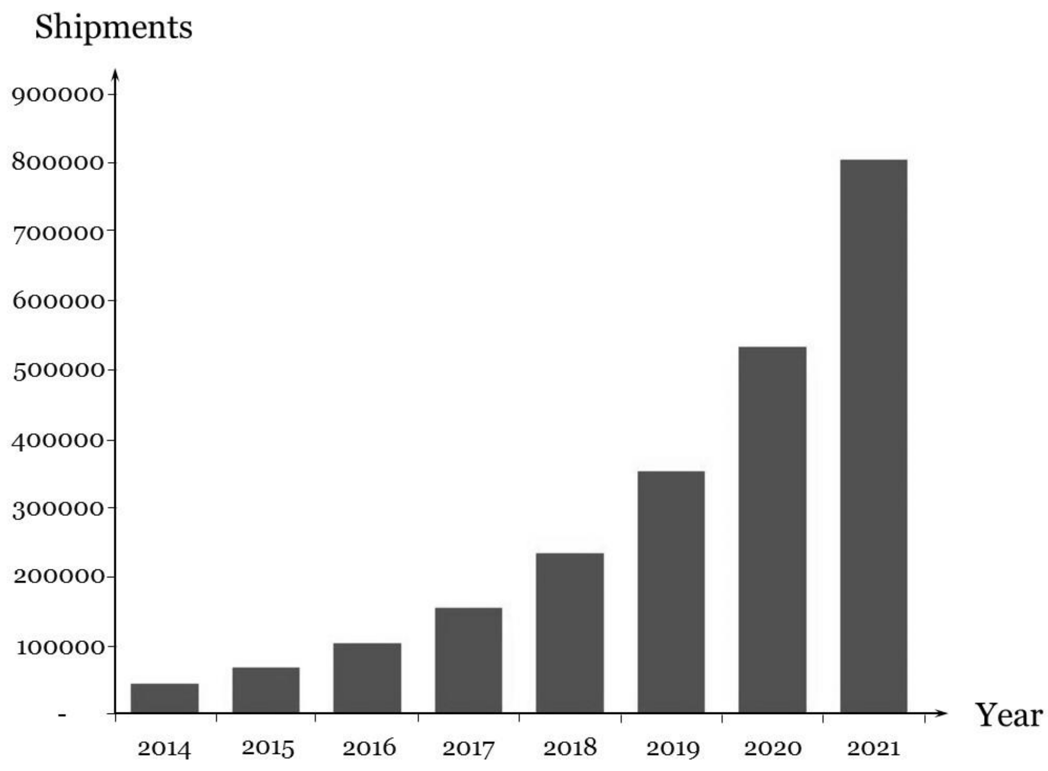

Figure 1.6 Enterprise Global Drone Shipments (Source: BI Intelligence Estimates, 2016)

In order to have the clearest picture as possible of the potential evolution of Drone technology, the Table 1.1 summarises several other forecasts regarding the potential size of UAVs market over the next years.

Research Firm	**Aerial Drone Market**	**Market Size [$Billions]**	**Year**
U.S. Consumer Electronics Association	Consumer	$0.3	2018
ABI Research	Small	$8.4	2018
MarketsandMarkets	Small	$1.9	2020
Teal Group	Total	$11.5	2024
Lux Research	Commercial	$1.7	2025
Tractica	Commercial Hardware	$4.0	2025
Tractica	Commercial Services	$8.7	2025

Table 1.1 Drone Market Forecasts (Source: Companies' Press Releases)

A March 2013 report from the Association for Unmanned Vehicle Systems International (AUSVI) estimated that from 2015 through 2017, aerial drones would create over 70,000 jobs in the United States generating more than $13.6 billion in economic benefit. From 2015 through 2025, AUVSI forecasts more than 100,000 jobs and an $82 billion economic impact resulting from UAVs.
According to Lux Research projects, the commercial aerial drone market will reach $1.7 billion by 2025, led by agricultural applications.
The U.S. Consumer Electronics Association forecasts that that consumer drones will approach $300 million by 2018 on global sales of almost 1 million units. This builds from a 2014 base estimate of $84 million in revenue on almost 250,000 units, compared to a 2015 $130 million forecast on 425,000 units.
In early 2015, ABI Research forecasted the market opportunity for small aerial drones, too. The firm forecasted that the market would exceed $8.4 billion by 2018, dominated by commercial applications ($5.1 billion market, 51% CAGR from 2014 through 2019).
MarketsandMarkets states that the small aerial drone market will reach $1.9 billion by 2020 (a 12.3% CAGR from 2014 through 2020) agreeing with Business Insider, in saying that it will be driven by growth in Military applications.
In 2014, Teal Group released a ten-year forecast that projected global UAV spending would grow from $6.4 billion to $11.5 billion. Cumulatively over the ten-year period, Teal Group estimated total UAV spending at almost $91 billion with the military consuming 86% of spending over the decade and civilian 11%, with the estimates changing to 86% military and 14% civilian by the end of the ten-year forecast period.

1.3 Barriers to UAVs introduction

As already mentioned in explaining the early uses of drone technology, when discussing the constant development of new drone applications it is important to consider the regulatory and technological perspectives together. Airspace governing bodies are facing the crucial challenge of ensuring the safety and privacy of citizens without suppressing innovation and growth.

It was previously stated that the shift form a military use of the technology toward a civilian one required many years. One possible cause could be the fact that the determination of the potential applications of the UAV technology has not been straightforward from the beginning. However, together with this, the regulatory pressure has surely impacted the exploration of new possibilities.

When talking about the regulatory environment and the adoption of new technologies, it is worth considering the “Laws of Disruption” model (Downes, 2009). This describes an interesting pattern of how fast different types of change manifest themselves, and the model is very applicable to the UAV situation. Technological advancements are rushing ahead of social and political change. That is exactly what has been happening with UAVs until today. From a technological perspective, lately various use cases appeared to be feasible, but many of these were not accepted yet by the public. Social change is occurring at a substantially slower pace than the technological progress, and the last domain to react and adapt is the political one (as show in Figure 1.7). Following this model, what can be anticipated is that regulatory barriers for UAVs will remain in effect for some time.

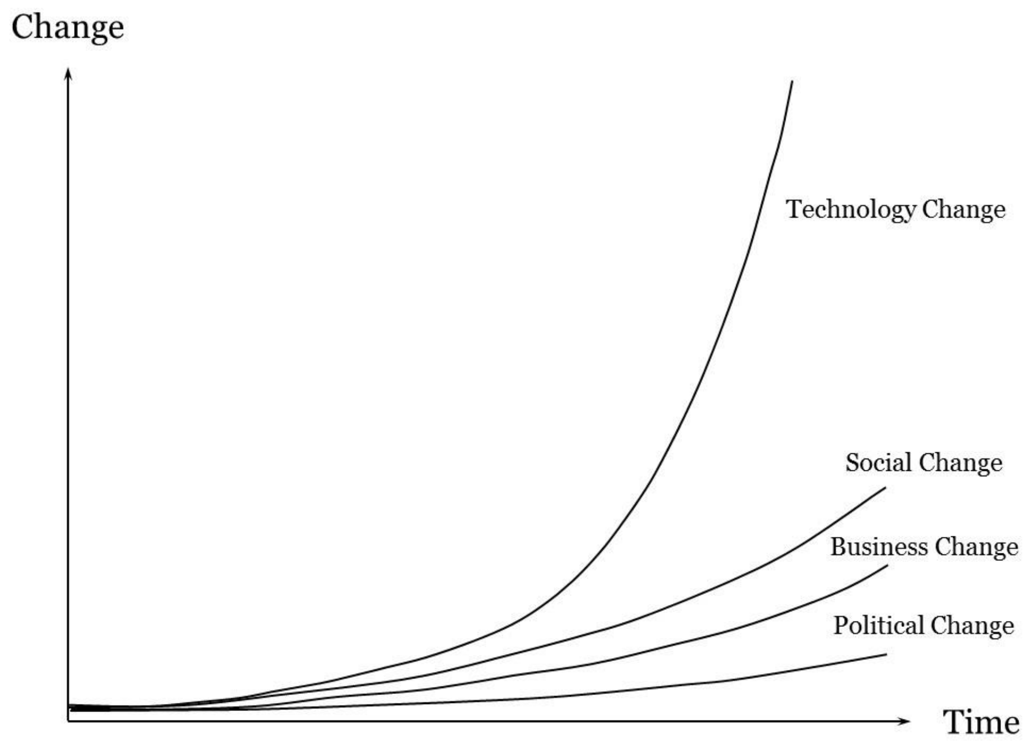

Figure 1.7 The Laws of Disruption (Source: Downes, 2009)

The regulatory aspect of commercial drone operations is currently one of the most important factors affecting the pace of drone powered solutions' adoption by businesses and government entities. Today many organisations are considering testing and using drones in their business operations, but are wondering about the legal aspects. They see the benefits of using drones, but they need transparent rules on how and where they can use them, what they should do to guarantee the safety and efficiency of drone operations, and the grounds on which authorities issue licenses or permits for commercial drone applications. National and international aviation authorities have started developing regulatory frameworks to guarantee that drones will be used in secure and business-friendly ways.

1.4 Research Scope

In order to demonstrate how powerful the exploration of the opportunities provided by a technology could be, an example taken from another industry will be presented.

In 2003, KUKA developed the Robocoaster, which was the world's first passenger-carrying industrial robot. The ride used roller-coaster-style seats attached to robotic arms and provided a roller-coaster-like motion sequence to its two passengers through a series of programmable manoeuvres. Robocoaster was a product for the amusement industry, and its success led to the creation of an entirely new entertainment division within KUKA. The idea came from Gino De-Gol, a worker in one of KUKA's factories, who combined his interest in amusement rides with his knowledge of robotics to develop the concept of an interactive passenger-carrying robot. After founding his own company, Robocoaster Ltd., he approached KUKA with a detailed plan to establish a partnership to accomplish his dreams. The proposed "Robocoaster" was considered a joke by all the other industry players whom De-Gol had approached. One of KUKA's major competitors preferred not to develop a similar robot, arguing that such a product was too dangerous for humans. However, KUKA recognized the opportunity presented by this new project thanks to their new strategy, which was to be open to new opportunities. After introducing the concept in 2003, the Robocoaster became the world's first and only passenger-carrying industrial robot. Most of the technology was already available, and the company only needed to modify one of its industrial robots by adding some precautionary safety features to have it certified to carry humans by TÜV (technical inspectorate).

Even 10 years after its introduction, the Robocoaster remains the only passenger-carrying robot on the market (Verganti and Oberg 2013). The success of the Robocoaster has driven KUKA to open its vision to the possibility of considering robots as entertainment machines. The company created a division dedicated to the entertainment and simulation sector, exploring other applications as tools for movie and theatre productions, for public events and fairs, or even for museums and research environments.

The case of KUKA is three times as useful for the purposes of this research. Firstly, it provides a clear example of how looking at an existing technology, unless small modifications, from another “perspective” has opened to new opportunities. Secondly, it outlines the peculiarities of the actor involved in this specific explorative process. Last, but not least, it highlights how the identification of new opportunities, has allowed entering new industries that have not got into contact with that technology ever before.

Similarly, this research aims at understanding which are the opportunities that the UAV technology has to offer. Opportunities that were not yet considered in the early phases of the technological development, when the military application seemed to be the only possible one. More in depth, it focuses on how the identification of such opportunities can lead to address new industries. Indeed this process could be developed adopting different decisions. Thus, making essential to consider within the research, both the way companies have exploited these opportunities and the characteristics defining the first adopters of the technology within new industries.

CHAPTER 2
LITERATURE REVIEW

This chapter aims at presenting the theoretical framework that the thesis refers to. The first topic that will be addressed is the innovation one. After introducing some definitions of the concept, the focus will be put on understanding the radical-incremental dichotomy and on the technology as one of the main drivers of innovation.

Furthermore, the concept of innovation will be enriched in considering the search for meaning as another innovative dimension. The explanation of the so-called "Design Driven" approach will follow.

At a first stance, this approach will be compared to the "User-centred Design" and in second place it will be included in the discussion about the main innovation strategies.

In explaining how intertwined these strategies are, the concept of technology epiphany will be described.

2.1 Innovation

According to the definition of Schumpeter, innovation is a process of industrial mutation, that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one. The latest edition of the Oslo Manual defines innovation as is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organization or external relations (OECD, 2005).

Innovation is the embodiment, combination, and/or synthesis of knowledge in novel, relevant, valued new products, processes, or services (Leonard *et al.*, 1999). Over the past years, economists, scientists and academics have proposed a plethora of different definitions in trying to determine the main elements characterising innovation and the outcome resulting from such a complex process. One common thread among all possible representations is the concept of novelty. Innovation, whichever forms it assumes, is always accompanied by a change of the status quo that could vary in terms of both intensity and form.

2.1.1 Innovation vs Invention

"A new idea, method, or device. The act of creating a new product or process, which includes invention and the work required to bring an idea or concept to final form" (Kahn, 2012).

An important distinction is normally made between invention and innovation. Invention is the first occurrence of an idea for a new product or process, while innovation is the first attempt to carry it out into practice. Sometimes, invention and innovation are closely linked, to the extent that it is hard to distinguish one from another. Tom Grasty in a great column over at MediaShift Idea Lab stated that "if invention is a pebble tossed in the pond, innovation is the rippling effect that pebble causes". Someone has to toss the pebble, but there is then the need to recognize the ripple that will eventually become a big wave, before it happens.

Roberts (1988) has formalised this concept onto a simple, but effective, formula.

Innovation = Invention + Exploitation

The invention process covers all efforts aimed at creating new ideas and getting them to work. The exploitation process includes all stages of commercial development, application and transfer, including the focusing of ideas or inventions toward specific objectives, evaluating those objectives, downstream transfer of research and/or development results, and the eventual broad-based utilization, dissemination and diffusion of the technology-based outcomes.

2.1.2 Radical vs Incremental

As these few definitions may have already anticipated, there are many ways to look at innovation. Classifications may vary according to the object of innovation, for example innovation of socio-cultural systems, ecosystems, business models, products, services, processes, organizations, institutional arrangements, etc., to the drivers of innovation (technologies, markets, design, users, etc.), or to the intensity of innovation.

Assuming this last point of view, of the intensity of innovation, mainly referring to Schumpeter's work, the objective has been to classify innovations according to how radical they are, compared to current technology (Freeman and Soete, 1997). From this perspective, continuous improvements are often characterized as “incremental” or “marginal” innovations, as opposed to “radical” innovations (such as the introduction of a totally new type of machinery) or “technological revolutions” (consisting of a cluster of innovations that together may have a very far-reaching impact).

The concepts of radical (or discontinuous) innovation and incremental innovation can be seen as representing opposite ends of a novelty spectrum (De Brentani, 2001).

Dealing with products, incremental innovation refers to the small changes in a product that helps improve its performance, lower its costs, and enhance its desirability or simply to the announcement a new model release. Most successful products undergo continual incremental innovation, lowering their costs and enhancing effectiveness. This, by far, is the dominant form of innovation and even though it is not as exciting as radical innovation, it is just as important. Radical innovations seldom live up to their potential when first introduced. At first, they are often difficult to use, expensive, and limited in capability. Incremental innovation is necessary to transform the radical idea into a form that is acceptable to those beyond early adopters.

The bottom line is that both forms of innovation are necessary. Radical innovation brings new domains, new paradigms, and creates a potential for major changes. Incremental innovation is how the value of that potential is captured. Without radical innovation, incremental innovation reaches a limit. Without incremental innovation, the potential enabled by radical change is not captured.

Several concepts have been used, including outside, discontinuous, breakthrough, radical, emergent and revolutionary; as well as evolutionary, continuous, and incremental (Abernathy and Clark, 1985; Cooper and Schendel, 1976; Florida and Kenney, 1990; Morone, 1993; Utterback, 1994).

2.1.3 Radical vs Disruptive

Most of the writings on innovation within the design community focuses upon radical innovation. It is often characterized as disruptive, competence destroying, or breakthrough, with all these labels sharing the same concept that radical innovation implies a discontinuity with the past (Garcia and Calantone, 2002). However, one has to be cautious in using different terms when trying to determine the intensity of the innovation. In particular, more attention will be paid in underlining how the concept of radical and disruptive do not necessarily have the same meaning.

The concept of disruptive innovation (driven by technology) has been firstly introduced by Christensen in the "Innovator's Dilemma" (1997) who stated, "There is a strategically important distinction between what I call sustaining technologies and those that are disruptive. These concepts are very different from the incremental-versus-radical distinction that has characterized many studies of this problem". Indeed, some sustaining technologies can be discontinuous or radical in character, while others are of an incremental nature. What all sustaining technologies have in common is that they improve the performance of established products, along the dimensions of performance that mainstream customers in major markets have historically valued. While, disruptive technologies bring to a market a very different value proposition than had been available previously. Generally, disruptive technologies underperform established products in mainstream markets. However, they have other features that a few fringe (and generally new) customers value.

The main reason "disruptive" causes confusion is that it sounds like a major upset, which suggests that the technological cause should be major as well. This leads to falsely combine disruptive innovation with technically radical innovation. Consequently, confusion is made between disruptive and radical and between sustaining with incremental. The two are orthogonal axes. In fact, in most documented cases of disruption, the disruptive innovation was a minor/incremental change and well within the technical capabilities of the incumbent. Similarly, companies have taken huge risks, massively refreshed their workforces and mastered extremely complex new technologies for innovations that were valuable to their existing mainstream customers and, therefore, sustaining.

2.1.4 Technological Perspective

After clarifying misconceptions about possible definitions related to the intensity of innovation, further attention will be given to the radical-incremental comparison, in adopting the technological perspective, one of the most used by previous studies.

As noted earlier, the origin of the radical-incremental dichotomy in the innovation literature is most commonly traced to the economist Joseph Schumpeter (Freeman 1992; Dahlin and Behrens 2005).

In a technological sense, radical innovations have been commonly defined as innovations that could not have evolved through improvements to, and modifications of, the existing technology (Helpman 1998; Lipsey *et al.*, 2005). Radical innovations are based on a different set of science and engineering principles (Henderson and Clark, 1990), and incorporate substantially different core technology (Chandy and Tellis, 2000). Incremental innovations in contrast, improve upon and extend existing technology. Radical innovations are also commonly described as innovations that serve as the basis for many subsequent technological developments (Ahuja and Lampert, 2001). They represent a significant leap forward in the technological frontier in adding significant new value to the marketplace. For example, Tushman and Anderson (1986) defined a technological discontinuity as an order-of-magnitude improvement in the maximum achievable price-versus-performance frontier of an industry.

Since the focus has been put on the technological driver, it becomes useful to provide a theory explaining what is the general evolution, within an industry, of the technology itself and of subsequent technological introductions.

The technology S-Curve has become a centrepiece in thinking about technology strategy. It represents an inductively derived theory of the potential for technological improvement, which suggests that the magnitude of improvement in the performance of a product or process occurring in a given period or resulting from a given amount of engineering effort differs as technologies become more mature. The theory, depicted in Figure 2.1, states that in a technology's early stages, the rate of progress in performance is relatively slow. As the technology becomes better understood, controlled, and diffused, the rate of technological improvement increases (Sahal, 1981). However, the theory posits that in its mature stages, the technology will asymptotically approach a natural or physical limit, which requires that ever greater periods or inputs of engineering effort be expended to achieve increments of performance improvement.

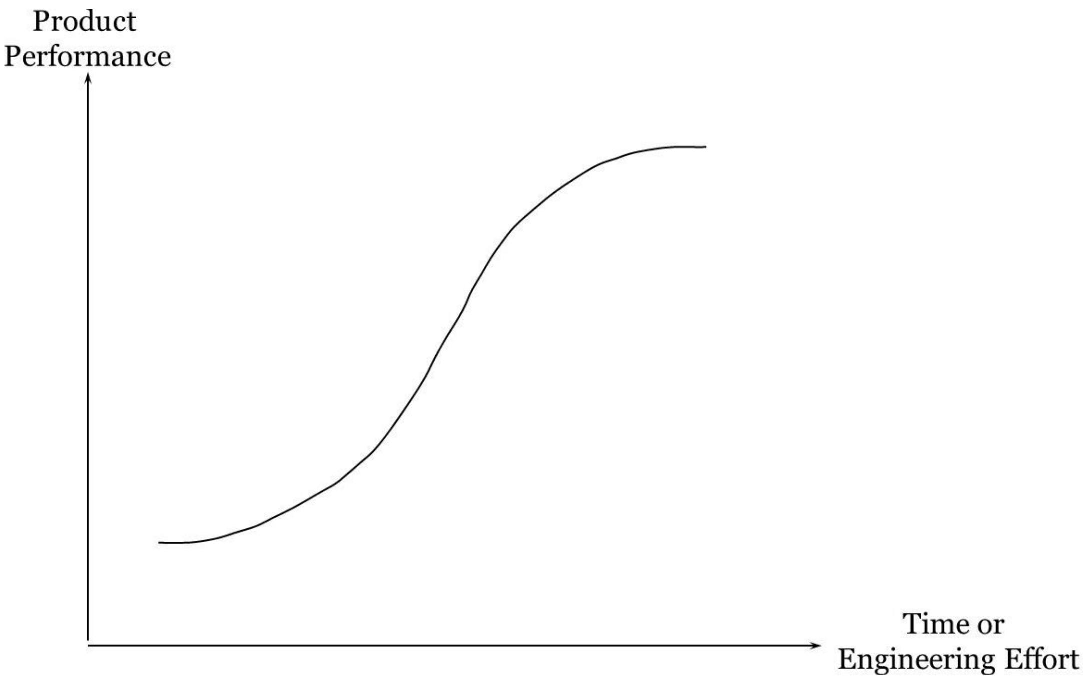

Figure 2.1 The Technology S-Curve (source: Christensen, 1997)

Many scholars have asserted that the essence of strategic technology management is to identify when the point of inflection on the present technology's S-Curve has been passed, and to identify and develop whatever successor technology rising from below will eventually supplant the present approach. Hence, as depicted by the dotted curve in Figure 2.2, the challenge is to successfully switch technologies at the point where S-Curves of old and new intersect. The inability to anticipate new technologies threatening from below and to switch to them in a timely way, has often been cited as the cause of failure of established firms and as the source of advantage for entrant or attacking firms.

