Managing skunkworks to achieve ambidexterity:

The Robinson Crusoe effect

Abstract

Literature on ambidexterity emphasizes the need for both exploration and exploitation. Large firms usually choose to implement structural ambidexterity to separate both activities. We here focus on an extreme case of such structural partitioning implemented as a secret skunkworks project in a large French automotive company. A qualitative survey using both primary and secondary data shows that the major basic and initial characteristics of a skunkworks (i.e. secrecy, urgency, and autonomy) created favorable conditions for the technological exploration. However, exploitation failed due to precisely those same characteristics coupled with the fact that the project did not respond to a specific market demand: The skunkworks suffered from what we call the "Robinson Crusoe effect." We therefore contribute to the literature on skunkworks, which have remained understudied in the academic literature, as well as on ambidexterity, by showing how the interrelation between different factors is crucial for structural ambidexterity to be successful.

Keywords: ambidexterity, exploitation/exploration, skunkworks, radical innovation.

1. Introduction

Exploration and exploitation processes are crucial for organizations' long-term performance (March, 1991; Tushman & O'Reilly, 1996; Schnellbaecher, Heidenreich & Wald, 2019). Exploitation refers to the use and development of existing knowledge; it tends to encourage incremental innovation. Exploration instead seeks to generate new knowledge and helps develop radical innovations. While small firms have been found to be more able to pursue contextual ambidexterity, i.e. exploration and exploitation in the same place by the same people (Lubatkin et al., 2006), large bureaucratic firms usually separate these activities. Indeed, they often excel in day-to-day operations and incremental innovation initiatives but might rely on overly rigid managerial procedures and organizational structures that diminish their radical innovation potential (Garud & van de Ven, 1992; Damanpour, 1996; O'Connor & Rice, 2013). Given the difficulties companies face in renewing their product and technological portfolios, the literature on ambidexterity and radical innovation has provided an organizational solution: structural ambidexterity (Gibson & Birkinshaw, 2004; Raisch & Birkinshaw, 2008). This means that corporate management creates a separate satellite structure devoted to exploration that generates radical innovations, while the mainstream organization concentrates on its well-established, routine-based exploitation activities to deliver incremental innovations (Benner & Tushman, 2003; Hill & Birkinshaw, 2008; Bessant et al., 2014). Some organizations are able to undertake such structural ambidexterity successfully (Raisch & Birkinshaw, 2008; Chang & Hugues, 2012; Bonesso, Gerli, & Scapolan, 2014), i.e. achieving exploration and exploitation at the same time. However, in large firms, problems may arise and decrease performance because of the negative effects of formalization (Jansen et al., 2006) and of balancing problems between exploration and exploitation (Stettner & Lavie, 2014). In addition, the structural partitioning might generate concerns due to the risk of tensions between the mainstream organization and the satellite

structure. The new satellite structure needs to be protected from counterproductive corporate forces (McDermott & O'Connor, 2002), but the mainstream organization may resent the diversion of resources to exploratory projects, particularly those that threaten to cannibalize its established products.

To solve some of the above-mentioned problems, the US Lockheed Martin company created, in June 1943, an isolated secret satellite structure, the first "skunkworks," to quickly develop a jet fighter in the midst of World War II. Previous studies emphasize that secrecy can protect creative projects and foster radical developments (O'Connor & McDermott, 2004; Criscuolo et al., 2014). Although such structures are widespread in some industries, they have been rarely studied, perhaps due to the confidentiality that surrounds them. Hence, our research question is: "Do skunkworks facilitate ambidexterity in large organizations?"

In the scarce literature on skunkworks, most descriptions center on the event and outcomes, without clear insights into the processes, the reasons for initiating the structure, the obstacles that arose, or how the firm managed its explorative learning processes and potential ambidexterity. For this research, we gained privileged access to employees and chief operating officers of a skunkworks satellite structure (Hybrid Air) operating secretly within the car manufacturer PSA Peugeot Citroën. Following recent proposals to examine ambidexterity from a dynamic point of view (Schnellbaecher et al., 2019), we analyzed the Hybrid Air project from 2011 to 2013. This project was established to rapidly create a radically new technology with a compressed air energy propulsion system for hybrid motors in order to produce less-polluting vehicles and compete with electrical cars.