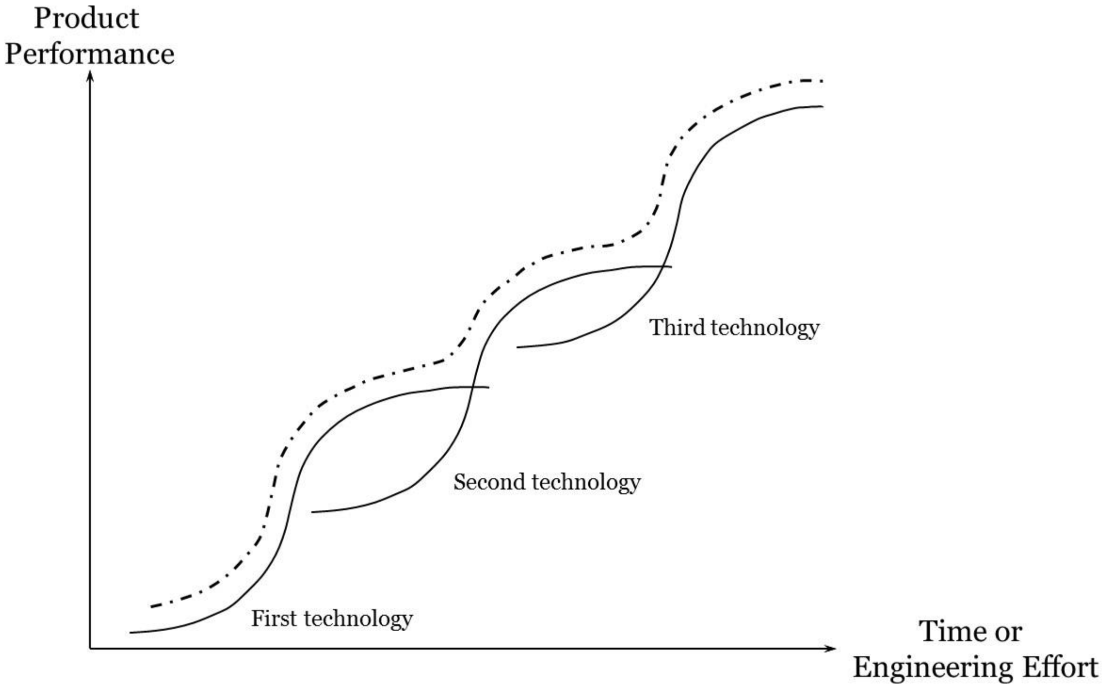

Figure 2.2 Prescriptive S-Curve Strategy (source: Christensen, 1997)

Going back to the radical-incremental dichotomy, technological changes could be considered as an external dimension differentiating between incremental and radical innovation and thus affecting market competitiveness. An incremental innovation will then involve modest technological changes and the existing products on the market will remain competitive. A radical innovation will instead involve large technological advancements, rendering the existing products non-competitive and obsolete.

Together with this, an internal dimension has to be taken into account, the knowledge and resources involved. An incremental innovation will build upon existing knowledge and resources within a certain company, meaning it will be competence enhancing. A radical innovation, on the other hand, will require completely new knowledge and/or resources and will be, therefore, competence destroying.

If innovations are competence destroying, they will change the basic performance metrics along which firms compete, rendering established technologies obsolete and destroying the value of incumbents' linkages to existing customers (Danneels, 2004).

2.2 Technology Epiphany

2.2.1 The Search for Meaning

What has been presented so far is in line with the belief that most studies have, that "innovation" is usually a shortcut for "technological innovation", so to say improvement driven by technological change. There are instead multiple drivers of change, within which technology is only one and not necessarily what builds most value in both business and society. Another major driver of innovation is in fact the search for "meaning". This leads to another major topic regarding innovation, design. Design deals with the meanings that people give to products, and with the messages and product languages that one can devise to convey that meaning. However, when dealing with "design" there is the general tendency to mistake the so-called Design Driven approach for the Human-Centred one. Design Driven Innovation will represent a major element within this paragraph, but before understanding how processes and concepts in Design Driven Innovation and radical technological innovation could both be different and at the same time mirror each other, further attention will be paid to clarifying the misconception regarding User-centred Design.

2.2.2 User-centred Design and Design Driven Innovation

User-centred design, or Human-centred design, was the response to the interest on investigating people's experiences and the interaction with products, when understanding the users' needs became essential. Significant effort has been put in defining User-centred Design (Chayutsahakij and Poggenpohl, 2002; D. A. Norman, 1998; D. A. Norman and Draper, 1986; Sanders, 2002; Veryzer and Borja de Mozota, 2005). This approach, in the spotlight because of the success of major firms like IDEO (Kelly, 2001) or Continuum (Lojacomo and Zaccai, 2004), implies that product development starts from the analysis of the user's needs. User-centred design should inform product innovation by investigating users' needs, or by observing users' behaviour when interacting with an existing product. This approach has helped to surpass the interpretation of design as 'style' and as a process that is exclusive of the designer. The user-centred perspective uses research-led approaches coming primarily from marketing and the social sciences to make incremental improvements to existing products or products lines. The design-led perspective uses design thinking and has the potential for significant innovation but it does not value the input of potential end-users as being participants in the early front end of the process (Liem and Sanders, 2011).

This perspective identifies User-centred Design as having a participatory mind-set (where users participate in the design research), and most importantly as being research-led; user-centred design is therefore a research process. However, the main argument against User-centred Design is that users cannot anticipate radical changes in meanings; it can only produce incremental innovation because it focuses on things people already know about.

Norman realized that this continual process of checking with the intended users would indeed lead to incremental enhancements of the product, but only as a form of "hill climbing" (see figure 2.3). Although the hill climbing procedure guarantees continual improvement with eventual termination at the peak of the hill, it has a well-known limit: there is no way to know whether there might be even higher hills in some other parts of the design space. Hill climbing methods get trapped in local maxima. Incremental innovation attempts to reach the highest point on the current hill, while radical innovation seeks the highest hill. The implication for design is clear: because Human-centred Design is a form of hill climbing, it is only suited for incremental innovation. (D. A. Norman and Verganti, 2012)

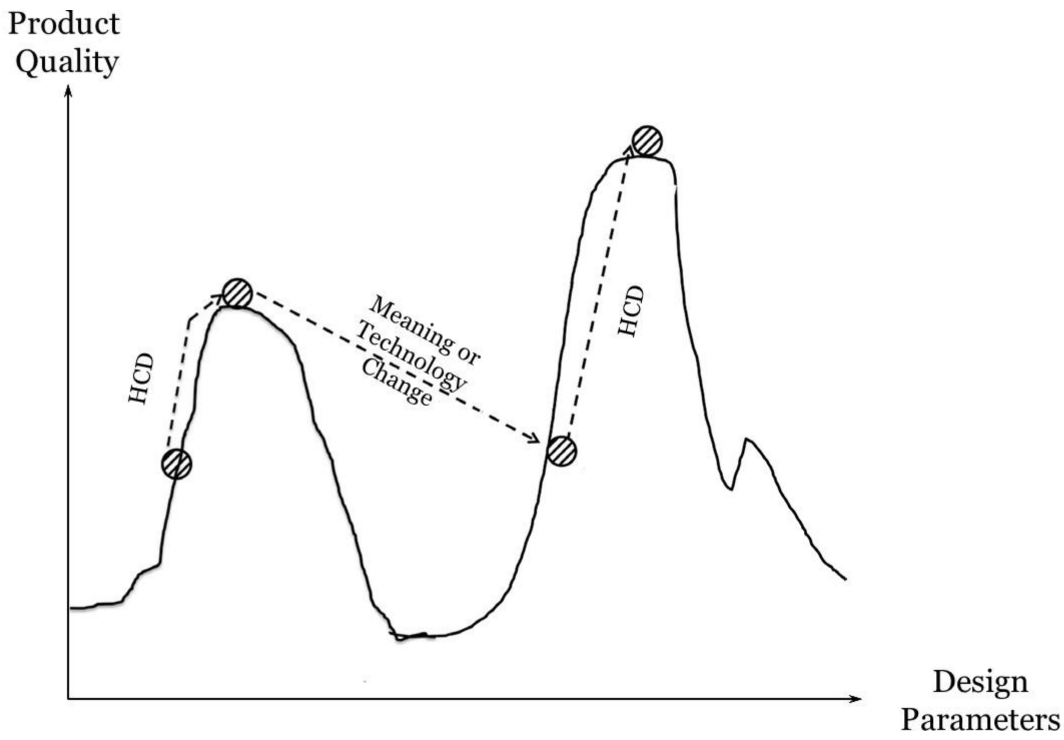

Figure 2.3 The hill-climbing paradigm applied to incremental and radical innovation (source: Norman, Verganti, 2012)

Then how is the abovementioned radical change of meaning achieved? Verganti gives a short answer with the title of a section of his book "Design-Driven Innovation: Want to be radical? Forget user-centred innovation" (Verganti, 2009). Analysing successful Italian manufacturers, such as Alessi, Artemide and Kartell, Verganti understood that their approach to innovation is not centred on users but centred on meanings.

In fact, no one questions the importance of user-centred design. Yet, it is only one piece of the puzzle. There are indeed firms that have effectively developed a different approach to leverage on design, an approach that does not fit the user-centred model, and to a large extent, it is orthogonal to it. The innovation process is definitely not user-centred, indeed the firms Verganti has analysed in his study have rather developed superior capability to propose innovations that radically redefine what a product means for their customers. The strong focus of recent literature on user-centred design has left a major empty spot in theory of product innovation management. What is missing is the capability to understand how breakthrough innovations driven by design are created. Following the approach of many design theorists, the preeminent belief is that design deals with the meanings that people give to products, and with the messages and product languages that one can devise to convey that meaning. In other words, we adopt the definition proposed by Klaus Krippendorff on Design Issues in 1989 (Krippendorff, 1989). "The etymology of design goes back to the latin de+signare and means making something, distinguishing it by a sign, giving it significance, designating its relation to other things, owners, users or gods." Based on this original meaning, one could say that design is making sense (of things). If functionality aims at satisfying the utilitarian needs of the customer, the product meaning tickle his affective and socio-cultural needs. It proposes to users a system of values, a personality and identity that may easily go beyond style.

While user-centred design has the merit of moving the attention of design management scholars and practitioners upstream from product development to concept generation, another approach asks to move the focus even earlier in the innovation process, where firms sense the dynamics of socio-cultural models and think of new languages and visions with an exploratory aim.

Design Driven Innovation concept actually starts to emerge during 1980s when Jim Utterback and Bengt-Arne Vedin became part of a team of Swedish and American researchers conducting study to address sources of future growth. To their surprise, the most successful in the sample of 60 new firms from Sweden, are coming from the firms that were stressing design, instead of technology, in their innovation (Utterback *et al.*, 2006). Later, as already mentioned, Verganti (2009) also started investigating successful innovation practices and the results demonstrated that radical innovation of product meanings leads to products with long lives, significant, sustainable profit margins, brand value, and company growth.

Design Driven Innovation (DDI) is a process that allows a company to create its own vision and proposal and to develop a radical new meaning; it is based on the idea that each product has a particular language and meaning. As a scheme, it expands and elaborates on the concept of form, in order to better capture the communicative and semantic dimension of a product (Verganti, 2003). As Verganti (2009) says, design management literature is characterized by two major findings. The first is that radical innovation is one of the major sources of long-term competitive advantage. The second is that "people do not buy products but meanings" (Verganti, 2009), a statement that is very close to what Levy said in 1959: “people buy products not only for what they can do, but also for what they mean” (Levy, 1959). Verganti explains that the process of Design Driven Innovation is a research project, it is exploratory, it aims at creating an entire breakthrough product family or new business and it occurs before product development. It is not the fast creative and brainstorming sessions that are typical of concept generation, but rather a deep investigation that, like technological research, escapes attempts to imprison innovation in simple and sequential ten-step rules (Verganti, 2009).

Design Driven Innovation therefore is a phase of the design process, the very initial phase. It aims at opening up opportunities before thinking in terms of product or solution to be designed. Design Driven Innovation should be adopted to “sense the dynamics of sociocultural models and think of new languages and visions with an exploratory aim” (Verganti, 2008).

2.2.3 The Dimensions of Innovation

If indeed technological innovation creates an improvement in performance and therefore has a direct impact on value, innovation of meaning cannot be put on a scale, it is impossible to quantitatively claim that a meaning is “better” than another meaning. Therefore assessing the value of a change in meaning and associating it with either an incremental or radical change, implies to redefine assumptions about the value of innovation and challenges the related theoretical frameworks, even if a change in meaning does not necessarily substitute an incumbent dominant solution. In the previous “Innovation” paragraph the technology S-Curve has been presented in order to show the potential of a technological change, as well as its evolution. Now comparing it with a change of meaning, differently than technological change that is predestined to saturation cycles, there is always a potential for creating, or destroying, value by a change in meaning. In fact, it leaves major questions open about how to assess and capture this potential. Innovation of product meanings does not spring merely from technology nor from transferring solutions to new markets. Instead, it is driven by the search for meaning, which is the purpose for users to buy and use products. Meanings are concerned with the “why” of use, not the “how”. It is about making sense of an experience of use, and therefore connected to artefacts as products or services and the system surrounding them. These two considerations seem to point into one direction: it seems that there is always a potential for an innovation of meaning, without a specific condition explaining what are the circumstances that prevent it or make it more or less fruitful. This statement differs from what we can find in innovation studies, especially those related to technological innovation. Indeed, there is a profound difference in the dynamics through which investments in technologies and investments in meanings may create value.

Technological innovation may be described as a process of “problem solving based on optimization”, it aims at improving performance by finding a better solution to a defined problem. In this process the solver knows when a solution is better, it happens when the solution allows to move further. However, in this process technological innovation is associated to a process of saturation. This is due to two combined phenomenon. First, the saturated (S-shaped) relationship between investments in technological research and increase in performance, at a given point reaches a limit, a local maximum. Second, the progressive transformation of the relationship between performance and value, as explained in the Kano model (Kano *et al.*, 1984). When a new performance is proposed and improved, it usually acts as a major delightful differentiator, small improvements in performance turns into relevant increases in value.

Later however (as shown in Figure 2.4), the relationship becomes linear and eventually flat, the feature becomes a “must-have” and improvements in performance, even the most radical jumps, are not associated anymore with increase in value. Along this process of optimization, the challenge in technological innovation is to find the solutions that allows moving further up until the maximum, but the existence of this better solution is always uncertain.

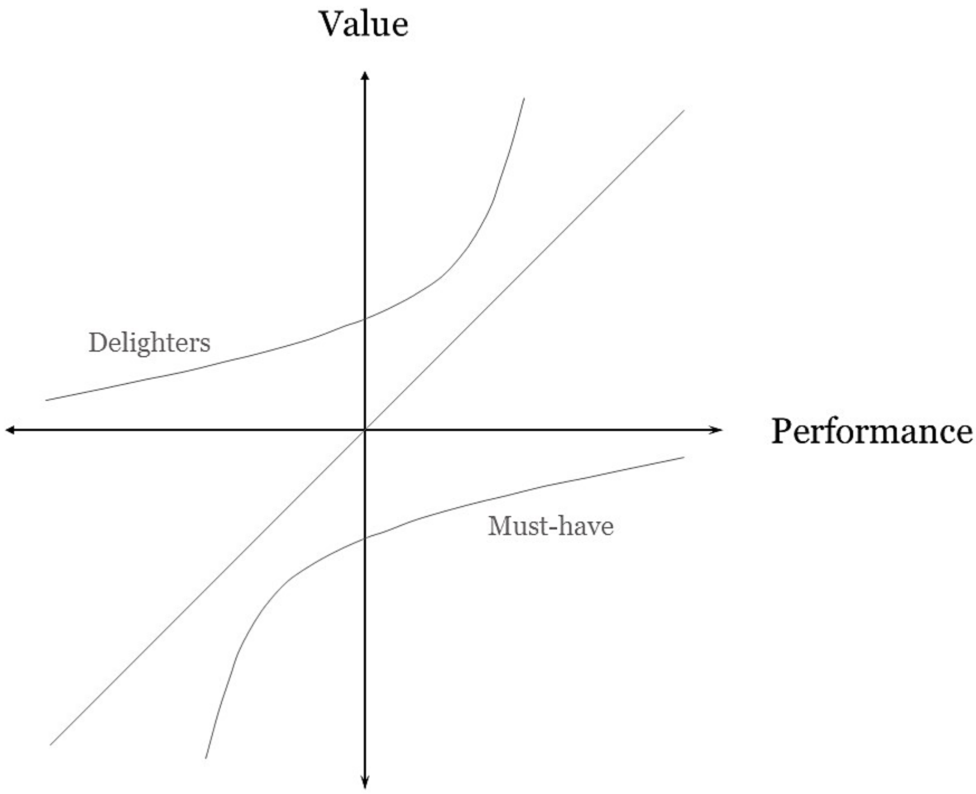

Figure 2.4 The Kano Model (source: Kano *et al.*, 1984)

Innovation of meaning instead works differently. Since meanings cannot be put into a scale, their innovation does not move upwards in a process of optimization, but rather it changes the purpose (e.g. the structure of value). Furthermore, meanings are not subjected to saturation, since they are not connected to filling the gaps between needs and existing solutions, but about creating new dimensions and new purposes.

Even if a person is satisfied with what he/she has, a new meaning may always emerge and be proposed. This implies that there is always the potential for a new meaning; new meanings can always be envisioned without incurring into a process of saturation.

After outlining the main differences between technology and meaning as drivers of innovation, it is essential to understand how intertwined they could actually be when developing an innovation.

Consider in particular the diagram in Figure 2.5. Building on the above discussion we may say that innovation may concern a product's functional utility, its meaning or both. Moreover, alike functional innovation may imply an incremental or radical improvement of technical performance, also innovation of the semantic dimension may be more or less radical. In particular, innovation of meanings is incremental when a product adopts a design language and delivers a message that is in line with the current evolution of socio-cultural models. However, innovation of meanings may also be radical, which happens when a product has a language and delivers a message that implies a significant reinterpretation of meanings.

For example, the Swatch, launched first in 1983 was a radical innovation of what a watch previously meant to people. As watches were considered to be jewels in the '50s and in the '60s, and moved to be considered time instruments in the '70s (with the advent of the Taiwanese quartz watch industry), the Swatch radically overturned watch's meanings into that of "fashion accessories". Easy to be said … after they conceived it. However, before them, no one thought that watches could ever achieve that meaning (Glasmeier, 1991). The Swatch's design language, with its intensive use of plastic, colourful style and low price, helped to convey this new meaning. Nowadays Swatch launches into the market a couple of new collections every year. Each collection consists of style and graphic changes that simply adapt its original meaning to evolutions in socio-cultural trends. Every Swatch collection may therefore be interpreted as an incremental innovation of meanings.

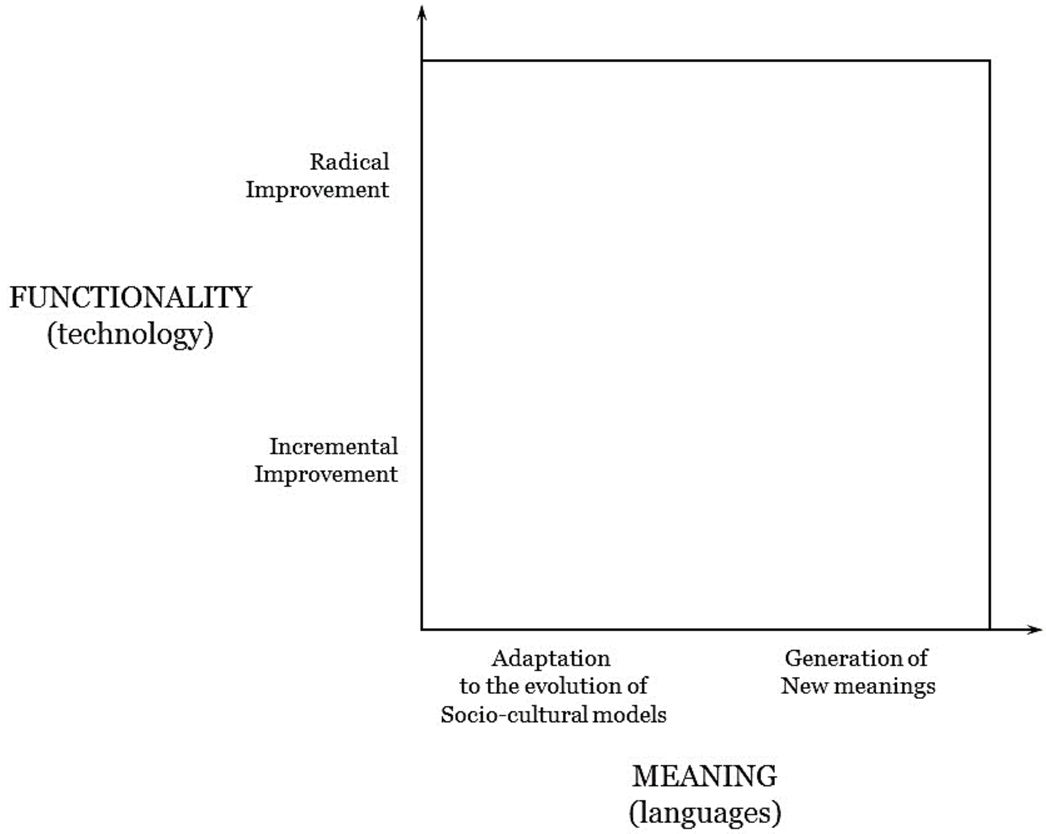

Figure 2.5 The dimensions of innovation (source: Verganti, 2008)

The area in the right hand side of Figure 2.5, where novelty of meaning and design language is radical, is what has previously defined as Design driven innovation. In other words, similarly to radical technological innovations, that ask also for profound changes in the technological regimes (Latour, 1987; Callon, 1991; Bijker and Law, 1994; Geels, 2004), radical innovations of meaning ask for profound changes in the socio-cultural regimes. These breakthrough changes serve the purpose of exploring new routes, satisfying latent desires and aspirations, moving the frontier of design languages, setting new standards of interpretation.

2.2.4 Innovation Strategies

Design Driven Innovation, together with the Market pull and the Technology push approaches, represent the potential approaches to innovation. All of the three has its own features that will be briefly synthetized.

Market pull innovation starts with user analysis of user needs and then searches for technologies that can better satisfy them, or updates product languages to respond to existing trends. With the market pull approach, the market is the main source of innovation and new product development is a direct consequence of explicit needs expressed by the consumers. The primary assumption of this approach is that user needs are explicit elements that can be identified, captured, and translated into new products that satisfy those needs (Iansiti and Khanna, 1995).

Technology-push approach looks at the innovation process from completely different perspective. Rather than being driven by the market, innovation stems from the company's research and development activities that, through the identification and development of new technologies, allow it to create new products (Abernathy and Clark, 1985).

Design Driven or Design Push approach is complementary to market pull and technology-push. In the Design Push approach, innovation stems from a third knowledge source, one that adds knowledge about user need and technological opportunities (Verganti, 2003). Design-driven innovations are instead proposals, which however, are not dreams without a foundation. They end up being what people were waiting for, once they see them. They often love them much more than products that companies have developed by scrutinizing users' needs.
Reading the previous analysis in the light of this realm of investigations, what can be recognized is that Design Driven innovation is actually closer to Technology Push rather than User-centred Innovation. These considerations are mapped in the diagram represented in Figure 2.6 on the dimensions of innovation, highlighting the major areas of action of the three modes of innovation.

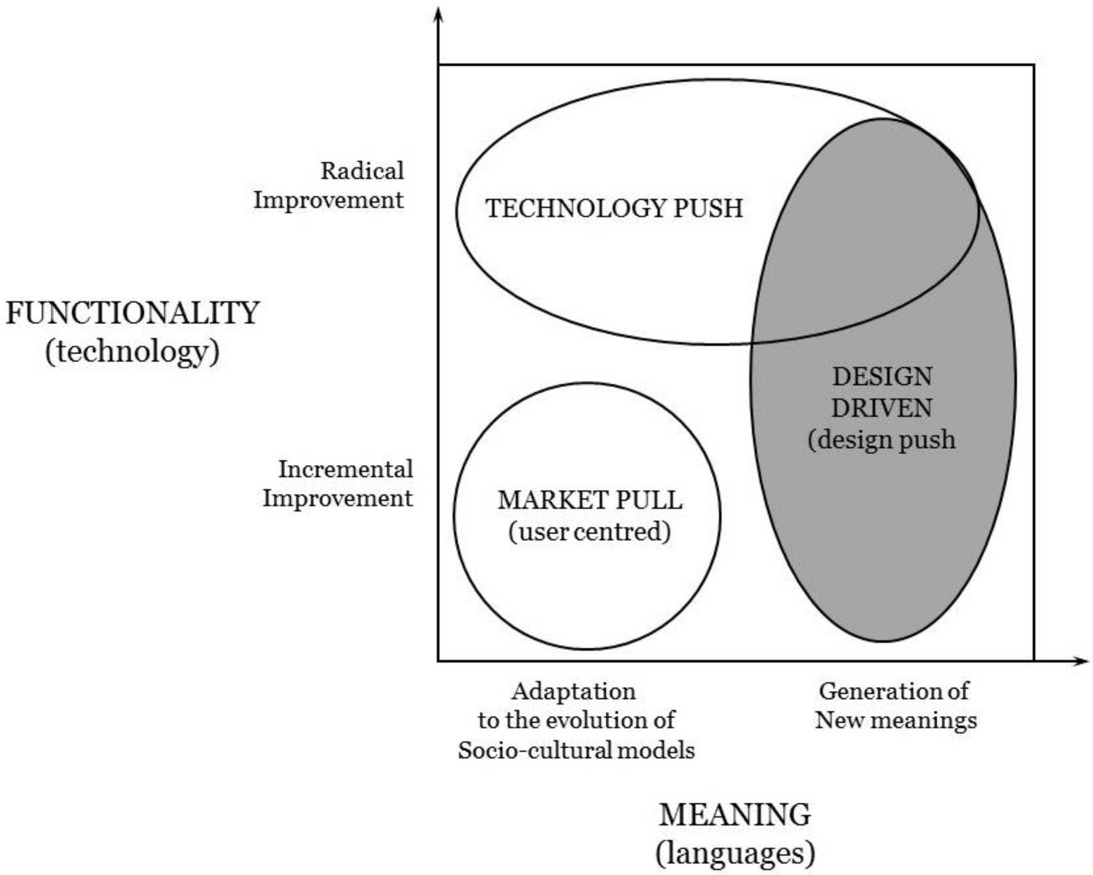

Figure 2.6 Innovation Strategies (source: Verganti, 2008)

Putting again the focus on the interplay between radical innovation of meanings and radical innovation of technologies, an interplay that can reconfigure competition in an industry, means focusing on the upper-right corner of the map of innovation strategy, where technology-push and design-driven innovation overlap. Although these two strategies do not conflict, some companies tend to focus on only one aspect. Microsoft, for example, has mastered technological transitions while often allowing competitors to define breakthrough meanings.

2.2.5 Celebrating a Technology Epiphany

Design starts playing a role as a differentiator during incremental innovations, as stated before when explaining Human-Centred Design, by making products different from those of competitors by leveraging on creativity, user interface and style. Moreover, design plays a major role in a technology's inception as well, particularly when a technology discontinuity arises. When a technology discontinuity emerges, it embeds many potential meanings and many potential opportunities. Some are immediate and promoted by those who have initially guided technological development. Other meanings are quiescent, but sooner or later they become manifest.

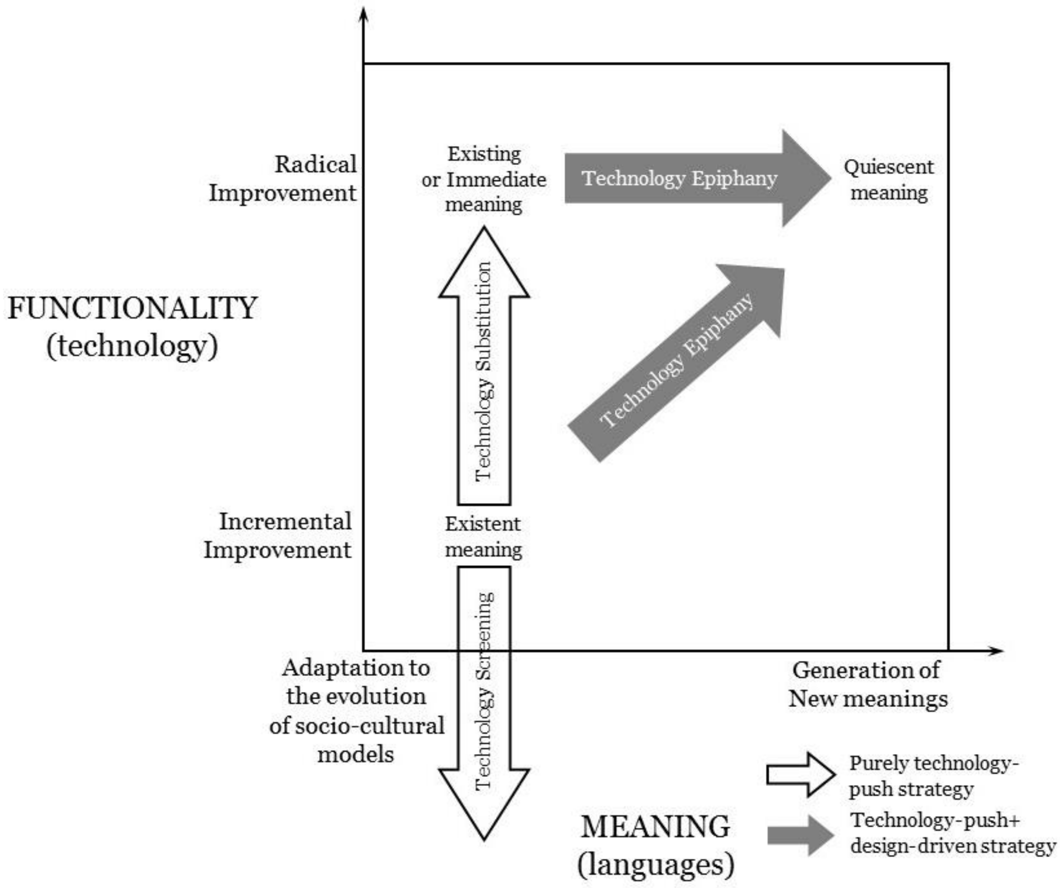

Figure 2.7 Comparison of strategies: purely technology push or interwoven with design-driven innovation (source: Verganti, 2009)

A company that sees innovation strategy as mono-dimensional, that is consisting only of technological innovation, will not search for the quiescent meaning. This approach leads to two myopic behaviours. On the one hand, if the most immediate meaning of a new technology does not fit with the existing meaning in the market, companies will likely screen that technology off and consider it irrelevant to competition (the down-pointing white arrow in Figure 2.7). If the most immediate meaning of the new technology does fit the existing meaning, a company will invest by substituting the new technology for current technologies (the up-pointing white arrow in the diagram). However, someone will eventually have a technology epiphany, the manifestation of the essential and more-powerful meaning of the technology. As Verganti stated "each technology is considered to embed a set of disruptive new meanings that are waiting to be uncovered. If a company reveals those quiescent meanings, it will seize the technology's full value, celebrating a Technology Epiphany" (Verganti, 2009).

A technology epiphany may occur when a company has understood that a radical new meaning can emerge in the market and therefore is open to new technologies (the diagonal arrow in Figure 2.7). Alternatively, a technology epiphany may occur when a company searches for the more-powerful meanings that a new technology embeds (e.g. Swatch), as indicated by the horizontal arrow.

The real challenge to investigate is how to achieve the discovery of the potential applications and envision new meanings within new or existing technologies. This can be achieved by mixing research activities related to new technologies with studies regarding emerging lifestyles and societal values to introduce radical design-driven innovations. This involves a process of research and analysis in unusual fields, with unusual customers, towards unusual and powerful meanings.

The case of KUKA's Robocoaster presented in the first chapter, the world's first passenger-carrying industrial robot, represents a perfect example of a Technology Epiphany (see Figure 2.8).

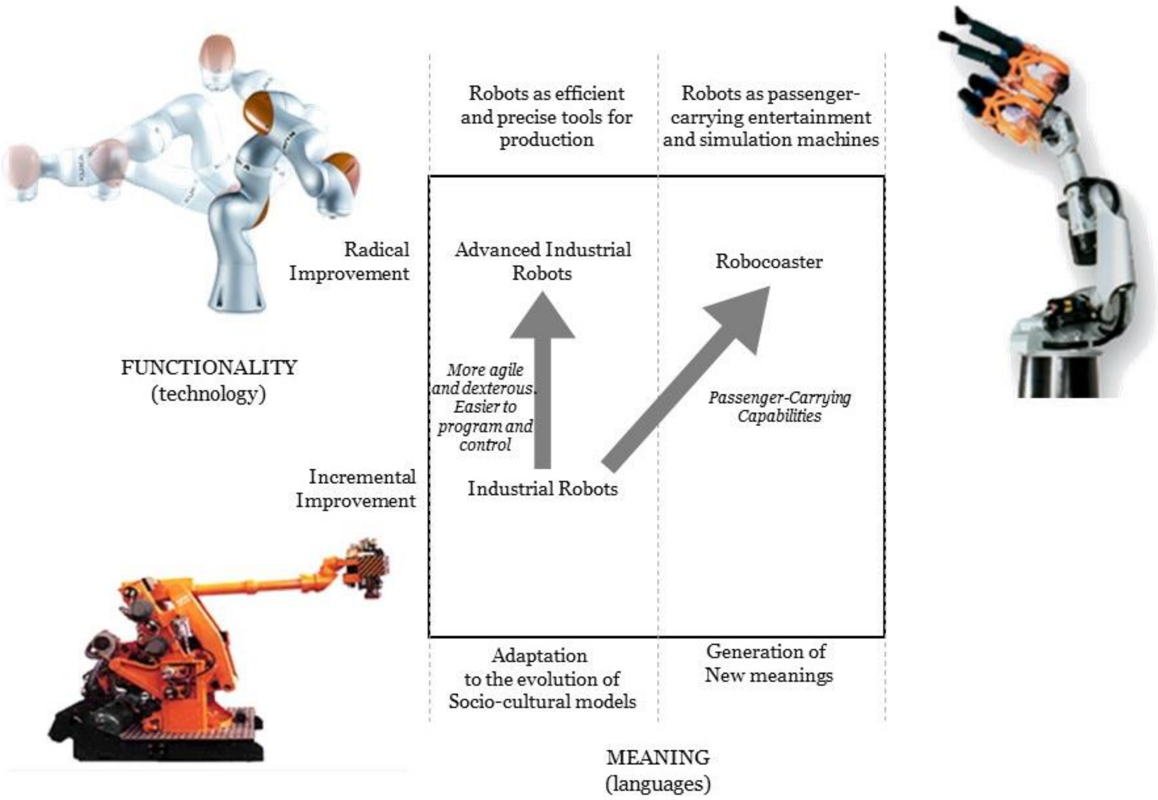

Figure 2.8 KUKA (Robocoaster) – Technology Epiphany (source: Dell'Era *et al.*, 2016)

Indeed, this case study shows some of the key points that were previously mentioned in addressing the theoretical framework. There is a clear example of those "short-sighted" companies that, in perceiving the meaning of "Robocoaster" as not fitting with the existing meaning in the market, decided to screen it off and consider it irrelevant to competition. What took to experience a technology epiphany was courage and the drive of searching for the unusual. Therefore, a slight modification together with the re-interpretation of an existing technology as a platform that enables the discovery of quiescent meaning has allowed KUKA to significantly valorise their potentialities and consequently capture great additional value, which would have not otherwise been achieved.

The bottom-line implications of this analysis are that first, the full potential of technological breakthroughs is achieved only when someone uncovers the more-powerful quiescent meaning of a new technology. Second, a technology epiphany is usually much more disruptive to competition than is the technological breakthrough itself. Third, as soon as a new technology emerges, companies should ask, “What is the hidden meaning of this technology? What is its real interpretation? How can we explore its opportunities? What breakthrough changes in meaning (and therefore in competition) could it drive?” In other words, they should invest in both technology-push and design-driven innovation.

CHAPTER 3
RESEARCH METHODOLOGY

This chapter aims at defining the research process that has been followed throughout the research in detailing each step composing it. Together with this, the adopted methodology will be presented in describing the reasons of selection. The objectives of the research will be furtherly detailed as well as the relevance of the research itself. A short digression regarding the regulatory framework will follow, in highlighting the importance it had for the advancement of the research.

3.1 The Methodology

This first paragraph aims at defining the process that has been followed throughout the research as well as the methodology that has been adopted, in order to provide a framework to refer to during the development of the thesis.
However, before representing the steps composing the research process, the problem setting of the thesis will be shortly recalled in order to have a clear reference when making further explanations.

As previously explained, Unmanned Aerial Vehicles are recently generating growing interest as people start to see their potential and to invest in this emergent technology. However, from the very early uses in the military field, several decades passed before realising that the technology could have been adopted somehow else. Indeed, the research aims at understanding how firms were able to explore the set of opportunities that was enclosed into the technology and not determined in the early technology development. Also in the light of the fact that expressing such potential represents a powerful way to approach new application fields, the research will try to comprehend how to explore such opportunities in addressing new industries. What is expected is that there would not be a unique way of pursuing this "exploration objective", thus making interesting for the research purposes, to also study the characteristics describing the first adopters of such a technology in new applications.

Going back to the definition of the research process, Figure 3.1 illustrates the main steps that has been followed throughout the research.

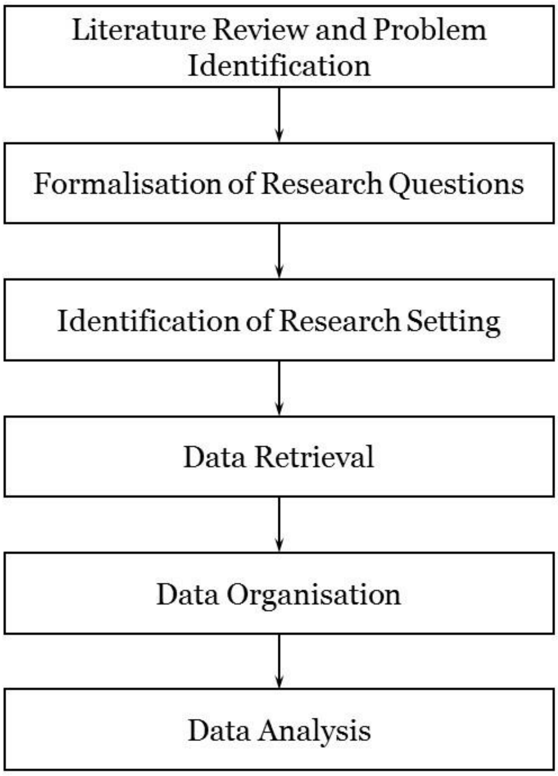

Figure 3.1 The Research Process steps

Before detailing, within the subsequent paragraph, each step composing the process, the methodology that has been adopted will be presented.

Despite on-going debate about credibility, and reported limitations in comparison to other approaches, “Case Study” is an increasingly popular approach among qualitative researchers (Thomas, 2011). Case study research indeed has a level of flexibility that is not readily offered by other qualitative approaches such as grounded theory or phenomenology. Together with this, case studies are designed to suit the case and research questions. Several prominent authors have contributed to methodological developments, which has increased the popularity of case study approaches across disciplines.

Firstly, according to the definition of Yin “a case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context” (Yin, 2009). As a research method, the case study is then used in many situations, to contribute to the knowledge of individual, group, organizational, social, political, and related phenomena. For the purposes of the research, when investigating a small number of firms that were able to understand that the UAV technology had huge opportunities to offer, the study of each of the cases seems to be the most suitable choice. Together with this, other reasons why this method represents the most appropriate one for the research goals will follow.

The main motivation is related to the nature of the research objectives. A basic categorisation scheme for the types of research queries is the familiar series: “who”, “what”, “how”, and “why” questions (Hedrick *et al.*, 1993). According to this representation one may say that regarding the scope of this research, the nature is more on the “how” side. Indeed, the investigation aims at understanding “how” companies were able to understand that the UAV technology could offer opportunities beyond the military use. Furthermore, it also questions “how” these companies proceeded when adopting the technology for addressing new industries. Once again referring to the studies developed by Yin, the “how” question is indeed more explanatory and likely to lead to the use of case studies as the preferred research methods. The goal is to explain a situation, mostly in the form of a causal relationship, which is excessively complex for surveys or experimental strategies.

Together with this, the case study's distinctive strength is its ability to deal with a full variety of evidence-documents, artefacts, interviews, and observations-beyond what might be available in a conventional historical study. Therefore, this approach is also preferred when examining contemporary events (Yin, 2009) as in the case of this research, thus making it the best methodology to adopt.

3.2 The Research Process

This paragraph aims at detailing each step composing the research process.

3.2.1 Literature Review and Problem Identification

In the previous chapter the concepts of Innovation and Technology Epiphany has been deeply investigated, representing the first step of the research methodology. Indeed, together with building a conceptual framework upon which to work, the literature review has allowed the identification of potential limits and areas of investigation. In presenting the concept of innovation, it seems that, when addressing the technology as a driver of innovation, this necessarily implies a technology substitution. The challenge for innovators is to successfully switch technologies at the point where S-Curves of old and new intersect. The inability to anticipate new technologies and to switch to them in a timely way, has often been cited as the cause of failure. Therefore, little attention is given to valorising technologies that only seem to have "exhausted their potential". Indeed, in the case of drones, one may have perceived the potential of the technology as already completely expressed after a military use. Through the explanation of the Technology Epiphany, this limit seem to be somehow overcame, in stressing the fact that the real challenge for innovators is not just finding a "better technology", rather is to unveil new meanings within new or existing technologies.
However, such a representation fails to enhance some important elements that companies could benefit from. Indeed the Technology Epiphany is mainly referred as revealing the quiescent meanings of a technology. What one could not understand from such a definition is that capturing the meaning of a technology, could intend being able to identify the opportunities offered by that technology. Indeed, when approaching a new or existing technology one should understand that instead of looking at it as just a tool or a device, he/she should be able to see the plethora of possibilities that are waiting to be discovered and in the meantime not to fall into the overwhelming concept of "meaning".

What is missing from a theoretical point of view is the definition of a framework, a guideline that companies could follow when exploring the opportunities provided by a technology. Moreover, what is not enough stressed within the literature is that opening to new opportunities could represent the best way to address new industries. The KUKA example, shown in Chapter 1 and recalled in Chapter 2, is a clear evidence of this. Once having identified the opportunities that the technology had to offer, the innovator has explored them in firstly addressing the amusement park industry and then opening to new applications ranging from the filmmaking industry to the research one.
Similarly, this research aims at understanding which are the opportunities that the Unmanned Aerial Vehicle (UAV) technology has to offer. Opportunities that were not yet considered in the early phases of the technological development. More in depth, it focuses on how the identification of such opportunities can lead to address new industries. Moreover, as already said the focus will also be put on the first adopters of the technology in new industries themselves. The aim is in understanding their characteristics, the traits that led them to understand how the UAV technology could have offered opportunities beyond the mere military use.

3.2.2 Formalisation of Research Questions

After having identified the main elements upon which the research will focus, the formalisation of the research questions will follow, in adding a further level of precision to the purposes of the research.

RQ1*: How do companies explore the opportunities provided by emerging technologies when addressing new industries?*

RQ2*: Which are the peculiarities characterising the first adopters of emerging technologies in new industries?*

Before reinforcing the relevance that these research questions have in studying the development of an emergent technology, a clarification is needed for a better understanding of the research objectives. When referring to “new industries” that companies address, implicitly there is the assumption that the "newness" is adopted from the technological point of view. In other words, the research investigates the way companies have adopted the UAV technology in those applications in which the technology has never been used before.

In the first chapter, some market trends have been presented in stressing the relevance of the technology. Indeed, the attention towards the drone technology has continuously grown since the last years. Together with this, through the literature review some gaps and possible "limits" have been identified.
Some other elements will be presented in supporting the relevance of the research.