With this research, we contribute to the innovation and ambidexterity literatures in three main ways. First, we offer a thorough description of how a skunkworks is implemented and of its implications in the specific case of a radical technological development. Second, we provide a theoretical justification for using secret satellite structures to deal with organizational tensions

related to ambidexterity. Third, we highlight the major barriers to the transfer of technological exploration achievements between a skunkworks and the mainstream company. We call it "the Robinson Crusoe effect."

2. Theoretical framework

2.1. Exploration in large firms through structural ambidexterity

In response to ongoing pressures, organizational structures in large established firms must find ways to encourage radical innovations (O'Connor & Rice, 2013; Lin & Ho, 2016). While this applies to all large organizations, it is particularly the case for the automotive industry where complex operations, low margins and high risks tend to favor incremental innovations (Van Den Hoed, 2007)—which are far from being able to meet the increasingly demanding environmental sustainability goals. In an extensive review of scientific studies on sustainability and innovation in the automotive sector in the last 13 years, Rodrigues-Vaz et al. (2017) show that 97% of the articles produced address incremental innovation, whilst only 3% deal with radical innovation.

Radical innovation requires autonomy and flexibility, which is difficult to implement in mainstream organizations (Kelley et al., 2009). As a result, many studies call for dual structures and strategies (Benner & Tushman, 2003; Blindenbach-Driessen & van den Ende, 2014). Additionally, incremental innovations have been found to benefit from a formal (rigid & inflexible) structure, whereas an informal (flexible and fluid) structure is best for supporting radical innovations (Menguc & Auh, 2010). A separate organization could also exist for venturing into disruptive technologies, which "are typically simpler, cheaper, and more reliable and convenient than established technologies" (Christensen, 1997, p. 192). In this vein, Bessant et al. (2014) recommend the specific use of skunkworks or satellite structures by large companies to deal with exploration and radical innovation.

The rationale for dedicated exploration projects is that large companies need specific organizational tools to achieve radical innovations (Lin & Ho, 2016). However, to generate new radical knowledge, projects often need specific organizational routines and knowledge searches that are distant from the company's core, leading to integration challenges (Bonesso et al., 2014; Schnellbaecher et al., 2019). Research on new product development suggests that an organization's ability to innovate rests on its capacity to deal with contradictory forces (Sheremata, 2000). In turn, organizational arrangements must allow project teams to consider many different ideas, consult a wide variety of knowledge sources, and function autonomously enough to explore avenues that are truly new compared with the firm's existing knowledge base. But this original knowledge also needs to be translated into coherent collective actions, so that the output can be integrated into and ultimately benefit the mainstream organization. Dedicated exploration projects require, almost by definition, specific organizational practices that "balance" their autonomy and isolation with sufficient control and integration. Indeed, in order to explore, innovators should be autonomous and protected from the central organization, whereas in order to exploit, the firm needs efficient organizational processes (McDermott & O'Connor, 2002).

In line with this idea, Hill and Birkinshaw (2008) propose investigating dedicated projects that represent flexible forms used to explore. These structures are distinct entities, controlled by a parent company whose mission is to develop a new business (Block & MacMillan, 1993). The agility and independence of dedicated innovation projects allow them to break free of constraints and inertia, and to develop new products or services more quickly. Separation favors experimentation and the development of new competences, and it buffers the team from the influence of ongoing operations. However, this ability to explore far beyond the company's routines also constitutes a great challenge, because the greater their distance from the knowledge base of the company, the more difficult it is to integrate projects into its

mainstream activities and operations. Too much separation between the parent company and a dedicated project can lead to failure as a consequence of a lack of proximity with the routines and knowledge established by the parent company (Hill & Birkinshaw, 2008).

From an exploration perspective, pulling a small satellite structure out of a large organization has several advantages. The isolation may protect the project from counterproductive forces (McDermott & O'Connor, 2002). Because the structure is usually small, informal, and flexible, it is likely to achieve effective communication and knowledge sharing, which are essential to problem solving. Moreover, employees of the new structure often express a different attitude toward learning and are more risk oriented (Bessant et al., 2014). Finally, fed by the large organization's resources, the satellite structure can avoid classical small firm disadvantages, such as poor financial and human resource endowments (Camisón-Zornoza et al., 2004; Blindenbach-Driessen & van den Ende, 2014).