As stated in the ***RQ2***, the research is not only directed towards the definition of a framework in order to explore new technological opportunities. Thus, a description of the elements characterising the adopters of the technology will be outlined. From a theoretical point of view the study of the early adopters, whether it is the adoption of a new product or of a new technology, has always provided fundamental insights regarding innovative contexts. Table 3.1 summarizes the main features Moore (1991) identifies regarding the "early adopters" and the "early majority".

Early Adopters	**Early Majority**
Proponents of revolutionary change	Proponents of evolutionary change
Visionary users	Pragmatic users
Willing to take risks	Averse to taking risks
Willing to experiment	Look for proven applications

Table 3.1 Early Adopters and Early Majority features (Source: Moore, 1991)

Therefore, the role of early adopters is key in the identification of the potential opportunities embedded into a technology and therefore in defining the evolution of its adoption. Hence, the study of their peculiarities and choices in terms of innovation strategy is quintessential in understating the development of the technology itself. Moore than suggests, "The transition from the early adopters to the early majority is essential to an innovation's success, offering particular potential for breakdown because the differences between the two groups are so striking." (Moore, 1991). This, however, does not pertain to the aim of this research and in addition to that, it would be hard to determine since the early stage of the exploration of the UAVs' opportunities.

Reconnecting to the insights coming from the literature review, the research is then useful in providing a framework that companies could follow when trying to explore the opportunities provided by a technology. The creation of an environment of active learning could help in setting direction and priorities based on others' successes, and of course mistakes, and in motivating and initiating focused innovative programs. Therefore, the findings of the research on the UAV technology could be useful for all those companies that are seeking new opportunities provided by emerging technologies.

3.2.3 Identification of Research Setting

In order to develop the analysis, a narrower focus was needed, in fact even though the technology is still under development, its diffusion has already been traced worldwide. Even from the very early researches, the US market appeared to be the most suitable setting for the research objectives for two main reasons. Firstly, because it is generally considered a high-velocity environment where demand, competition and technology are in constant and accelerated change (Wirtz *et al.*, 2007). Therefore, the process of adoption could be observed and results analysed over a reasonable time span where performance data are available, that is indeed the second reason for choosing it. Together with the main elements driving the implementation of UAVs, in the first chapter the role of regulations has been presented as one of the most powerful barriers. Indeed, when proceeding with the research, the role of regulations increasingly gained much relevance. Therefore, the definition of the Research Setting has been somehow affected by the regulatory environment, as it will be further explained.

When dealing with the regulations in place within the American context, the Federal Aviation Administration (FAA) represents the major actor in being the federal agency responsible for ensuring the safety and efficiency of the National Air Space (NAS) and protecting people and property on the ground. A first distinction that will direct the selection of the proper research setting is the classification that the FAA makes when addressing the possible uses of drones.

The FAA categorises the operational use of UAVs into two main categories, the “Fly for Fun” and the “Fly for Work”. The former is related to a private recreational use, which does not require any permission from the FAA, as far as the pilot is at least 13 years of age, aware of the safety guidelines and the drone is registered and labelled. The latter category is related to a non-recreational use of UAVs and can be furtherly subdivided according to whether it is a “Public use” or “Private use”. Public use means that it is operated by federal, state, or local agencies for law enforcement or other public safety purposes, or by a qualifying state university for conducting research. The Private use is instead operated by either individuals or firms for commercial purposes.

In 2007, the FAA issued a policy statement declaring that "no person may operate a UAS (Unmanned Aerial System) in the National Airspace System without specific authority" and that such policy would apply to both public and private UAVs. Later on, until recently, there was only one way to obtain specific FAA authority to operate UAVs, which was in being granted a Certificate of Waiver or Authorization (COA). However, this mechanism was hardly restricted to public use of UAVs, while there was no legal way of operating a drone for commercial purposes.

Section 333

In order to enable the nascent drone industry to grow, Congress wrote provisions into the 2012 FAA Modernization and Reform Act (FMRA) that required the Federal Aviation Administration to develop and implement regulations for the commercial use of drones in the National Airspace System. Congress set a deadline for the FAA of September 30, 2015 to prepare and implement its drone regulations. In order to allow a degree of growth in the in-between period prior to the implementation of these rules, the 2012 FMRA authorized the FAA to allow certain non-recreational drone operators to begin flying low-risk operations before the full regulations for drones were implemented. Under Section 333 of the Act, the FAA developed a process to review, on a case-by-case basis, petitions from individual operators wishing to be exempted from standing rules that ban the commercial non-recreational use of drones. Users who are granted exemptions could take to the sky without an airworthiness certificate, which is the FAA's standard for determining whether an aircraft is safe to fly. These exemptions are accompanied by a list of guidelines and restrictions on how and when the exemption holder can fly (see Table 3.2). This temporary measure became known as a "333 exemption," and it is the principal mechanism by which non-recreational commercial drone users are taking to the skies until the implementation of full regulations, which has then been delayed well beyond the September 30, 2015 deadline.

	Fly For Work
Pilot Requirements	Must have Remote Pilot Airman Certificate Must be 16 years old Must pass TSA vetting
Aircraft Requirements	Must be less than 55 lbs. Must be registered if over 0.55 lbs. Must undergo pre-flight check to ensure UAS is in condition for safe operation
Location Requirements	Class G airspace
Operating Rules	Must keep the aircraft in sight (visual line of sight) Must fly under 400 feet Must fly during the day Must fly at or below 100 mph Must yield right of way to manned aircraft Must NOT fly over people Must NOT fly from a moving vehicle
Legal or Regulatory Basis	Title 14 of the Code of Federal Regulation (14 CFR) Part 107

Table 3.2 Rules for operating an Unmanned Aircraft (source: FAA official website)

Even though the Section 333 could be considered in some way as an obstacle to overcome before actually being able to operate an UAV, in the meantime it represents a powerful source of information for the objectives of this research.
Indeed, when mentioning that the regulatory environment would have directed the selection of the Research Setting, the Section 333 became decisive within this step of the Research Process. As previously mentioned, the objective of the research is in providing a framework for the exploration of the opportunities provided by the UAV technology when addressing new industries. In following the development of this technology it has been stated that the military use represented the very first application ever. After several decades, new opportunities emerged, but representing just the first step in the explorative process of the drone opportunities. The Section 333 is the tangible proof of the full value embedded within the UAV technology, which was just waiting to be seized. Even though some advancements has been made when allowing the public use of UAVs through Certificate of Waiver or Authorization (as mentioned before), the real outbreak of the opportunities provided by the technology took place when firstly regulating its commercial use.

3.2.4 Data Retrieval

In highlighting the relevance of Section 333, it was mentioned that it represents a powerful source of information. Indeed, the analysis is built from data extracted from FAA Section 333 database, as well as from exemption letters, which are both publicly available on the FAA's website. In Figure 3.2 a shot of the official database of FAA Section 333 is shown, starting from the first ever granted exemptions in late 2014.

Grant Issued	Petitioner	Operation / Mission	Authorizations (includes grant of exemption documents)
09/25/2014	Aerial MOB	Closed-set filming	Exemption 11066 Docket Record Amendment C (PDF) Amendment D (PDF) Amendment E (PDF) Amendment A (PDF)
10/01/2014	Astraeus Aerial	Closed-set filming	Exemption 11062 Docket Record Amendment A (PDF) Amendment B (PDF) Amendment C (PDF)
10/10/2014	Flying Cam	Closed-set filming	Exemption 11080 Docket Record
12/10/2014	Woolpert	Precision aerial surveying	Exemption 11111 Docket Record
12/10/2014	VDOS Global	Flare stack inspection	Exemption 11112 Docket Record
01/06/2015	Advanced Aviation Solutions	Precision agriculture	Exemption 11136 Docket Record
01/06/2015	Douglas Trudeau, Tierra Antigua Realty	Real estate photography, videography	Exemption 11138 Docket Record

Figure 3.2 Authorizations Granted via Section 333 Exemptions (Source: FAA official website)

The exemption letters together with the FAA's database provide information including the date of the exemption, the name and location of the exempted, a short description of the activities that the exempted has received permission to engage in, and a list of unmanned aircraft systems that the exempted will be using for said operations. In fact, the FAA requires petitioners to describe how they plan to use their drones. For example, a petitioner hoping to use a drone for commercial real estate photography must state in his/her petition something to the effect of "I plan to operate unmanned aircraft commercially for real estate photography." It is generally understood that if a commercial drone user holds an exemption that lists "aerial photography and videography for real estate" as the only service covered by the exemption, that person will not then use his or her drone to conduct aerial surveys for the oil and gas industry. This information was essential in order to develop a detailed picture of the types of missions that non-recreational drone users engaged in.

3.2.5 Data Organisation

After having identified all the available information provided by the FAA's website, the need of a framework as useful as possible for the objectives of the research became essential. As already detailed and shown in Figure 3.2, each exempted company has shared with the FAA the intended use that they were going to make of the UAV technology. However, since the research is focused on understanding how companies could address new industries, a categorisation was needed in order to even out the available information and to make a more proficient use of it. Starting from the description of operations provided in the database, therefore, homogeneous categories have been defined.

The theory suggests some models for the industry taxonomy, like the International Standard Industrial Classification of All Economic Activities, which however does not offer a sufficiently granular portrait of the drone applications. Indeed, categories are designed to more precisely reflect the types of operations petitioners will engage in. Through a research made upon several key words, operations have finally been classified into uniform categories. In some cases the used terminology for making such researches could seem to overlap and to be redundant (e.g. photography and inspection), however it was essential to consider all possible definitions of operations, since no unique terminology was used. Logically partitioning the database into smaller portions aims at helping its "manipulation" and together with this, having classified the operations according to the affiliate industry allows the research to move one step further.

In the end 18 categories, corresponding to specific industries that petitioners indented to address, have been identified. In the next chapter, the results coming from this categorisation will be presented.

Although the "Section 333" represents a powerful source of information, it is however organised in such-a-way that does not allow to effectively depict both the overall picture and the path of single petitioners. In fact, together with the identification of the addressed industries, the other major element characterising the research is represented by those companies that firstly entered these industries. However, before investigating the peculiarities characterising these companies, their identification is obviously the first move to make. When explaining that the Section 333 is not organised in an effective way, the main "issue" regards how operations are listed with respect to each petitioner. It must be said that more than half of all petitions list more than one kind of operation. For example, a petitioner might have requested an exemption for "flare stack inspections and aerial photography for real estate".

This laid the basis for the realisation of another database, that is closely intertwined with the FAA's one, but in giving more emphasis to the industries and the petitioners themselves. More specifically, going back to the previous example, if a petitioner had filed an exemption for "flare stack inspections and aerial photography for real estate", the exemption within the newly realised database will be categorised as both belonging to Oil&Gas and Real Estate industries. On the contrary, if an exemption had listed two kinds of intended operations that both fall under a single category, for example an exemption that lists "oil pipeline inspection" and "flare stack inspection", the category will not be repeated for that exemption. Thus, in having a more structured picture of all granted exemptions as well as the exact day in which these have been granted, the identification of the "first adopters" with respect to each industry became straightforward.
As already mentioned, the "Section 333" is the first and only way for privates to commercially fly an Unmanned Aerial Vehicle, which in turns means that the first petitioner exempted in an industry is indeed the "first adopter" of the UAV technology with respect to that specific application.

After having identified the industries of interest, as well as the petitioners that firstly adopted the UAV technology within each of these, all the available and relevant information about these firms and the industry they have entered into has been collected. As previously stated, the exemption letters together with the FAA's database provide information including the date of the exemption, the name and location of the exempted, a short description of the activities that the exempted has received permission to engage in and a list of unmanned aircraft systems that the exempted will be using for said operations. Through secondary resources information regarding the age of the companies, the main business in which they operate and the decisions regarding the implementation of the UAV technology has been gathered. In parallel, a research concerning the actual implementation of the technology within each industry is developed, in trying to define how UAVs can express their potential, when employed in different applications. The results of the data retrieval and organisation will be shown in the following chapter.

3.2.6 Data Analysis

The last step of the research consisted in the critical analysis of the gathered data. Once having collected the relevant information, the objective was in trying to define a framework to be followed when firstly addressing an industry with an emergent technology. Firms wondering how to proceed when having identified the opportunities provided by a technology would then have some approaches derived from the Drone Industry that could be suitable for them.

Together with this, in detailing the peculiarities of those firms that were able to foresee such potential, companies may recognise some similarities that would help them in figuring out how to move in such a delicate context, taking the best decisions.

CHAPTER 4
RESULTS

This chapter aims at reporting all the information gathered within the research. Firstly, the categorisation of data will be presented and together with this, the time frame within which the research will focus on, is outlined. The identification of first adopters, with respect to each new industry that has been addressed by the Unmanned Aerial Vehicle technology, will follow. Finally a more detailed explanation of the opportunities offered by UAVs with respect to each case is presented, as well as a description of the main traits of first adopters.

4.1 Industry Identification

In the previous chapter the steps composing the research methodology has been outlined. Following this structure, the results will be progressively presented along this chapter. Starting from the description of operations provided in the database, homogeneous categories have been defined through a research made upon several key words.

In the end 18 categories, corresponding to specific industries that petitioners indented to address, have been identified. Table 4.1 shows the outcome of this classification in associating to each operation/mission the industry in which they belong to.

Operation/Mission	Industry
Oil Pipeline Inspection Flare Stack Inspection Gas Emission Monitoring	Oil&Gas
Solar Panels Inspection Wind Turbine Inspection	Renewable Energy
Utility Inspection Power Line Inspection Electrical Infrastructure Inspection High-tension line inspection	Power Utilities
Construction Site Inspection Residential/buildings Inspection Civil Engineering Inspection (dams and aqueducts, bridges, roofs) Industrial Inspection (Industrial infrastructure, Manufacturing plants)	Construction
Inspection of mining facilities Stockpile mapping	Mining
Railroad/Railway Inspection	Railroad
Search and Rescue Operations	Search&Rescue
Aerial Photography/Videography for Law Enforcement	Law Enforcement
Aerial Photography/Videography for Law Enforcement	Advertising
Surveying Marine Property Marine Resource Management	Marine
Precision agriculture Crop Scouting Crop Monitoring Agriculture Mapping/Surveying/Inspection	Agriculture

Operation/Mission	Industry
Air pollution inspection Water Supply Monitoring Forestry Monitoring Wildlife Monitoring	Environment
Journalism and News Media&Broadcasting Aerial photography/videography for television	TV
Closed-set filming Cinematography Motion Picture	Filmmaking
Aerial photography/videography for Real Estate	Real Estate
Fire inspection and Firefighting Support Natural Disaster Response Emergency Response Operations	Emergency Response
Aerial Photography/Videography/Data Collection/Surveying/Inspection/Acquisition Market Research Research&Development	Research
Safety Inspections Surveillance	Safety&Security

Table 4.1 Categorisation of Operations in Industries

After having identified the industries of interest for the purposes of the research, the concrete retrieval of data has begun. When firstly addressing the information provided by the Section 333 database, it became essential to define also a time frame within which the research was more likely to have consistency.

4.1.1 Time Frame definition

As already mentioned, in 2012 under Section 333 of the FAA Modernization and Reform Act (FMRA), the FAA developed this process to review, on a case-by-case basis, petitions from individual operators. Therefore, representing the only way to legally fly commercial drones until the implementation of full regulations, which has been delayed well beyond the September 30, 2015. The starting point of this analysis is marked by the first ever granted exemption, which is dated September, 2014. Exemptions under Section 333 have been granted until September, 2016, however for what concerns the objectives of this research, the time interval has been restricted to March, 2016. The reason behind this choice lies on the fact that after this month the numbers of exemptions were no more comparable to the previous ones. The event behind that was the announcement, on February, 2016 from the FAA, regarding the long-awaited full regulation concerning commercial drone use. The FAA proposed a framework of regulations "that would allow routine use of certain small unmanned aircraft systems (UAS) in today's aviation system, while maintaining flexibility to accommodate future technological innovations". After this first announcement, the public has been able to comment on the proposed regulation for 60 days from the date of publication in the Federal Register. Indeed, after having processed this proposal, firms started to avoid submitting requests for exemption through Section 333, since the amount of information required and, above all, the long-lasting waiting time. The new proposed Part 107 rule has promised to reduce time for obtaining authorization to actually take to the sky, since the new review process would not be developed on a case-by-case basis no more. The attractiveness of this new regulation has therefore led Section 333 data to become inconsistent after March,2016.

4.2 First Adopters Identification

After having defined the interval of interest, the determination of the number of granted exemptions is straightforward. More specifically during the period ranging from September, 2014 to March, 2016 the total number of petitioners who have been granted a Section 333 exemption amounted to 4086.

Following the framework detailed in the previous chapter, the subsequent step consisted in sorting the different operations listed in the FAA database within their affiliate category (industry). This has led to the realisation of a second database, within which every list of intended operations has been decomposed according to the relative industry, therefore the same company could be present twice or more times. Thus, the total number of voices composing the database has almost doubled, reaching 7754.

In Figure 4.1 a temporal distribution of the granted exemptions, listed within the newly realised database, with respect to the industries is depicted.

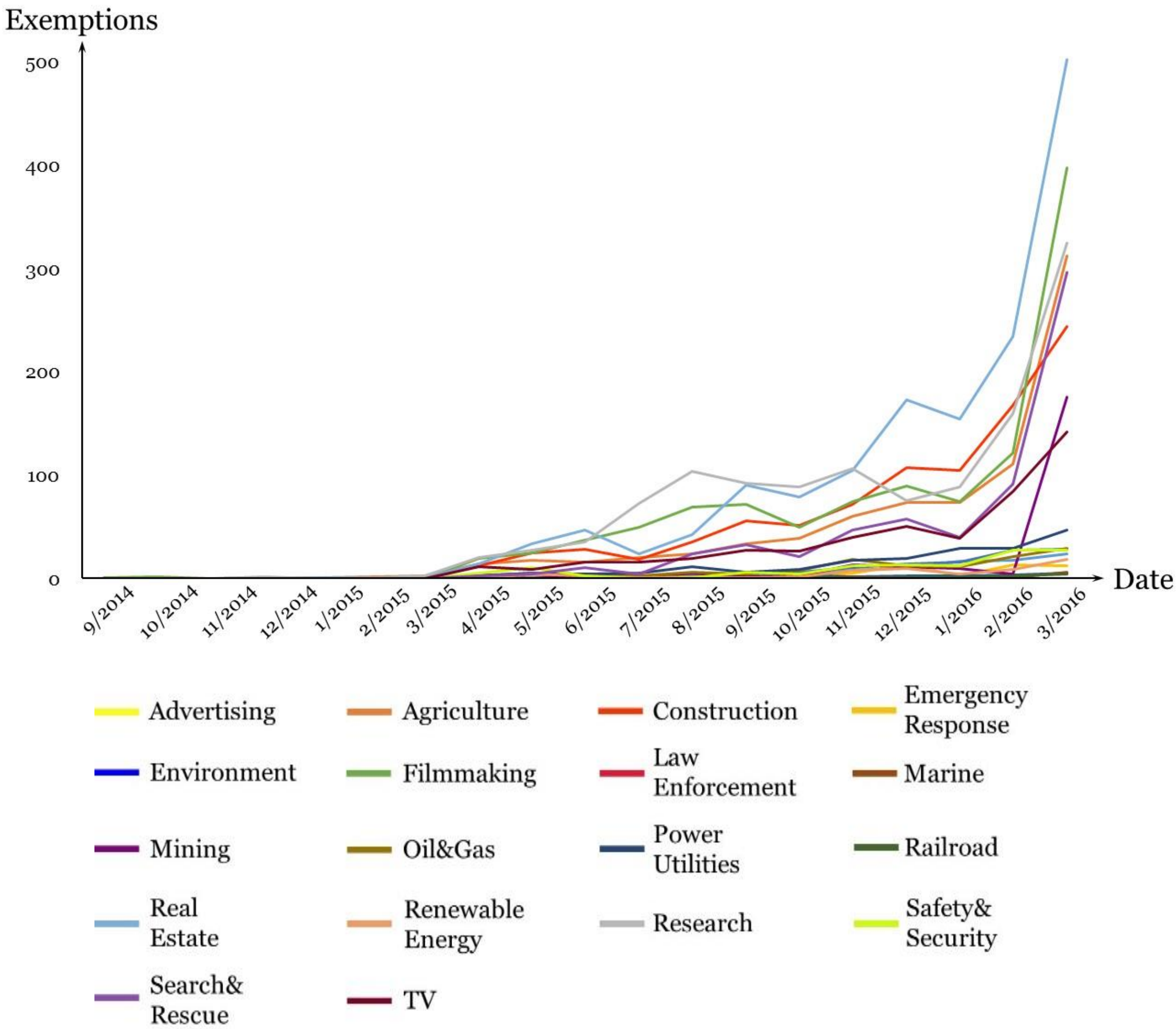

Figure 4.1 Temporal distribution of granted exemptions grouped by industry

As already presented in Chapter 3, the identification of first adopters is then straightforward from the database that has been built starting from the FAA's one. As shown in Figure 4.2, first adopters are represented as the first ever granted exemptions with respect to each industry.

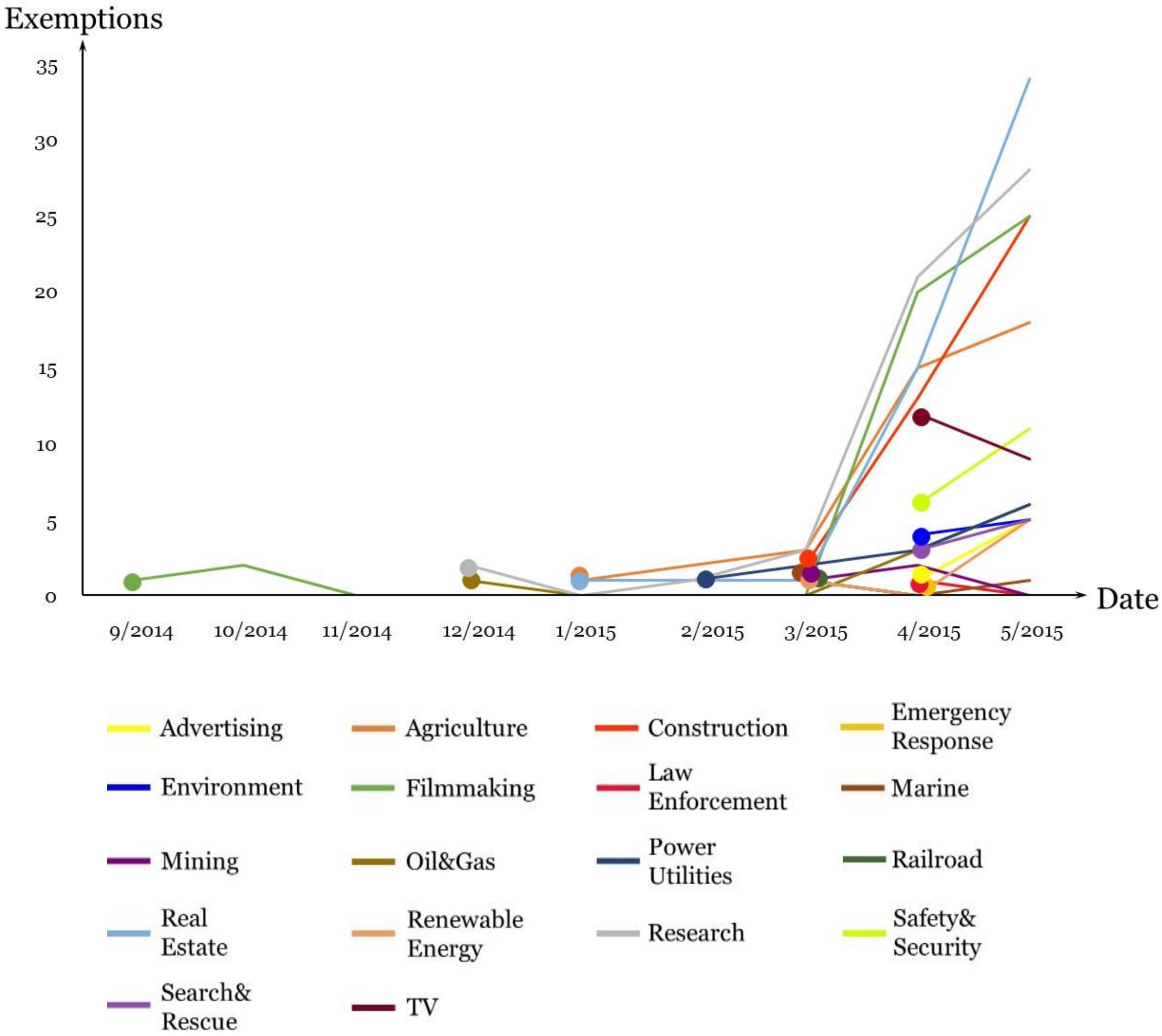

Figure 4.2 First Adopters with respect to each industry

What may not emerge from Figure 4.2 is that each of the 18 identified industries was firstly addressed by a diverse petitioner. Thus, providing another insight for the research. Together with this, another feature characterising all of the "first adopters" is that, for each of them the first exemption that they have ever been granted represented what legitimises them as first adopters. In other words, it has never happened that a company seeking to explore the opportunities provided by the UAV technology, has filed its very first exemption request only for an industry that had already been addressed by some other companies before.

After these first understandings, the identification of first adopters will move a step forward in actually associating the name of the company that explored the use of the UAV technology to the addressed industry.

In Table 4.2 a list of the industries is displayed, together with the respective first adopters and the date of the granted exemptions.

Industry	**First Adopter**	**Exemption Issued**
Advertising	Hovershots APV	04/2015
Agriculture	Advanced Aviation Solutions	01/2015
Construction	Bechtel Equipment Operations	04/2015
Emergency Response	Aerologix Consulting	04/2015
Environment	Toledo Aerial Media	04/2015
Filmmaking	Aerial MOB	09/2014
Law Enforcement	Advanced Robotics Corporation	06/2015
Marine	FalconSkyCam	03/2015
Mining	EnviroMINE	03/2015
Oil&Gas	VDOS Global	12/2014
Power Utilities	Commonwealth Edison Company	02/2015
Railroad	BNSF Railway	03/2015
Real Estate	Douglas Trudeau	01/2015
Renewable Energy	Notus Access Group	03/2015
Research	Woolpert	12/2014
Safety&Security	Jackson Family Wines	04/2015
Search&Rescue	Down East Emergency Medicine Institute	04/2015
TV	Upward Aerial	04/2015

Table 4.2 Addressed industries with relative first adopter and date of granted exemption

After having outlined the overall representation, a more detailed description of each case will follow. Therefore, the focus will be put on understanding how the UAV technology could address new industries. Indeed, details will be given with respect to how UAVs could be implemented in each specific case, as well as information regarding the first adopters in each of those cases will be provided.

4.3 Addressed Industries and First Adopters

4.3.1 Advertising Industry

The UAV technology can address this industry in several ways, with different disruption potentials. Drones can fly banners to promote an event or product; they can be used to physically reach consumers in new and innovative ways. UAVs could become actors themselves in video commercials as surprising flying objects bringing the "wow" factor. However, maybe the most powerful use is as videographer tools, they can be used in commercials to produce innovative video content and offer new perspectives. Indeed, in addition to technology shifts in established projects, new customers for aerial photography are entering the market; these customers would not have previously considered buying this type of service, because of prohibitive cost. For example, hotels and spas are now using aerial photography and video material for advertising purposes, especially on their websites.

Born in 2014, **Hovershots APV** "combines over **25 years of Flight experience** (Kevin Haley, Pilot/Owner), with over 10 years of Production & Design experience (Brandon Haley, Creative Director) to bring your vision to life! Our skilled Flight Ops Team and our Social Media & Marketing Team (Shari Haley & Lindsay Tester), will provide you with a fantastic final product, as well as help to promote your project." Hovershots APV's client base consists of small to medium sized businesses looking to increase their awareness of structures or landscape on their respective properties through data collection and to advertise them. "**Aerial videography for geographical awareness and for marketing** has been around for a long time through manned fixed wing aircraft and helicopters, but for small business owners, its expense has been cost-prohibitive." Granting this exemption to the petitioner would allow providing this service at a much lower cost. The UAS proposed by the petitioner is a **Steadydrone QU4D** (Figure 4.3) equipped "to conduct aerial photography for the media and advertising industries".

Figure 4.3 Steadydrone QU4D

After obtaining the exemption for "Advertising" operations in April, 2015, Hovershots APV decided **not to file any other request**.

4.3.2 Agriculture Industry

Drones can provide farmers with three types of detailed views. First, seeing a crop from the air can reveal patterns that expose everything from irrigation problems to soil variation and even pest and fungal infestations that are not apparent at eye level. Second, airborne cameras can take multispectral images, capturing data from the infrared as well as the visual spectrum, which can be combined to create a view of the crop that highlights differences between healthy and distressed plants in a way that cannot be seen with the naked eye. Finally, a drone can survey a crop every week, every day, or even every hour. Combined to create a time-series animation, that imagery can show changes in the crop, revealing trouble spots or opportunities for better crop management.

Founded in 2011, **Advanced Aviation Solutions** (ADAVSO) is composed of aviation professionals with over 100 years of combined aeronautical experience. With diverse backgrounds as operators, instructors/educators, logicians, and executives in the civilian, military and government sectors, ADAVSO **is specialized in the aerospace application of remotely piloted aircraft**. The company has been granted its first exemption in January, 2015 for "Precision agriculture" operations. As a pilot, Steve Edgar, President and Founder of ADAVSO, said he appreciates "the challenges the FAA faces in safely regulating commercial drone use. But, **the agriculture industry may be one of the safest places to employ UAS technology**, given the low flight path of UAS for crop scouting and that most farms are not in densely populated areas". The proposed exemption has allowed Advanced Aviation Solutions to operate the **eBee Ag** (see Figure 4.4) manufactured by senseFly, to conduct photogrammetry and crop scouting in order to perform precision agriculture.

Figure 4.4 senseFly eBee Ag

Later, the same year the company filed **additional exemption requests**. In July,2015 ADAVSO was granted exemption for "Aerial surveying and mapping " in using the **3DRobotics Aero-M** (Figure 4.5), while in November, 2015 "Aerial surveying, aerial photography, agriculture, wildlife and forestry monitoring, wild land firefighting support, patrolling, aerial inspection, real estate surveying, and mapping" operations has been granted.

Figure 4.5 3DRobotics Aero-M

Several other models (3DR Solo, SteadiDrone Flare, SteadiDrone Mavrik, DJI Matrice 100, DJI s1000 +, DJI S900, DJI Inspire 1, DJI Phantom 3, DJI Phantom 2 Vision +, DJI Phantom 2 as shown in Figure 4.6) have been listed within the request for exemption dated in November. As well as several other industries have been addressed by the company when filing these two additional requests ("Research", "Agriculture", "Environment" and "Real Estate"). Thus, through this series of exemptions ADAVSO has progressively branched out the services offered to its clients.

Figure 4.6 UAV models listed in the November, 2015 exemption of ADAVSO

4.3.3 Construction Industry

In addressing this industry, the simplest application is in analysing a site from above, using live footage from a UAV. This gives an overview of the site and indication of site specifics. Moreover, using predefined flight paths is ideal for monitoring progress on construction sites with high accuracy and minimized effort. Indeed, there is a lot to keep track of on a job site (project progress, the location of equipment, the volume of materials left) and an aerial view makes it all a lot easier. Drones are cheaper to fly than manned aircraft and faster than human surveyors are, and they collect data far more frequently than either can do. Thus, letting construction workers track a site's progress with a degree of accuracy previously unknown in the industry. With the right computing tools, builders can turn sensor data into 3D structural models, topographical maps, and volumetric measurements (useful for monitoring stockpiles of costly resources like sand and gravel). Collectively, that intelligence allows construction companies to more efficiently deploy resources around a job site, minimize potential issues, trim costs, and limit delays.

Founded in 1898, **Bechtel Equipment Operations** is a global **engineering, construction, and project management company** delivering landmark projects that create long-term progress and economic growth. The firm filed an exemption "for aerial imaging for safety and monitoring of secured and controlled environment construction sites. This exemption request is exclusively for the use of the **UAS manufactured by Skycatch**, Inc. (see Figure 4.7), a San Francisco based company". Moreover, instead of just adopting its UAV model, the firm, said Bechtel's manager of construction Mike Lewis , "**teamed with Skycatch** to explore innovative ways of integrating drones into the execution systems, particularly on the megaprojects Bechtel is building around the world". Together with the exploration of innovative approaches in order to employ the UAV technology, Skycatch has also **provided to Bechtel its pilots** in order to actually take drones to the sky.

Figure 4.7 Skycatch UAV model

Bechtel Equipment Operations, **after** having obtained in April, 2015 the Section 333 **exemption for "Construction"** operations, then decided **not to file any other request**.

4.3.4 Emergency Response Industry

The Universities of Rome and L'Aquila published a paper on 'UAV Application in Post-Seismic Environment', which concludes that "Even if these [conventional surveying] techniques represent instruments of extreme operability, there are still many evident limits on their use, especially regarding the survey of both the roofs and the facades of tall buildings or dangerous places, typical of post-earthquake situations. So using UAVs for surveying in such particular cases, many of these problems can be easily bypassed." (Baiocchi *et al.*, 2013). In a more distant future, UAVs might carry out small maintenance and repair tasks in "difficult-to-reach or high-risk spaces".

AeroLogix Consulting Inc. ("AeroLogix") is the **designer, builder and the operator of the GeoStar UAV aerial imaging system**. The system is capable of creating high-resolution geospatial ("GIS") imagery and engineering grade survey products. **The heart of the system is the GeoStar UAV** (Figure 4.8), a semi-autonomous fixed wing aircraft with electric power and a payload capacity exceeding 10 pounds.

Figure 4.8 GeoStar UAV

The small company, founded in 2007, filed the exemption request for "Aerial survey to produce imagery and terrain modelling products useful in applications ranging from land and water resources management, environmental research, disaster response, and agriculture" altogether in April 2015. After being granted the exemption for the abovementioned operations, belonging to the "Environment", "Emergency Response" and "Agriculture" industries **altogether** (see Table 4.1 for more details), **the company then decided not to file any other request**.

4.3.5 Environment Industry

UAVs can play a vital role in environmental protection, for example in the safeguarding of an endangered species, or monitoring the status of forests. Inspections can be conducted in areas which can be difficult or hazardous to access by other methods and allows for greater coverage than conventional approaches. Further, as the imagery transmitted by the UAV can be viewed in real-time or on the screen immediately after flight, more detailed on the spot inspections can be carried out as needed.

Founded in 2014, **Toledo Aerial Media** is a **media/technology company that plans to exploit the capabilities of Unmanned Aerial Systems to offer a multitude of services**. In order to achieve this goal the company filed an exemption request in April, 2015 for "aerial surveying, remote sensing, photography, agricultural, construction, and wildlife monitoring". Formed by professional remote pilots, Toledo Aerial Media has extensive experience with and knowledge of drones and works closely with clients to harness the power of these unmanned aircraft systems for their needs and applications. The company is also committed to promoting the UAV research efforts of policymakers including the FAA, NASA, DOD and DARPA by sharing data from its commercial UAV operations and serving as a resource for future UAV research operations. The petitioner filed the exemption for using a **DJI Phantom 2 Vision +** and a **DJI Inspire 1** (Figure 4.9) and after being granted exemptions for "Environment", "Research", "Agriculture" and "Construction" **operations altogether** in April, the company opted **not for filing any other request of exemption** to the FAA.

Figure 4.9 UAV model within the Toledo Aerial Media exemption

4.3.6 Filmmaking Industry

Film missions that would previously have used a helicopter can now be executed at a fraction of the cost. In some instances, the UAV replaces expensive technology that is not even a flying device; for example, instead of using computer technology to create scenes, these can now be filmed by UAV. Moreover, UAV technology allows carrying out movements that were previously unconceived. Indeed, no other filming method can start a sequence inside a building and end up at 400ft altitude in one uncut shot.

Founded in 2013 and based in Southern California, **Aerial MOB** is a **leading company in the field of aerial cinematography and photography, utilizing the latest technology in unmanned aerial vehicles**. "To make a living, we've had to go outside the U.S. borders for the last years" said Tony Carmean of Aerial Mob, as it waited for the FAA's blessing, his company only filmed with drones in foreign countries. Until then, however, Aerial MOB continued focusing on **its product line**, Carmean said. The company produces quad-, hexa- and octo-copter drone packages for filming and provides a series of hardware upgrades and technological consulting. After receiving the exemption in September, 2014 for using its **own hexa-copter** (Figure 4.10) in the "Filmmaking" industry for major film productions, the company then filed **another request** in April, 2015.

Figure 4.10 Aerial MOB Hexa-copter

This was meant **to use several other UAV models** (HexaCrafter HC-1100, Aeronavics SkyJib 8 Heavy Lifter, Aerial Mob Discovery Pro Light Lifter, A.M. Halo 8 Heavy Lifter, DJI Phantom 2 as in Figure 4.11) for “scripted, closed-set filming for the motion picture and **television industry**” in adding to its portfolio of “Filmmaking” operations, the “TV” ones.

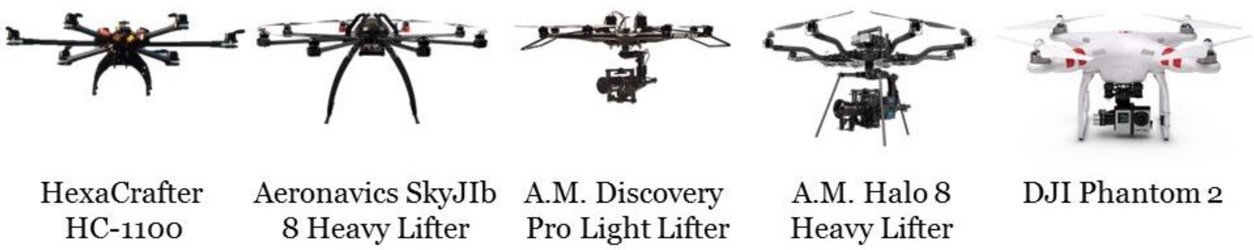

Figure 4.11 UAV models within the April, 2015 exemption of Aerial MOB

4.3.7 Law Enforcement Industry

UAV technology addresses the law enforcement industry in offering agencies eyes in the sky, which aid in all types of pursuit and reconnaissance, while protecting the lives of officers on the ground. UAVs allow police forces to search wide areas in real time, and gain vantage points otherwise unavailable. Whether giving an accurate, high definition portrayal of an overall scene, or zooming in on particular details, like a potential weapon on a suspect, drones can provide an invaluable tool for law enforcement. With real time overview, law enforcement forces on the ground can know how best to stay out of harm's way and how to best reach their objective. They can also use UAVs to collect evidences from different vantage points.

Advanced Robotics is a corporation founded in Arizona in 2014 specializing in education, knowledge and **solutions supporting development and application of Unmanned Aircraft Vehicles** and robotics to satisfy Government and Commercial needs. The filed exemption allowed Advanced Robotics to use **its own Advanced Robotics AR–960 and AR–540** to conduct operations "within **a variety of industry** and business applications such as Education and Training, Aerial Survey/Inspection and Imaging, Agricultural, Forestry, Wildlife Preservation, Law Enforcement, and Search and Rescue". Briefly after having being granted, in June, 2015, this exemption for "Law Enforcement", "Research", "Agriculture", "Environment", and "Search &Rescue" industries, the company decided to go under the name of "Aerial Sciences Corporation" and filed another request for exemption in November, 2015. More in depth, the newly named corporation opted for narrowing the number of industries addressed by the **second exemption request**. Indeed, the corporation submitted the request for **using the previously mentioned UAV models** for "Aerial survey, inspection, imaging, search and rescue, and training" operation. Thus, addressing a smaller number of industries ("Research" and "Search&Rescue") with an equal number of models.

4.3.8 Marine Industry

Addressing the Marine industry, means both surveying marine property and managing and inspecting marine resources. Indeed, by augmenting conventional surveying methods with Unmanned Aerial Vehicles, one can cost-effectively and autonomously gather data over large ocean/sea areas in any conditions.

FalconSkyCam is based in San Diego and provides **remote UAV aerial photography and video to a wide range of clients** from private individuals up to large corporates. The filed exemption allowed the company to operate a **DJI Phantom 2** (Figure 4.12) for "aerial photography for real estate, surveying, marine photo and video and agriculture".

Figure 4.12 DJI Phantom 2

FalconSkyCam is also a member of the abovementioned Academy of Model Aeronautics (AMA), the largest model aviation association in the world. After having been granted exemptions in ”Marine”, “Real Estate”, “Research” and “Agriculture” industries **altogether**, the company then decided **not to file any other request** of exemption.

4.3.9 Mining Industry

By allowing surveyors to collect accurate spatial data from above, the UAV technology can vastly reduce risk by minimizing the time these staff spend on site. Moreover, knowing the volumes of stockpiles is vital information in mining decisions about whether to extract or process more material to fill the orders. With the ability to monitor stockpiles, map exploration targets and track equipment, the usage of drones in the mining industry is limitless. Overall potential benefits spread across the value chain, from safety (monitoring/providing information from dangerous and difficult locations) to exploration and development (such as aerial photography and remote sensing) and productivity (stockpile mapping, mine mapping & reconciliation and time-lapse photography).

EnviroMINE is a 24-year-old firm specializing in **planning, permitting and compliance work for mining operations** in the California and western Arizona. EnviroMINE utilizes aerial imagery for producing accurate surface maps for mine operations and regulatory agencies through the use of mapping software. The company sought “to operate its UAV for the special purpose of collecting aerial photographs to create surface maps and updated imagery in the support of and use by mine operators”. The company sought the exemption to operate an **eBee**

senseFly UAV (Figure 4.13) for commercial purposes within the national airspace system ("NAS").

Figure 4.13 senseFly eBee

EnviroMINE's team is formed by experts with a background of "35 years of experience with environmental analysis, land use planning, and environmental mediation". Together with this, employees are "**proficient** with using eMotion and Postflight software in order to s**uccessfully fly EnviroMINE's Unmanned Aerial Vehicle** for aerial mapping purposes... (and) creating topographic mapping, using GIS, AutoCAD, and Virtual Geomatics 4D". EnviroMINE, after having obtained in March, 2015 the Section 333 exemption for Mining operations, opted for **not requesting any other** one.

4.3.10 Oil&Gas Industry

Until now, methods of surveying, detecting, and locating leaks in the oil and gas fields have been inefficient and costly to conduct. Workers have risked their lives to climb high-rising stacks and inspections have caused lengthy activity shutdowns. Drones are a cost effective and safe solution to all of these problems. Another advantage is that UAVs can follow a pre-programmed flight path, and fly closer to both the infrastructure and the ground. This allows for highly detailed flight plans, higher measurement accuracy, and increased repeatability. Moreover, no plant outage is required, with plant able to stay online and operational during inspection. A major consideration for energy companies is the early detection, response and recovery to oil spills, therefore the possibility to survey infrastructures while operational, becomes key.

Founded in 2011, **VDOS Global** is a safety focused **vertically integrated inspection Service Company** providing the systems, software, personnel, and data to its clients. The company has filed an exemption request for the Section 333 in December, 2014 in order to use an **Aeryon Skyranger** (Figure 4.14) for conducting "flare stack inspection" operations.

Figure 4.14 Aeryon Skyranger

In June 2015, Al Spain joined VDOS Global Advisory board in bringing "over 50 years of aviation operations and corporate knowledge that will help VDOS Global grow and expand in the commercial and drone market". Together with the received exemption for "Oil&Gas" operations date in December, 2014, later on, in January, 2016 VDOS Global has then **submitted another request** for getting exempted in using the **same UAV model** (Aeryon Skyranger) to conduct "aerial inspection" ("Research" industry).

4.3.11 Power Utilities Industry

Transportation & Distribution utilities have traditionally performed line inspections and maintenance, storm damage assessments, and vegetation management using line crews, helicopters, and third-party inspection services companies. The collected information was then manually reviewed and, in many cases, it was not digital. UAV technology addresses the Power Utilities industry in providing all necessary 3D models (historical and current) that can be quickly analysed based on different circumstances, so potential issues can be addressed immediately.