However, from an internal perspective, this new structure can create problems, especially in terms of its relations with the mainstream organization. Some decision-makers may resent the diversion of resources to exploration projects, particularly if the projects could cannibalize established products. The high visibility of such groups makes them an easy target for cutbacks if they produce little profit and come to be viewed as a drain on earnings (Kelley et al., 2009). Fundamental conflicts between the mainstream organization and the radical innovation unit may also generate organizational uncertainties (O'Connor & Rice, 2013). Therefore, autonomous ventures for exploration may require protection from pressures imposed by the mainstream organization (O'Reilly & Tushman, 2004). Structural partitioning or, more precisely, non-secret satellite structures have proved to be a successful option for ambidexterity (Gibson & Birkinshaw, 2004). However, there is also evidence that, in some particular situations, such structures could face some dangers (Kelley et al., 2009). In such cases, skunkworks present some advantages (Bessant et al., 2014).

2.2. Skunkworks for exploration

Skunk Works® is a registered trademark of Lockheed Martin Aircraft Corporation. It was the name1 given to a secret R&D team at Lockheed during World War II as the firm, in response to the urgent war effort requirements of the US army, asked engineer Kelly Johnson to bring together a group of 43 engineers and to quickly develop a jet fighter. The team had to operate in strict secrecy with no managerial oversight from the mainstream organization, no contracts in place, and with an extreme time constraint. Engineers worked in a tented facility just outside the main Lockheed plant in Burbank, California, and delivered in only 143 days the XP-80, an innovative, high-performing jet fighter for the US army (Hindle, 2008). Since that period, the aircraft manufacturer continues to anticipate "tomorrow's capability gaps and technology needs to solve the most critical national security challenges today" through skunkworks projects with the slogan: Quick, Quiet, and Quality. While the initial skunkworks was a project, it has now become, at Lockheed, the name of the structure that houses exploration projects.

Since the original skunkworks project at Lockheed, there has been an appropriation of the concept by both firms which implemented such projects (e.g., Ford, Michelin, Apple, Walmart, Nike, 3M) and by academics who started to study them. Accordingly, there has also been an extension of its meanings, dimensions, and definitions (see Appendix 1). The term "skunkworks" has been used to characterize, variously, a method, a body, an environment, a team, a project, a structure, a group of people, or a model of innovation! However, the idea according to which skunkworks are now a structure is largely accepted in firms that use them to explore radical innovation projects (e.g., BMW, Google, Lockheed). When it is the first project for a firm, a skunkworks characterizes the structure or the project. This is the case for the skunkworks analyzed in this research (Hybrid Air).

1 "There have been many stories over the years about the name's origin: It evolved from a comic strip or the color of a tent it was housed in or because what was inside that tent smelled so bad... In the same neighborhood was a plastic factory that produced a terrible odor that permeated the tent" (https://generalaviationnews.com).

In all cases, skunkworks imply innovation-focused small groups. They operate (secretly or not) with the top management's support but with totally informal processes: no notable management control, oversight, formal rules, or procedures. Such informal procedures and processes favor radical innovation and clear goal orientations with strong speed constraints (Bessant et al., 2014; Brown, 2004; Gwynne, 1997; Johnson & Smith, 1985; Single & Spurgeon, 1996). Skunkworks distinguish themselves from other organizational forms dedicated to exploration thanks to their original and initial characteristics at Lockheed, which the literature (e.g. Bessant et al., 2014; Brown, 2004; Gwynne, 1997; Johnson & Smith 1985; Single & Spurgeon, 1996) summarizes as follows: (1) a relatively small sized team composed of members who display a passion for (radical) innovation, (2) autonomy with a general lack of management control or oversight, few formal rules and procedures, (3) top management direct (and almost exclusive) sponsorship and protection, (4) urgency, and (5) secrecy.

Interestingly, these authors generally do not indicate that skunkworks (projects) should also be market oriented in order to allow for the commercial exploitation of the radical innovation. Nevertheless, this reference to exploitation was essential in the case of Lockheed: The skunkworks was set to respond to a very specific market, the US army, a client who was not so much interested in the final price as in the final product (i.e., a product, not a project or a prototype). This aspect is somehow paradoxical as, in the mainstream of the innovation literature, exploitation is meant to develop products for a specific market while exploration is done without, at the beginning, any idea of the future market (Chandy et al., 2006).