Formed in 1907 when Chicago Edison was combined with Commonwealth Electric, **Commonwealth Edison Company** (ComEd) is a northern Illinois-based electric utility that **delivers reliable electricity** for 3.8 million customers throughout more than 400 municipalities and 25 counties. The firm sought exemption from FAA for "Electric transmission and distribution utility system monitoring, powerline inspections, and damage assessments". The project of submitting a request was actually a **joint effort with Illinois Institute of Technology** (IIT), indeed "the requested exemptions would permit ComEd and the Illinois Institute of Technology to conduct trial operations of the **DJI Innovations S900** (Figure 4.15) for the limited purposes of electric transmission and distribution utility system monitoring".

Figure 4.15 DJI Innovations S900

After having obtained in February, 2015 the Section 333 exemption in "Power Utilities", ComEd then decided **not to file any other request**.

4.3.12 Railroad Industry

The UAV technology, in addressing the Railroad industry, could be able to carry out inspections in dangerous conditions, keeping rail employees safe, while improving railroads' ability to gather the necessary information to help detect safety problems and to plan and prioritize corrective actions. As drone and associated on-board detector technologies advance, an inspector could use data gathered by the drone to identify defects rather than needing to physically access the track. Moreover, hundreds of people are killed every year while trespassing on railroad property. Aerial drones would be significantly more effective than land bound security forces in detecting trespassers.

Founded in 1856, **BNSF Railway** is a Class I **freight railroad**, which rail system is the product of almost 400 different railroads. With 43000 employees and "given the volume and diversity of freight moved on the BNSF network, any disruptions or delays – due to mudslides, derailments, floods, or the like – can have serious consequences for shippers and the general public”. Therefore, the company filed the request to FAA “to allow the use of small unmanned aerial systems on land controlled by BNSF to **assist** in the safe supplemental **inspection of railroad infrastructure and operations**”. BNSF intends to use the **AirRobot AR180 and AR200 and the 3DRobotics Spektre** Industrial Multi-Rotor Aerial vehicle in its UAV operations (see Figure 4.16).

Figure 4.16 UAV model within the BNSF Railway exemption

BNSF Railway, after having obtained in March, 2015 the Section 333 exemption for the Railroad industry, opted for **not filing any other request**.

4.3.13 Real Estate Industry

Well-designed UAV shots not only look incredibly professional, they can generate a sense of awe and interest that one simply cannot get from ground-based photography. A camera drone can literally fly into a home through the front door, and travel throughout every room, creating a far more natural virtual tour than station-based photography can. Real estate agents could have the possibility to show homes in context to neighbours, landscaping, pools, nearby parks and schools, which are very important to many buyers. Indeed, clients could even get an idea of what the drive home or the kids’ walk to school looks like.

Douglas Trudeau is a licensed Realtor within the State of Arizona, experienced in flying hobby helicopters for recreational purposes. “Continually striving for the past **16 years** to do **real estate** better than the day before” Douglas Trudeau is a Residential Home Marketing/Associate Broker at “Tierra Antigua Realty” since

May, 2008 and the owner of "Doug Trudeau Photography" since 2011. Together with the experience in the real estate industry, Mr. Trudeau enriches his competences in **having flown** small RC electric helicopters for the last 9 years and **small UAVs, for recreational purposes, since 2012**. The realtor filed the exemption to fly a **DJI Phantom 2 Vision +** (Figure 4.17) "to benefit/stimulate attraction to the metro Tucson area and to enhance real estate listing videos for homeowners who cannot afford expensive manned aircraft for the same purpose".

Figure 4.17 DJI Phantom 2 Vision +

After having obtained in January, 2015 the Section 333 exemption for "Real Estate" operations, Douglas Trudeau then did **not request any other one**.

4.3.14 Renewable Energy Industry

Addressing the Renewable Energy industry in using the UAV technology means referring to both solar panel and wind turbines. Drones can be flown autonomously over solar fields using pre-programmed GPS waypoints. This enables the capture of both visual and thermal infrared imagery, allowing the identification of hot spots, glass cracks and shadings. Using pre-programmed waypoints means surveys can be repeated accurately, over large areas and quickly without the need to create new flight paths or manually check survey areas. Regarding wind turbines, companies can deploy UAV technology to get close-ups, 3-D images of wind blades to find out if there are any imperfections without having to stop the turbines from turning. Accuracy is key, current system produces readings that could be off by as much as 40cm in height, whereas drones would be accurate to 10cm, which can make the difference between "a flood and no flood". The overall process time would be reduced and the results of the inspection improved because they can be recorded in HD video and infrared/thermal formats.

Founded in 2012, **Notus Access Group** (NAG) performs **inspections, maintenance, and repairs on wind turbine** blades and towers for the renewable energy industry. These services are performed in a manner to minimize downtime of the wind turbine generator. The NAG team brings over 17 years of combined experience in the renewable energy industry. The firm filed an exemption request "to perform aerial inspections of wind turbine blades and towers used in the renewable energy industry" in operating the **InstantEye Mk-2** manufactured by Physical Sciences (Figure 4.18).

Figure 4.18 Physical Sciences InstantEye Mk-2

Notus Access Group, after having obtained in March, 2015 the Section 333 exemption for the "Renewable Energy" industry, opted for **not filing any other request**.

4.3.15 Research Industry

UAV technology represents a major change for surveyors and researchers. Firstly, unlike traditional surveying techniques, using a drone is fast and requires minimal staff, and using an aerial approach overcomes common site access issues such as impenetrable vegetation. Moreover, using a drone can vastly reduce the time spent collecting accurate data. By acquiring faster data from the sky in the form of geo-referenced digital aerial images, one can gather millions of data points in one short flight. With collection made so simple, energy can be focused on using and analysing data, rather than working out how to gather it.

Woolpert has been providing **surveying and mapping services for more than 50 years**, with a focused commitment on the advancement of related technologies and processes. Obtaining **awards** that range from MAPPS 2014 Geospatial Excellence Award to ACEC Georgia Honors 2015 Engineering Excellence Award. Woolpert was granted the exemption "to operate the **Altavian Nova Block III** unmanned aircraft vehicle (Figure 4.19) for the special purpose of precision aerial surveys" on December, 2014.

Figure 4.19 Altavian Nova Block III

Almost one year later, in November, 2015, Woolpert then filed for **another exemption** for "aerial data collection", thus **still** pertaining to the **"Research"** industry, in order to fly a "Skycatch" UAV (Figure 4.7).

4.3.16 Safety&Security Industry

Helicopters can be an important source of support to surveillance teams on the ground. However, as a form of air support they are expensive and can take time to be ready for engagement. The UAV technology becomes a quicker, more cost-effective and just as successful alternative. One particular advantage of drones is the ease with which it can be used. It takes only a short time to learn how to steer these aerial platforms, thereby saving on costly training programmes. Moreover, a drone can be instantly ready for action, allowing for immediate air support, which is key when addressing this kind of industry.

Founded in 1983, **Jackson Family Wines**, based in Sonoma County operates over 35000 acres on which it grows and harvests grapes and conducts its **large-scale wine production business**. The company has filed an exemption request for **surveillance over private property** since "vineyards are large areas of farm land that is vulnerable to trespass and illegal activities". Until the moment of exemption, Jackson has protected the integrity of these properties, contracting with private security companies and using human ground surveillance teams with local sheriff department's canine units integrated into the surveillance teams. The UAV proposed by the petitioner is an **AirCover QR–425** (Figure 4.20) and Jackson Family Wines **has acquired its own in-house drone team**, allowing it to fly above its vineyards.

Figure 4.20 AirCover QR-425

Jackson Family Wine, once having obtained in April, 2015 the Section 333 exemption for "Safety &Security" operations, then decided **not to file any other request**.

4.3.17 Search&Rescue Industry

In Search&Rescue, every second counts. In order to function as efficiently as possible, it is important to be able to obtain a rapid overview of the situation. While planes and helicopters require some time to be ready for deployment, drones can be put into action immediately, without any loss of time. One drone can search an extensive area in minutes that might take an entire group of ground personnel to cover in hours. Unmanned aerial vehicles can provide real-time visual information and data in the aftermath of an earthquake or hurricane. Together with this, drones provide a great way of exploring those areas that are usually difficult and often dangerous to examine, thus improving the chances of a successful result.

Down East Emergency Medicine Institute (DEEMI) was founded in 1991 with the **goal to improve Search and Rescue** in the State of Maine and New England Region. The company filed an exemption request "to conduct aerial Search and Rescue Operations in the US in order to get higher success rates on (Search&Rescue)

operations and to help prevent contamination of lands if there was a manned aircraft accident”.

The UAVs proposed by the petitioner are the **VK–FF–X4** Multirotor and **VK-Ranger EX–SAR** Fixed Wing (Figure 4.21).

Figure 4.21 UAV model within the Down East Emergency Medicine Institute exemption

The FAA requires licensed pilots to operate the drones, the group’s volunteer pilots “**already are aircraft pilots** but have to cross over into the [different] piloting world of the drone” DEEMI Director Richard Bowie said “and will **undergo an intensive training** and certification program provided by the drones’ manufacturer, Viking Unmanned Aerial Solutions. Once the pilots are certified, the drones will be put into use”. DEEMI, once having obtained in April, 2015 the Section 333 exemption for “Search&Rescue” operations, then decided **not to file any other request** for whichever application field.

4.3.18 TV Industry

Production companies could be able to use UAV technology to nail those shots that require dramatic panoramas, adrenalin-filled action sequences, 360-degree views of subjects or “birds’ eye” views. New opportunities are provided to media operators as well as to journalists too. Indeed, journalists could answer to a variety of reporting needs including investigative, disaster, weather, sports, and environmental journalism. UAVs become essential for covering stories with large spatial applications, particularly natural or man-made disasters. These visuals can be used to create maps of disaster areas and combined with data to explain how different sections of a community fared after a storm hit.

Founded in 2014, **Upward Aerial** filed an exemption request in the April of 2015 for "Aerial photography and videography for closed-set motion picture and television". Working for one of the Northern California's busiest wedding videography company, James Ferrandini, decided to found this **aerial videography company**, in having expert knowledge flying a variety of UAVs. After receiving the exemption in April, 2015 for operating a **DJI T600 Inspire 1** (Figure 4.22) for "Filmmaking" and "TV" operations **altogether**, Upward Aerial then decided **not to submit any other exemption request**.

Figure 4.22 DJI T600 Inspire 1

Within the next chapter, a critical analysis of the gathered data will be presented, as well as the main findings emerging from the research.

CHAPTER 5
DISCUSSION

This last chapter represents a critical analysis of the results that have been identified throughout the research. In answering the research questions, the scope is in providing a framework for exploiting the potential of an emergent technology within new industries. A representation of the adopters of the technology, coherently grouped, will follow. In the end, the findings of the overall research will be summarised.

5.1 Strategies Identification

In the previous chapter, each new industry addressed by the Unmanned Aerial Vehicle technology has been presented, together with a short description of the respective first adopter. The most relevant information has been highlighted throughout the different paragraphs, however a critical analysis is necessary in order to capture the value that this data could provide.

One first element that emerges after having gathered the information is the variety regarding the choices that first adopters have made in terms of requested exemptions. From a first look, one could notice that there are some firms that have been granted an exemption that is strictly related to the industry that they have addressed as first adopters. In other cases, other firms have opted for filing exemption requests for more than one industry either concurrently or in separate moments. Therefore, the analysis of the first adopters' data will not be developed on a case-by-case basis, which would have surely led to some results, but in some way limited ones. Indeed, it becomes far more interesting to study these petitioners according to their choices and to understand whether these decisions are somehow related to common characteristics and objectives. Much research depends on the estimation of the similarities and dissimilarities between pairs of things (Romesburg, 1984).

Two variables have been considered in the development of the analysis. The first variable regards the industries in which first adopters have decided to focus on. There are two values that the variable can alternatively take (see Figure 5.1); the first one is "Industry Focused" in referring to the case in which the company has been granted exemption(s) for only one industry. The second value that can be taken is the counterpart "Cross-Industry" obviously meaning that the firm filed exemption request(s) for at least more than one industry.

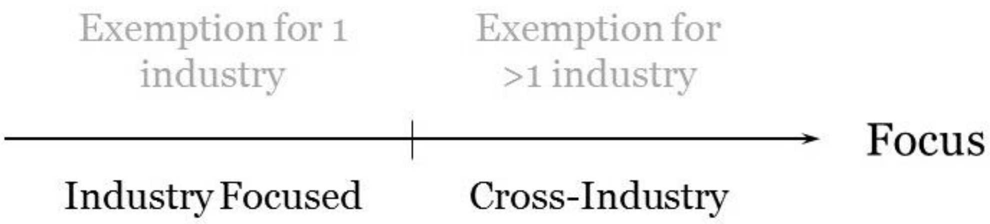

Figure 5.1 Focus level of first adopters

The second variable that has been taken into account is a time variable that aims at distinguishing first adopters according to the moments in which they have obtained exemptions. Therefore, two values can be taken by this variable (see Figure 5.2), "Spot Initiative" or "Progressive Initiative". The former refers to the case in which a firm has filed an exemption request just once, while the latter concerns the case of separate exemption requests.

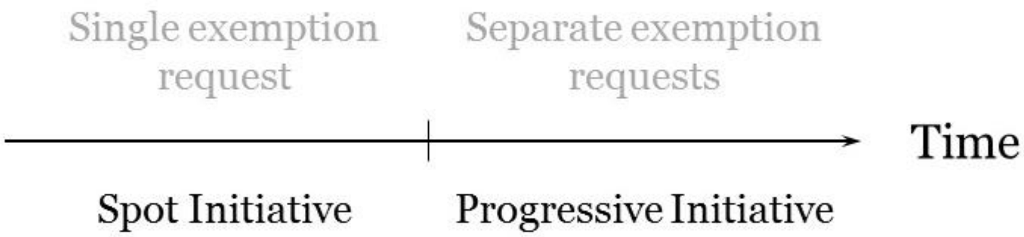

Figure 5.2 Time distribution of first adopters' exemptions

Is then in considering these two variables together that the realisation of a framework starts to take shape. Figure 5.3 illustrates the matrix generated in combining the values that the two variables can alternatively take.

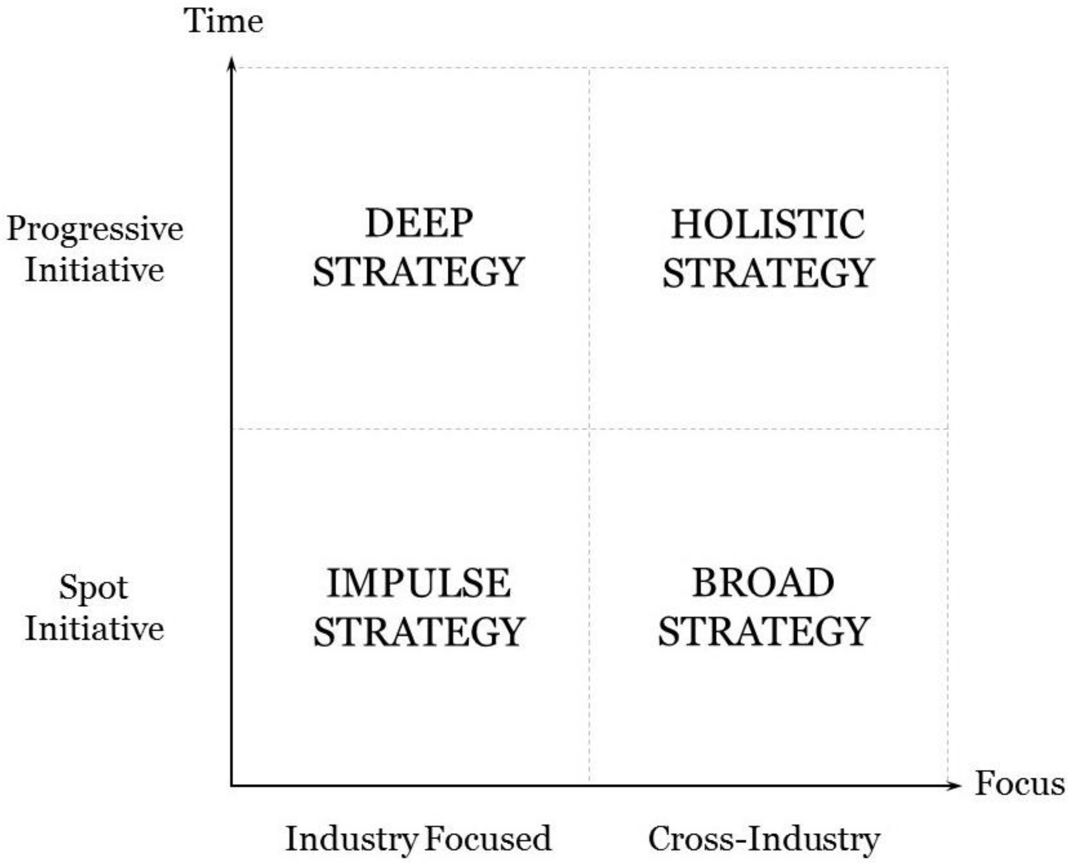

Figure 5.3 Strategies for exploiting technological opportunities

When questioning how companies can explore the opportunities provided by the UAV technology when addressing new industries (***RQ1***), the answer that emerges from the collected results is that four main strategies can be alternatively adopted. A description of each of the four strategies will follow.

Starting from the depicted matrix, the first strategy is what has been defined the "**Impulse Strategy**". This is the case in which a company, seeking to explore the opportunities offered by an emerging technology, decides to adopt this technology within a single industry. The focus is exclusive and only on this new industry, meaning that is not part of the company's interests exploring how to approach other application fields. Moreover, once having addressed the industry as first adopter, no further plans of entering new industries or reinforcing the presence in the current one are set.

The second strategy that can be adopted is the "**Deep Strategy**". In this case, a company, similarly to the "Impulse Strategy" case, could decide to focus its attention on a specific industry. Moreover, in addition to that, it could opt for reinforcing its presence within that specific industry in truly deepening it. Translated into "the language" of the research it would mean requesting an exemption for the same industry in which a company has been the first adopter.

The third strategy that a company could follow when addressing new industries is the "**Broad Strategy**". Differently from the previous two cases, in adopting this strategy a company is exploiting the opportunities of a new technology in selecting more industries. More specifically a firm decides to enter an industry in which the technology has never been used and together with this, it opts for exploring other industries that have instead already been addressed by some other firms. The other major element characterising this strategy is the fact that this openness to diverse industries is expressed within a unique time shot, meaning that the exemption requests have been filed all together.

The last strategy emerging from the analysis is the "**Holistic Strategy**". This case, differentiate itself from the previous one in terms of the period upon which the strategy is deployed. In other terms, a company exploiting the opportunities offered by the emerging technology, could decide to broaden/narrow its focus in addressing several industries. However, instead of doing it simultaneously, the firm decides to split it into separate moments on a developing base. Indeed, in a first moment, the company will approach an industry that is new for the examined technology. Together with this, it would address other industries (that have already been explored) either in a second moment, or spread between the first request and the subsequent ones. The identification of these four strategies is indeed extremely useful for all those companies seeking to exploit the opportunities provided by new technologies, as already mentioned in Chapter 3. After having detailed each one of them, a representation of how the 18 first adopters have proceeded with respect to the outlined strategies, will follow. Thus, allowing the understanding, at least in a qualitative way, of what went on in the case of the Unmanned Aerial Vehicle technology. Table 5.1 illustrate each industry with their respective first adopter, together with the strategy that has been followed.

Industry	**First Adopter**	**Adopted Strategy**
Advertising	Hovershots APV	Impulse Strategy
Agriculture	Advanced Aviation Solutions	Holistic Strategy
Construction	Bechtel Equipment Operations	Impulse Strategy
Emergency Response	Aerologix Consulting	Broad Strategy
Environment	Toledo Aerial Media	Broad Strategy
Filmmaking	Aerial MOB	Holistic Strategy
Law Enforcement	Advanced Robotics Corporation	Holistic Strategy
Marine	FalconSkyCam	Broad Strategy
Mining	EnviroMINE	Impulse Strategy
Oil&Gas	VDOS Global	Holistic Strategy
Power Utilities	Commonwealth Edison Company	Impulse Strategy
Railroad	BNSF Railway	Impulse Strategy
Real Estate	Douglas Trudeau	Impulse Strategy
Renewable Energy	Notus Access Group	Impulse Strategy
Research	Woolpert	Deep Strategy
Safety&Security	Jackson Family Wines	Impulse Strategy
Search&Rescue	Down East Emergency Medicine Institute	Impulse Strategy
TV	Upward Aerial	Broad Strategy

Table 5.1 Frist adopters and respective strategy

In order to have a more immediate impact, the content of Table 5.1 has been translated into Figure 5.4, thus allowing first considerations to be made.

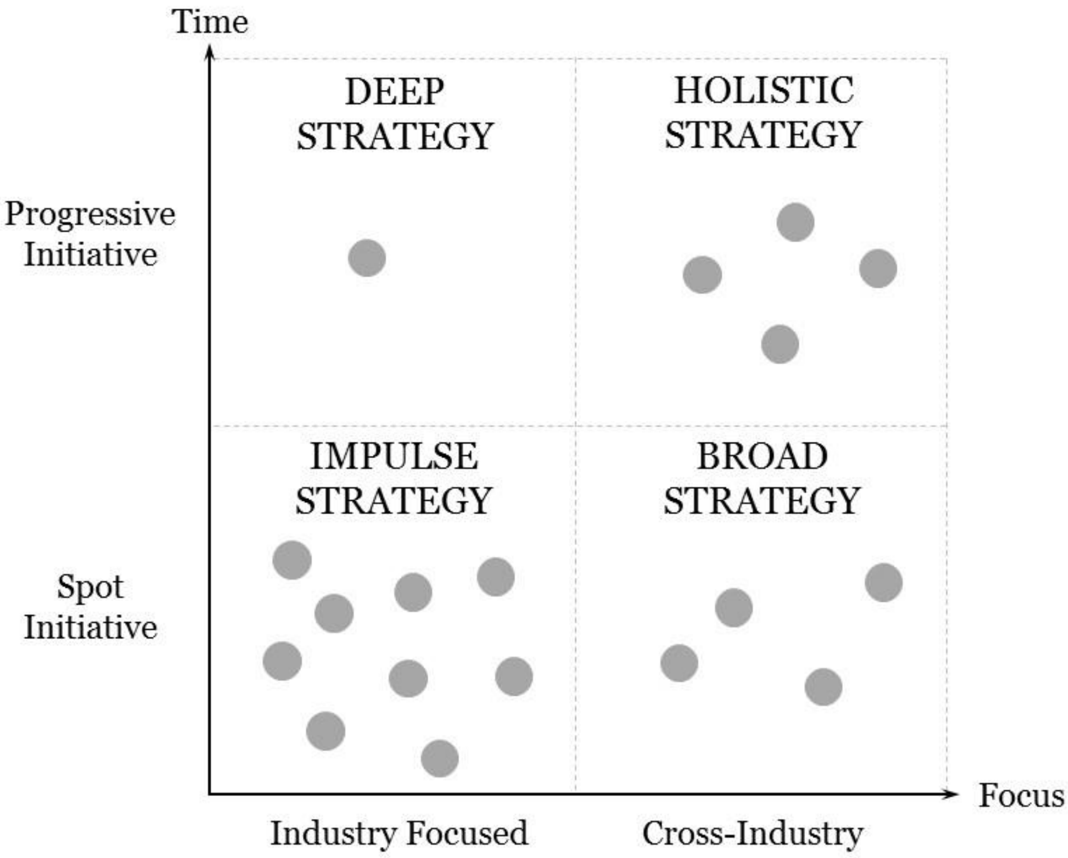

Figure 5.4 First adopters positioning with respect to the four strategies

As shown in Figure 5.4, the general trend is towards the adoption of a strategy that is more on the “Spot Initiative” half plane, which means that companies addressing new industries opted for requesting exemptions all in the same moment. In terms of strategy adoption, is then clear that half of the 18 first adopters followed the “Impulse Strategy”. When companies address a new industry, either they may feel to not have enough experience to address any others or they could succeed in the one they have entered and not believe necessary moving towards other applications. However, more details regarding the characteristics of such first adopters will be provided when answering the second research question.

Another insight that can be derived from Figure 5.4 concerns the fact that only one company has pursued the “Deep Strategy”. Through the following analysis, more details will be given for explaining why this happens and which are the characteristics a company should have when adopting such a strategy.

5.2 UAV Models

After having identified the four main strategies that companies have adopted when addressing new industries, more attention will be paid in understanding how the four of these are related to the other data gathered throughout the research. Within the previous chapter, when describing each case, the model of UAVs listed within the exemption requests, have been presented. Considering the four strategies one could expect that it will be more likely for "Broad Strategy" and "Holistic Strategy" adopters to utilise different models of drones, since the higher number of addressed industries. Figure 5.5 shows with respect to each of the four strategies, whether companies have filed the request(s) for using a unique model or more than one.

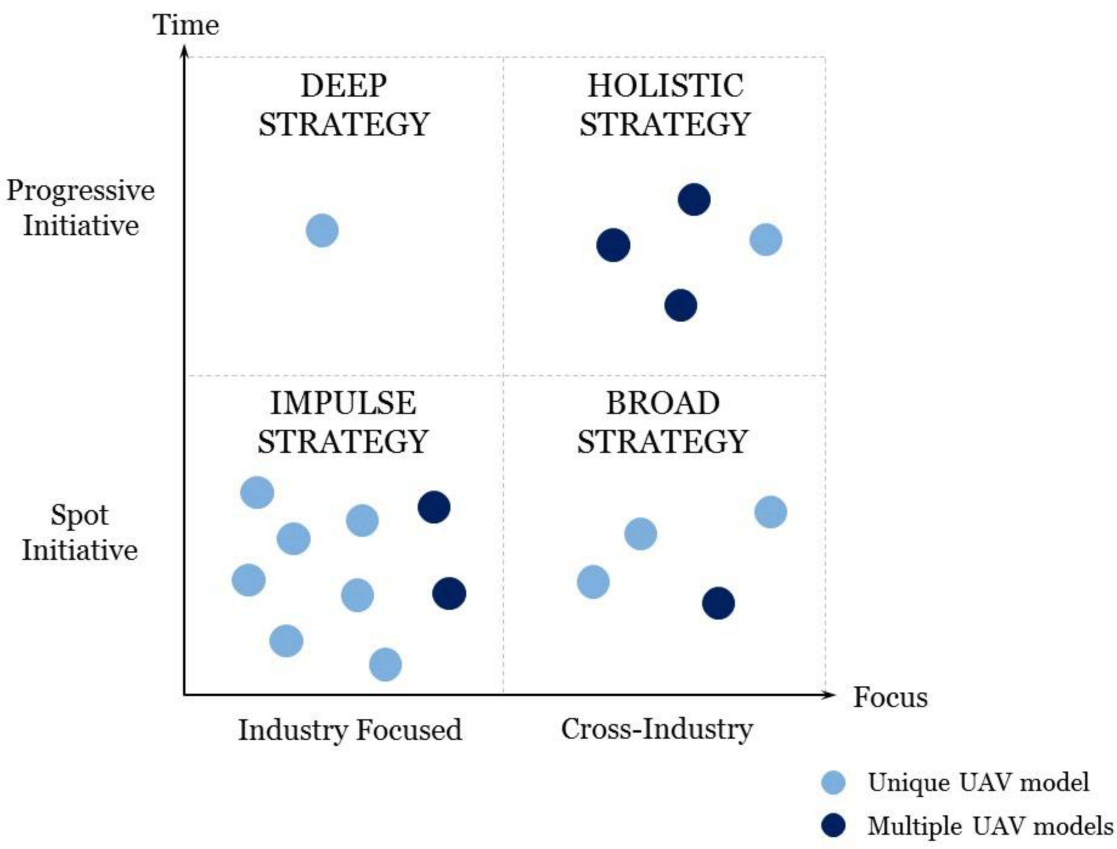

Figure 5.5 UAV models with respect to the four strategies

The hypotheses that were previously made seem to be validated by the available information. Indeed, the majority of those firms who have required the exemption for **more than one UAV model are in the "Cross-Industry" half plane**. Consequently, the vast majority of adopters of the "Impulse Strategy" and "Deep Strategy", exception made for two cases, made the choice of using a unique UAV model.

More in depth, some first features regarding first adopters can be outlined. Indeed, from Figure 5.5 it is clear that the adoption of **multiple UAV** models is not only common within the "Cross-Industry" half plane, but it is almost an intrinsic characteristic of those first adopters who followed a "**Holistic Strategy**". In fact, when addressing multiple industries in two separate moments, such first adopters have opted for increasing, or at least never diminishing, the number of UAV models from the first granted exemption to the subsequent ones. Aerial MOB, first adopter in "Filmmaking" industry, has firstly requested exemption for using an internally manufactured hexa-copter, while when filing the second request it included five different UAV models. Similarly, Advanced Aviation Solutions, first adopter in the "Agriculture" industry, filed two separate exemption requests for using one model of drone, however when presenting its third exemption request it submitted an application for ten new UAV models. Therefore, when adopting a "Holistic Strategy", the number of UAV models is never decreasing between subsequent exemption requests. This might be due to the fact that, since these companies are still shaping the focus of interest, they prefer having a **higher available variety**, in order to try and adapt according the context.

5.3 Industry Presence

In defining the first research question, a clarification has been made in order to avoid misunderstandings. It now becomes useful to recall it, since, in this circumstance, it can provide some interesting perspectives for deepening the analysis.

Until now, when referring to new industries that have been addressed by companies, the term “new” was always used in meaning that the UAV technology has never been exploited in that specific field, yet. However, the fact that since now the “newness” has not been considered from the company’s side, it is offering another way to look at the UAV adoption when trying to explore new opportunities. In other words, the focus will be put on understanding whether a company, when addressing an industry as first adopter of the UAV technology, was already operating within that industry or whether the adoption of UAVs has represented the first step ever taken within that field. In the latter case, the first adopter could be identified as a “**new entrant**” with respect to that industry, while in the former case, two situations could happen. Indeed, either the firm is present within that industry as a “**leader**” or as a “**follower**”. The extremely simplified flow chart of Figure 5.6 summarises what has been explained.

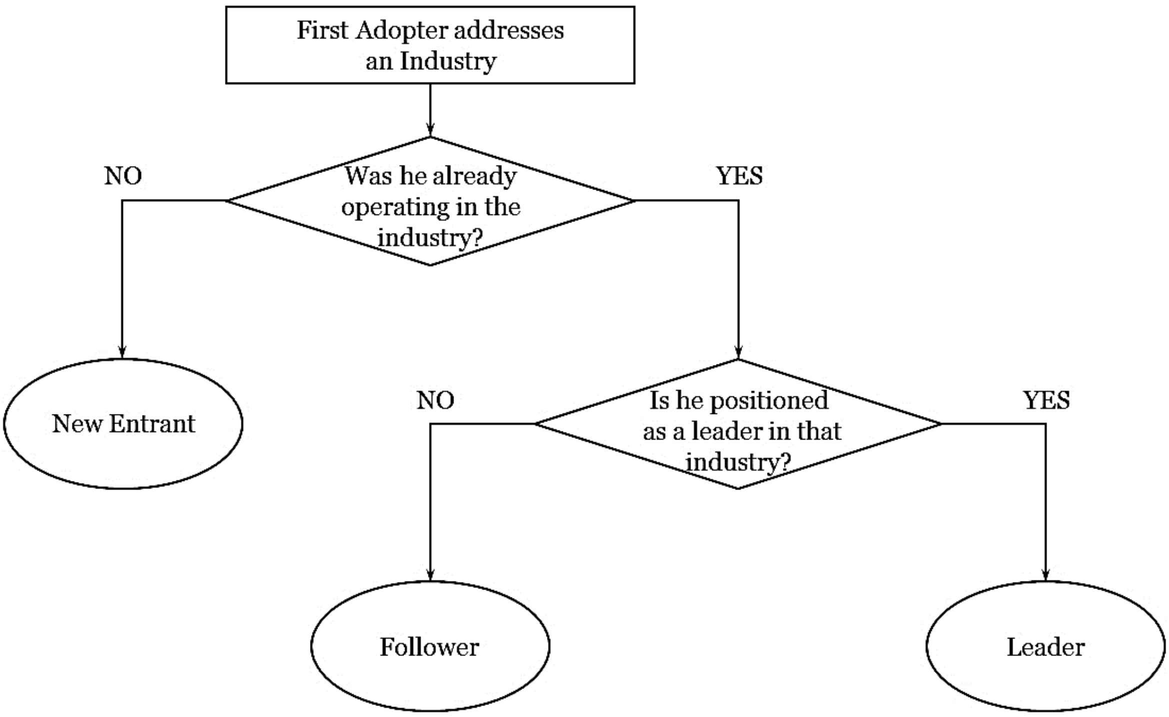

Figure 5.6 Industry Presence options flow chart

In order to determine the relative positioning of the analysed first adopters with respect to this newly identified attribute (“**Industry Presence**”), there is the need to recall what has been previously explained in Chapter 4.

Therefore, an example showing how assumptions have been made will follow. The previously mentioned Advanced Aviation Solutions (first adopter in "Agriculture" industry) with a strong aeronautical experience "is specialized in the aerospace application of remotely piloted aircraft". Founded in 2011 with the technology as the central element, when trying to identify how to explore the potential of UAV technology, Advanced Aviation Solutions (ADAVSO) not only considered the attractiveness of an industry, but also the requirements in terms of legal restrictions. As the president of the company said "agriculture industry may be one of the safest places to employ Unmanned Aerial System (UAS) technology, given the low flight path of UAS for crop scouting and that most farms are not in densely populated areas". Therefore, it is quite clear that the selection of this industry was not based on previous experience within that industry, leading to the identification of ADAVSO as a "new entrant" in the agriculture industry.

"Woolpert" is the first adopter of UAV technology in the "Research" industry and as previously mentioned it "has been providing surveying and mapping services for more than 50 years, with a focused commitment on the advancement of related technologies and processes". Obtaining awards from different entities is just a symbolic recognition of the leadership that the company exercises in the "Research" industry, thus positioning Woolpert as a "leader".

The Arizona-based realtor "Douglas Trudeau" is the first adopter within the "Real Estate" industry. "Continually striving for the past 16 years to do real estate better than the day before" the realtor has introduced the UAV technology within an industry that he deeply knew, but without being the leader within it, thus being a "follower".

Table 5.2 summarises the assumptions made for all of the 18 first adopters

Industry	**First Adopter**	**Industry Presence**
Advertising	Hovershots APV	New entrant
Agriculture	Advanced Aviation Solutions	New entrant
Construction	Bechtel Equipment Operations	Follower
Emergency Response	Aerologix Consulting	Follower
Environment	Toledo Aerial Media	New entrant
Filmmaking	Aerial MOB	Follower
Law Enforcement	Advanced Robotics Corporation	New entrant
Marine	FalconSkyCam	New entrant
Mining	EnviroMINE	Follower
Oil&Gas	VDOS Global	New entrant
Power Utilities	Commonwealth Edison Company	Follower
Railroad	BNSF Railway	Follower
Real Estate	Douglas Trudeau	Follower
Renewable Energy	Notus Access Group	Follower
Research	Woolpert	Leader
Safety&Security	Jackson Family Wines	Follower
Search&Rescue	Down East Emergency Medicine Institute	Follower
TV	Upward Aerial	New entrant

Table 5.2 Industry Presence of first adopters

Figure 5.7 represents what has been listed so far, with respect to the four identified strategies.

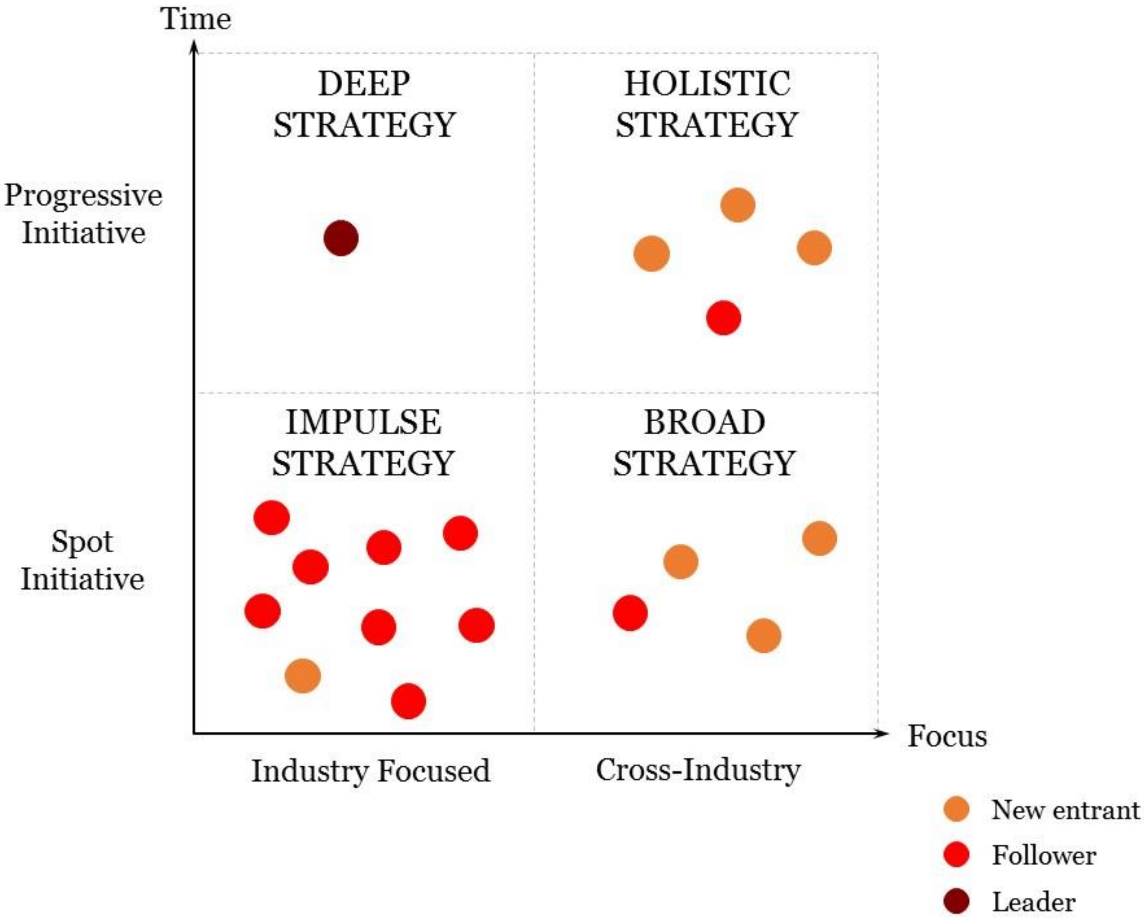

Figure 5.7 Industry Presence of first adopters with respect to the four strategies

Thanks to the insights already obtained, and in observing Figure 5.7, the research can move one step forward in defining which are the peculiarities characterising the first adopters of the UAV technology in new industries (***RQ2***).

Firstly, what can be observed is that the first adopters following an "**Impulse Strategy**" seem to have distinctive peculiarities. Indeed, it was already mentioned that the vast majority of them has adopted one single UAV model; now from Figure 5.7 it is possible to add that almost all of them are "**followers**" within the industry in which they are first adopters of the UAV technology. Put differently, those firms that decide to address one single industry (in which the UAV technology has not unleashed its potential yet) in a unique time interval, are usually already operating within that industry and have found the right UAV model that allow them to improve and enhance their performances.

Secondly, the case of "**Deep Strategy**" starts to become definite. Indeed, the case of a company deciding to address a single industry in two subsequent moments, coincide with the case of a "**leader**" company within that specific industry. In defining the peculiarities of this first adopter, it is clearer to directly refer to the actual company of this research, since it represents the only evidence of this strategy. As previously mentioned, Woolpert is the first adopter of the UAV technology within the "Research" industry; the decision to focus on a single industry and to do that repeatedly, lies on the fact that the company represents the leader in the examined industry. Therefore, there is the willingness from the company's side to both **re-establish** its leadership **position** in the market and in its current customers' minds, and to reach all potential customers in becoming their "go-to choice". After having analysed the real case within the UAV industry, one may say that the reason why the adoption of a "Deep Strategy" is not so common, is that for choosing it, a solid reputation as well as a strong presence within the specific industry are required to be successful.

Finally, the last insight regards the fact that pretty much all those firms that have addressed **multiple industries**, were not already present in the industry they have explored **as first adopters**. Moreover, starting from the cases that were presented, it is possible to say that the vast majority of these **companies** have actually been **founded with the purpose of exploring the opportunities provided by the UAV technology.** The first adopter in the "Law Enforcement" industry Advanced Robotics Corporation was founded with the aim of "specializing in education, knowledge and solutions supporting development and application of Unmanned Aircraft Vehicles" in 2014. Thus, in submitting the exemption requests for "Law Enforcement", "Research", "Agriculture", "Environment", and "Search &Rescue" industries in late 2015, the company represented a **new entrant** not only in the Law enforcement industry, but **in all the addressed ones**.
Similarly, Toledo Aerial Media first adopter in the "Environment" industry was founded in 2014 "to exploit the capabilities of Unmanned Aerial Systems" and offer a multitude of services. Thus, when filing a request for Environment", "Research",

"Agriculture" and "Construction" operations altogether in April, 2015 it addressed all those industries as new entrant.

5.4 Position in the Value Chain

In order to have the clearest analysis as possible, another element will be taken into account still starting from a critical analysis of the results presented in Chapter 4. When describing each case it was implicitly mentioned how companies were "linked" to the UAV technology. For instance, some first adopters not only introduced the technology in a new industry, but also produced the UAV model/s that was/were intended for that application. In order to create a simple structure, this variable would be defined as "position in the Value Chain". Therefore, starting from the information provided within the exemption letters, it is possible to identify first adopters as "**manufacturers**" of drones, "**final users**" and/or "**service providers**" in leveraging the UAV technology. (see Figure 5.8)

Figure 5.8 Value Chain of the UAV technology

Some explanatory examples will follow.
"Aerial MOB" is the first adopter of UAV technology in the "Filmmaking" industry and as previously mentioned, even before a rule for commercial drones has been defined, it was producing "quad-, hexa- and octo-copter drone packages for filming". After receiving the exemption, the firm was then able to provide shots taken by drones for major film productions. Thus, with respect to the "position in the Value

Chain" Aerial MOB has to be considered as both a manufacturer and a service provider. "

Bechtel Equipment Operations" first adopter in the "Railroad" industry, approached the UAV technology for "safety and monitoring of secured and controlled environment construction sites". Thus, meaning that the use the company has planned to make could be defined as a private use. The company is not interested in offering services to a third party in leveraging the opportunities offered by the drone technology. Therefore, Bechtel is considered as a final user.

Table 5.3 summarises the same reasoning developed for the 18 cases.

Industry	**First Adopter**	**Position in the Value Chain**
Advertising	Hovershots APV	Service Provider
Agriculture	Advanced Aviation Solutions	Service Provider
Construction	Bechtel Equipment Operations	Final User
Emergency Response	Aerologix Consulting	Manufacturer + Service Provider
Environment	Toledo Aerial Media	Service Provider
Filmmaking	Aerial MOB	Manufacturer + Service Provider
Law Enforcement	Advanced Robotics Corporation	Manufacturer + Service Provider
Marine	FalconSkyCam	Service Provider
Mining	EnviroMINE	Service Provider
Oil&Gas	VDOS Global	Service Provider
Power Utilities	Commonwealth Edison Company	Final User
Railroad	BNSF Railway	Final User
Real Estate	Douglas Trudeau	Service Provider
Renewable Energy	Notus Access Group	Service Provider
Research	Woolpert	Service Provider

Industry	First Adopter	Position in the Value Chain
Safety&Security	Jackson Family Wines	Final User
Search&Rescue	Down East Emergency Medicine Institute	Service Provider
TV	Upward Aerial	Service Provider

Table 5.3 Position in the Value Chain of First Adopters

Figure 5.9 represents what has been listed so far, with respect to the four identified strategies.

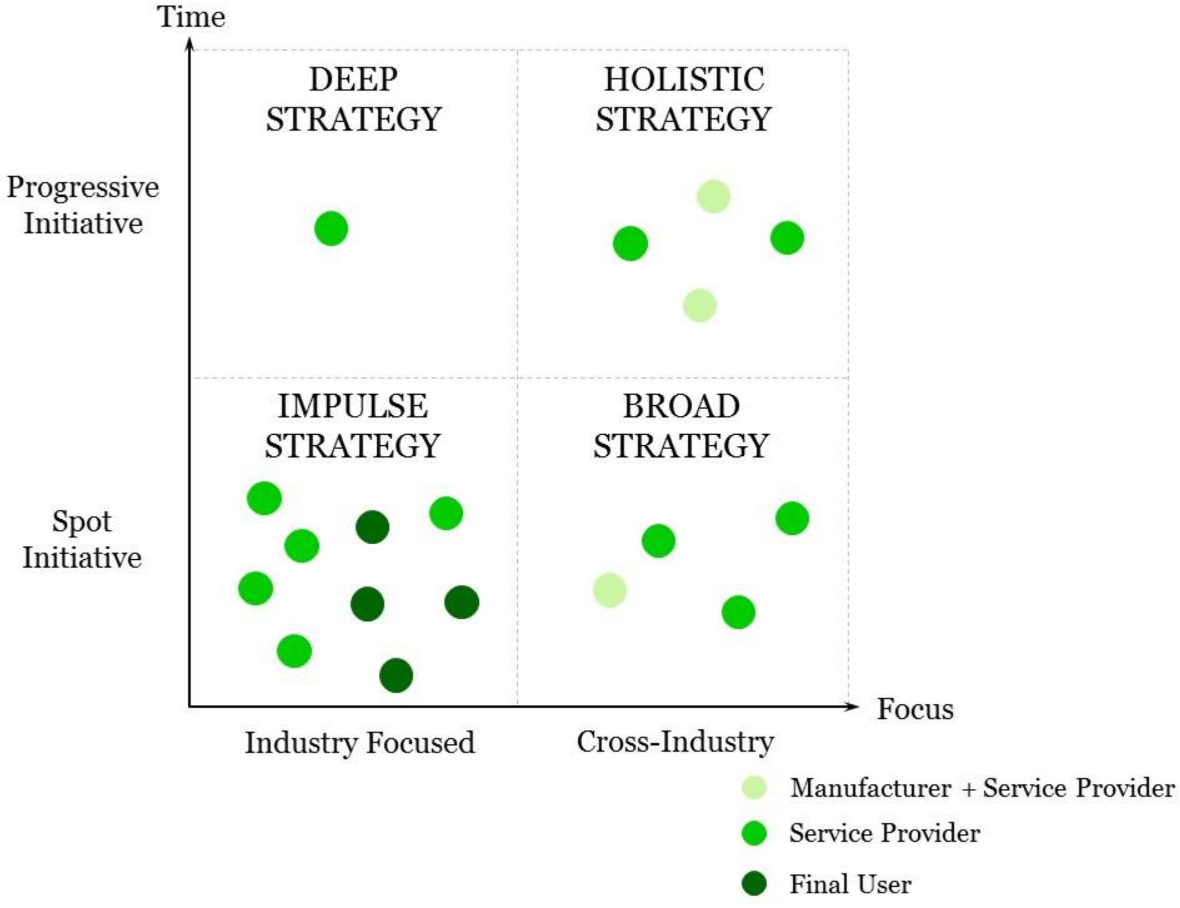

Figure 5.9 Position in the Value Chain of First Adopters with respect to the four strategies

The first observation that can be made regards the fact that "**Final Users**" univocally correspond to adopting the "**Impulse Strategy**". The same cannot be said looking at this relationship from the other way round. Since now, the study of the first adopters following an "Impulse Strategy" has led to homogeneous results in terms of the choice of a unique UAV model and of the presence within the respective industries as "followers". However, the consideration of the position in the value chain, offers the possibility to understand that **even among first adopters opting for the same strategy**, there are some **peculiarities** that go to a further level. In investigating the differences among "impulse strategy" adopters, it became evident that the first adopters identified as "**final users**" are those companies that are not necessarily interested in understanding what is behind the UAV technology and how to actually fly a drone. Furthermore, with a good level of confidence, one may say that in the long run they will not be interested in new applications of the technology. Indeed, those firms were brilliant in understanding that such a technology embedded opportunities that needed to be explored. After having identified how to exploit such an opportunity in their respective industry, the firms then **leveraged external competences to fully make use of the technology** itself. The California-based Jackson Family Wines "has acquired its own in-house drone team, allowing it to fly above its vineyards" for Safety&Security purposes.

The previously mentioned Bechtel Equipment Operations, first adopter in the "Construction" industry, rather than internally develop the capabilities to fly the Skycatch UAV, opted for partnering with the drone's manufacturer. Indeed, Skycatch's pilots were essential for Bechtel in order to "explore innovative ways of integrating drones into the execution systems".

After having explained and proved through examples which are the peculiarities of those firms following the "**Impulse Strategy**" as final users of the technology, the "counterpart" will be analysed. As shown in Figure 5.9, either firms can be considered as "final users" or as "**service providers**". What differentiate the latter from the first adopters that have just been examined, lies in the fact that these companies when actually using drones, **relied on internal competences and capabilities**. The previously mentioned realtor Douglas Trudeau adequately represents this concept. In fact, he was able to combine his long-lasting experience in the real estate industry with the ability to actually fly small Unmanned Aerial Vehicles, in order to offer the best service possible to his clients. Similarly, EnviroMINE's employees are "proficient with using eMotion and Postflight software in order to successfully fly EnviroMINE's Unmanned Aerial Vehicle for aerial mapping purposes… (and) creating topographic mapping, using GIS, AutoCAD, and Virtual Geomatics 4D". Thus, meaning that even if limited to a single UAV model, internal competences has allowed EnviroMINE to provide value to its clients within the "Mining" industry.

The second insight that emerges in observing Figure 5.9 concerns the fact that all the firms that **both provide a service** to a customer **and** both **manufacture the UAVs** to be used, are adopting either the "Broad Strategy" or the "Holistic Strategy", thus gathering on the "**Cross-Industry**" half plane. A possible explanation to this fact could be that when addressing multiple industries, firms prefer to have a deep knowledge of the technology itself in order not to lose any opportunity they see within these application fields. Together with this, in being the manufacturers of their drones, companies are able to eventually modify and adapt these devices according to the different requirements of the industries they are approaching, thus enabling the necessary level of flexibility.

5.5 Main Findings

A final summary may be useful for recapitulating what has been found out or for highlighting what may have not emerged yet. Table 5.4 shows the first adopters of each industry, grouped according to the strategy that they have pursued, detailing the number of UAV models, the presence within the industry and the position in the value chain.

Strategy	First Adopter	UAV models	Industry Presence	Position in the Value Chain
Impulse Strategy	Hovershots APV	1	New entrant	Service Provider
	Bechtel Equipment Operations	1	Follower	Final User
	EnviroMINE	1	Follower	Service Provider

Strategy	First Adopter	UAV models	Industry Presence	Position in the Value Chain
Impulse Strategy	Commonwealth Edison Company	1	Follower	Final User
	BNSF Railway	>1	Follower	Final User
	Douglas Trudeau	1	Follower	Service Provider
	Notus Access Group	1	Follower	Service Provider
	Jackson Family Wines	1	Follower	Final User
	Down East Emergency Medicine Institute	>1	Follower	Service Provider
Deep Strategy	Woolpert	1	Leader	Service Provider
Broad Strategy	AeroLogix Consulting	1	Follower	Manufacturer + Service Provider
	Toledo Aerial Media	>1	New entrant	Service Provider
	FalconSkyCam	1	New entrant	Service Provider
	Upward Aerial	1	New entrant	Service Provider
Holistic Strategy	Advanced Aviation Solutions	>1	New entrant	Service Provider
	Aerial MOB	>1	Follower	Manufacturer + Service Provider
	Advanced Robotics Corporation then named Aerial Sciences Corporation	>1	New entrant	Manufacturer + Service Provider
	VDOS Global	1	New entrant	Service Provider

Table 5.4 Information of first adopters grouped by strategy

The developed discussion was aimed at understanding in which way companies could address new industries, in seeking to explore the opportunities provided by a new technology. Four strategies emerged in considering both a time variable and the level of focus that the analysed companies have adopted. Further attention has then been payed to the comprehension of the main peculiarities characterising the first adopters also in taking into account the pursued strategy.

5.5.1 Impulse Strategy

The first outlined strategy is the “Impulse Strategy” according to which the focus is limited to a single new industry, with neither expansion towards other industries nor further deepening of the exclusively chosen one. Referring to the drone case, first adopters following this strategy generally opted for a unique model of Unmanned Aerial Vehicle for improving their performances within their respective industry. Indeed, the vast majority of these firms was already operating within the industries in which they represent the first adopters of UAV technology. The main difference among the first adopters pursuing this first strategy is represented by the way they actually made use of the technology itself. Firms either decided to internally develop the capabilities to fly the chosen drones or opted for leveraging external competences for getting the job done. In the former case, firms have exploited the opportunities provided by this technology in offering a service to their clients, while in the latter case the first adopters made use of drones for private purposes.

5.5.2 Deep Strategy

The second identified strategy is the “Deep Strategy”. In this case, the choice of focusing on a unique industry is reinforced by a further demonstration of commitment. Concerning the UAV case, only one firm adopted this strategy. This can be explained by the fact that, opting for this approach usually implies a certain level of confidence and a sound reputation behind one’s shoulders. Indeed the first adopter that opted for the “Deep Strategy” already had a leadership position in the industry in which it has introduced the UAV technology. Thus demonstrating that behind the choice of following the same direction and sharpening the competences, strong premises are needed.

5.5.3 Broad Strategy

The third detected strategy is the “Broad Strategy” according to which the focus is extended to a higher number of selected industries. Together with the industry in which a company is recognized as first adopter, a variable number of other industries that have already “seen” the introduction of the UAV technology, are taken into account. Moreover, firms adopting such strategy have usually been founded with the technology itself as central element and with the objective of exploring its potential. Thus in addressing multiple industries, these companies enter into fields that they have never explored before, thanks to the UAV technology.

5.5.4 Holistic Strategy

The last strategy that has been identified is the “Holistic Strategy”. In this final case, first adopters opt for addressing multiple industries, but the selection was developed on an ongoing and wider basis. Indeed the choice of new applications is changing through time and so is the adoption of different models of the examined technology. When addressing other industries, companies have never decided to narrow the number of adopted models, preferring to have a broader available set for adaptations and eventual changes. Moreover, in order to be able to exploit the full potential of the technology, a large part of these first adopters decided to actually manufacture some of the adopted models.

5.6 Cross-Strategy Analysis

The last paragraph of this chapter aims at providing an overview (see Table 5.5) of the identified strategies together with the variables that have been taken into account when defining the framework itself. This cross-strategy analysis could be then useful in providing some last elements enhancing the value of the framework itself. For those cases in which different peculiarities characterising adopters of the same strategy have the same relevance in terms of "occurrence", two rows have been considered within the table.

Strategy	**UAV models**	**Industry Presence**	**Position in the Value Chain**
Impulse Strategy	1	Follower	Final User
	1	Follower	Service Provider
Deep Strategy	1	Leader	Service Provider
Broad Strategy	1	New entrant	Service Provider
Holistic Strategy	>1	New entrant	Manufacturer + Service Provider

Table 5.5 Cross-strategy analysis

From the overall analysis and looking at the table, some final insights emerge. Firstly, if the objective of a firm is leveraging a technology for providing a service, the choice of addressing either a narrower ("Impulse Strategy") or a wider set of industries ("Broad Strategy" or "Holistic Strategy") is intrinsically determined by the presence within the industry/industries that the firm wants to address. Indeed, opting for addressing a unique industry – in which the technology has never been used before – means that a company should already "know" that field in order to better perform within it. While in the case of addressing multiple industries, the company is usually entering new fields, thus meaning that the technology represents the mean through which a firm is creating/enlarging its own portfolio of services.

Furthermore, if the technology is the way through which a company can explore multiple applications, the choice of either develop this exploration in a unique moment or in subsequent iterations could depend on the capability to effectively select the model of the examined technology. Therefore when being able to spot the right version that could suit multiple industries, a firm is more likely to not address any other in a second moment ("Broad Strategy"). While, when the selection of the model tend to change as the chosen industries change, the firm will more likely opt for a "Holistic Strategy". The last conclusive chapter will follow.

CHAPTER 6
CONCLUSIONS

After presenting the main findings of the research, the conclusions will recall the overall process of the research, in highlighting both the objectives and the main results. In the end, the managerial application as well as limits and follow-ups will be presented in order to complete the research and at the same time leave space for further development.

6.1 Research Objectives

The study on innovation guided by a technological driver has always been on the spot, but its relevance has grown conspicuously in the last years, since new variables have been taken into account. The general opinion regarding technological innovation was aligned in conceiving such a phenomenon as corresponding to a technological substitution. Indeed, the main challenge for firms was to successfully anticipate new technologies and to switch to them in a timely way. More recent studies have added new content to the study of this topic in stressing the fact that the real challenge for innovators is not just finding a "better technology", rather is to unveil new meanings within new or existing technologies. Concurring with this line of thinking, the research tried to investigate how companies could seek the unveiled opportunities offered by a technology. More specifically the objective was in trying to define a framework for all those companies that are willing to explore the full value of a technology in addressing new industries.

In fact, if the latest studies have moved the focus on to the full employment of a technology, it lacks in stressing how the latent opportunities could be expressed in several new application fields and in providing a structure to be followed. Two research questions have been identified in order to point out the precise objectives of the research.

RQ1*: How do companies explore the opportunities provided by emerging technologies when addressing new industries?*

RQ2*: Which are the peculiarities characterising the first adopters of emerging technologies in new industries?*

The choice of focusing on the emerging technology of Unmanned Aerial Vehicles has been taken considering the growing relevance that these devices are gaining in the last few years. Moreover, the exploration of this technology's potential has engaged several different industries, thus representing the ideal environment in which to conduct the research. A Case Study approach has been followed throughout the research benefiting from the higher level of flexibility that is not readily offered by other qualitative approaches such as grounded theory or phenomenology.

6.2 Main Results

After a critical analysis of the evidences coming from the drone industry, four main strategies have been identified when exploring the opportunities provided by the UAV technology for entering new industries. Thus, in answering the research questions, a framework has been defined as tangible outcome of the thesis.

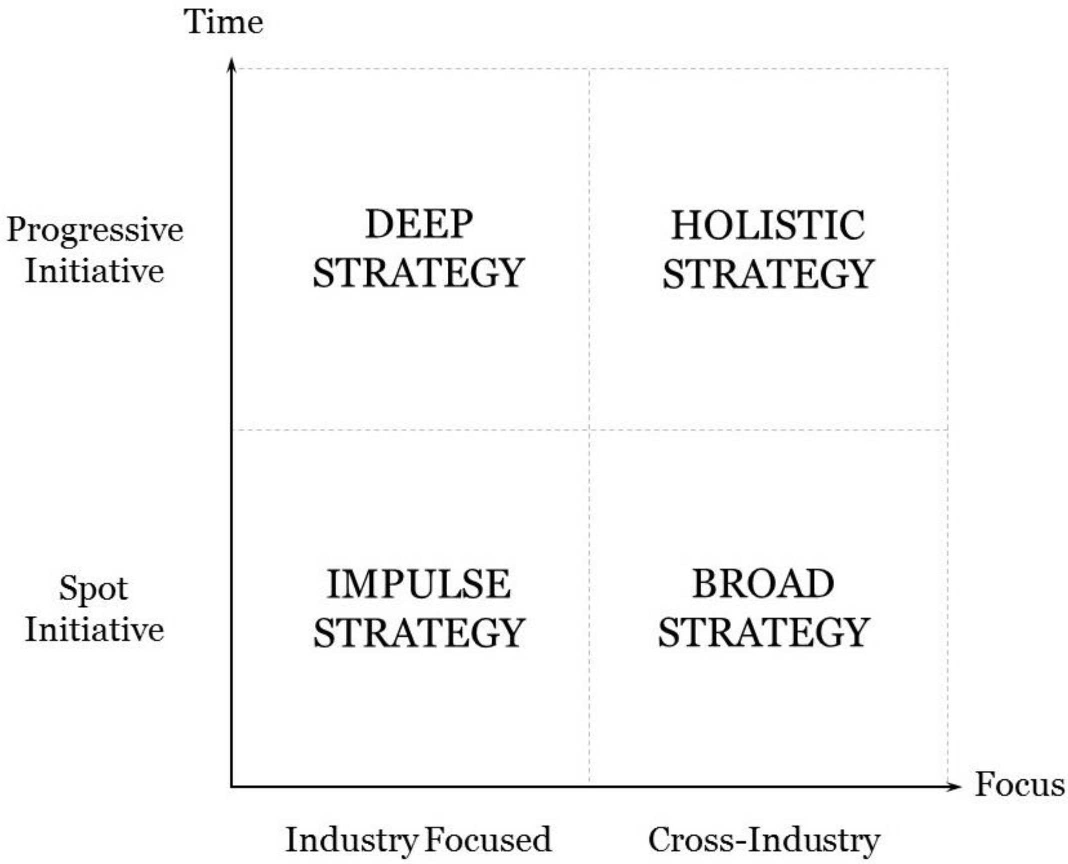

Figure 6.1 The four identified strategies

As already mentioned, the focus is in understanding how to unveil the opportunities offered by an emergent technology. Opportunities that were not yet considered in the early phases of the technological development. The outlined matrix provide four different approaches that a company could follow when addressing new industries with the technology.

The framework is indeed structured in a way that each strategy is univocally identified according to both the level of focalisation that a company may opt for and the time lapse within which strategic decisions are taken.

In order to enrich this picture, peculiarities regarding the first adopters of the technology, with respect to the identified strategies, have been outlined in taking into consideration the choices made regarding the actual implementation of the technology. Other elements that have been taken into account were whether the adopter of the technology was already operating within the industry/industries that has/have been addressed and the role practiced within the value chain of the examined technology. With respect to each strategy, the following results have emerged.

Focusing on a single industry in a unique moment in time, thus opting for an "Impulse Strategy", generally means opting for a unique model of the technology in order to upgrade the performances within an already known industry. What internally distinguishes the first adopters pursuing this strategy is the relative position within the value chain of the technology. Thus, leading firms either to internally develop the capabilities for flying the chosen drone and for offering a service to their clients; or to leverage external competences for a final private use of the technology.

When choosing to renew the commitment to a single industry in adopting a "Deep Strategy", the firm is implicitly reaffirming the leadership position that it has within that specific industry.

Choosing to address an extended set of industries in a unique time frame, thus following a "Broad Strategy", is usually the straightforward consequence of the purposes for which a firm has been founded. Indeed, the technology is both the pillar of the firm and the mean trough which multiple industries are explored.

When approaching different industries in subsequent moments, through a "Holistic Strategy", a first adopter tries to capture the full potential embedded into the technology. In order to do that, along with an amplified selection of versions and variations of the technology, manufacturing competences are developed. Indeed, when providing a service in each application, the firm is able to choose among a wider set of possibilities in which some of them are internally realised.

6.3 Managerial Application

After having recalled the main results coming from the research, a short explanation concerning the reason why such thesis could be useful in terms of managerial applications will follow. As already detailed when defining the research

questions, the lack of a clear framework when dealing with the discovery of technological opportunities in new industries emerged, especially after reviewing the literature. The definition of clear strategies that a company could pursue is therefore beneficial, when dealing with every kind of emergent technology. In following the example provided by the Drone industry, more sound choices will be made when exploring the opportunities of a technology. Moreover, in having delineated specific traits characterising the adopters of each approach, the "identification" process become much easier and effective. Indeed, one can say that the provided framework could have a two-sided reading, either starting from the strategies to the examined variables, or in the other way round. For instance, a company, seeking to explore the potential of an emergent technology, could look at it from the strategy side and determine if the approach that it would like to adopt, is aligned with its characteristic and peculiarities.
Supposing that the examined company has already addressed an industry and is willing to re-establish its commitment to it, thus identifying itself as a "Deep Strategy" adopter, the firm has to know that is better to stick to the version of the technology that has already been used if it aims at providing a service through it. Above all, the company should bear in mind that, before choosing to deepen an industry, it should gain a leadership position within it for ensuring the success.

Looking at the provided framework from the other side, a company may understand which strategy is the most suitable with its characteristics. Taking for example the case of a manufacturer of the examined technology that would like to provide services to clients. In this scenario, the company has to be aware of the fact that it can pursue a "holistic strategy", thus addressing multiple new industries in separate moments, while always keeping a solid set of different technological models and variables.
On the same line, another case could be represented by a company that has never exploited the opportunity of an emergent technology and is planning to make a private use of it. Then before actually trying to pursue this objective, the company should have already been operating within the industry that is trying to address, and it should be able to identify a unique version of the technology for this private use.

6.4 Limits and Follow-ups

In this last paragraph the main limits encountered during the development of the research and the one concerning the overall thesis will be presented, but also in highlighting how they can constitute the basis for further evolutions.

Within the previous chapters and briefly in the former paragraphs of the conclusions, the reasons for choosing the research environment together with the main benefits deriving from such a choice have been presented. However, at the same time some limitations could be identified.

Firstly, one limitation regards the basic assumption that has been made when identifying the first adopters. Their definition is in fact based on the idea that each first ever granted exemption with respect to the industries, represented the very first step that has ever been moved in that application field. For the purposes of the research, this has represented an effective simplification, that however may not necessarily be the most truthful when looking at the drone industry as a bigger picture. Secondly, the selection of such a narrow focus can represent a limit. Indeed, the information concerning the Drone industry has been collected only regarding the commercial use of the UAV technology within the US Market. Moreover, the defined time frame within which the analysis has been deployed is restricted to less than two years. These limitations however leave open the possibility of studies that could cover a wider area, also in highlighting if the traits characterising different environments (the regulatory framework, the availability of the technology, the availability of specific competences) could have an impact on the approach that companies could pursue when exploring the potential of a technology.

Concerning the period of time that has been evaluated, the ongoing process of regulations' definition and the availability of data, has almost forced the choice. Nevertheless, in a non-distant future the regulatory environment would be certainly more stable in making the information gathering more complete and precise.

Concluding, this thesis represents the first move towards further developments and follow-ups. The provided framework represents a valid reference when exploring the opportunities of a technology for addressing new industries and the proper outset for future researches.

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