Secrecy is probably the most specific and original characteristic of skunkworks inspired by Lockheed Martin. It is inherent in the skunkworks concept and an integral part of its origin (Brown, 2004). Indeed, the original Lockheed skunkworks was, of course, an ultra-secret, wartime military operation. However, since then, the notion has largely spread to encompass non-secret structures (see definitions in Appendix 1). Hence, the term evolved to the more

generic and larger version (usually written in the lower-case) that today is applied to innovative projects conducted in secrecy, semi-secrecy or, at least, outside the usual departments tasked with development within an organization. The fact that researchers (e.g., Bessant et al., 2014; Brown, 2004; Gwynne, 1997; Single & Spurgeon, 1996) do not focus on the secrecy issue is interesting. It probably reveals that secrecy is either never posed as a formal condition, or that the cases made available to researchers were precisely those which did not come under secrecy. Hence, perhaps because of the confidentiality surrounding most "genuine" skunkworks projects, innovation scholars have paid scant attention to such "genuine" skunkworks, despite their status as the most radical organizational forms of structural ambidexterity (Johnson & Smith, 1985).

On one hand, there are clear advantages of secrecy. Within the development team, working in secret implies fewer distractions, fewer compromises and a greater ability to fail, which leads to more creativity. At the organizational level, it can shield the satellite exploration structure against counterproductive forces in the mainstream organization (McDermott & O'Connor, 2002): Some managers might disagree with the diversion of resources for radical developments, especially if they could cannibalize their established products. At the competitive dynamics level, secrecy can be a useful means to protect new technological developments from imitation (Arundel, 2001). Such protection can boost first-mover advantages and ensure they last longer (Suárez & Lanzolla, 2007). Another justification for secrecy in radical technological development projects relates to the bootlegging benefits (Criscuolo et al., 2014; Globocnik & Salomo, 2015). Bootlegging creative initiatives normally take place informally and secretly. With their informal and hidden nature, such initiatives allow experimentation without requiring formal justification to other stakeholders. Generating new knowledge in a secret way entails testing and creating new things without needing to ask for permission. Therefore, these creative initiatives may be especially suitable for exploration

and divergent research (O'Connor & McDermott, 2004). Finally, secret development operations allow project managers to choose the best moment to communicate the project outcomes (Criscuolo et al. 2014). If the outcome is a failure, the decision-maker in charge of the skunkworks project might not communicate anything, to avoid a loss of reputation. If the outcome is a success, the decision-maker can strategically decide when, how, and where to communicate it within and outside the organization.

On the other hand, secrecy also has some drawbacks. Development outcomes may be difficult to reintegrate because the mainstream organization is less (or not) prepared. It may also cause greater organizational problems since secrecy often leads to suspicion. Thus, secrecy could be an important barrier to communication, coordination, and collaboration, both internally between different parts of the organization (especially between the satellite structure and the mainstream organization) or externally with other organizations (suppliers, consultants, universities, and research institutes). These aspects are well-known ingredients for successful innovation (OECD, 2018).

Taking into account skunkworks' pros and cons: Are secret skunkworks more effective in developing an explorative technological development? How effective is the transfer of technological exploration achievements between a skunkworks and the mainstream organization? This question has not been answered since it was asked by Brown (2004). Our case study explores it to analyze whether skunkworks facilitate successful ambidexterity in the context of large organizations.

3. Methodology

This research is based on the case study of Hybrid Air, a skunkworks project conducted by the French car manufacturer PSA Peugeot Citroën (PSA) between 2011 and 2013. After the 2008 financial crisis and its effects on the automobile industry, PSA faced difficult years, marked

by market share decreases and negative financial results. European environmental regulations also were urging car manufacturers to build less-polluting vehicles (Lin & Ho, 2016). In this context, the skunkworks Hybrid Air was created with the mission to rapidly work on a low cost, low CO_2 emissions car. In addition, Hybrid Air could be an opportunity to recapture the spirit of innovation that made PSA and its Citroën brand famous: the first "all-steel body," floating-power engine, front-wheel drive vehicle, hydro-pneumatic suspension, etc.[2]Barely three years later, the skunkworks revealed a successful prototype combining a petrol engine with a compressed air energy propulsion system.

3.1. Data collection

In the absence of prior studies, we use a qualitative approach to explore our target organizational phenomena in their own context and to obtain precise information about specific managerial issues. Following Eisenhardt (1989) and Yin (1989), we rigorously collected and analyzed primary and secondary data to write a case. Data collection started in February 2014 (i.e., a year after Hybrid Air's disclosure) and was completed in September 2015. However, the information gathered covers the period from 2010 to 2015, starting from the PSA Innovation Committee in June 2010 and ending in September 2015 with the definitive end of the Hybrid Air project.

First, we conducted 25 semi-structured interviews[3] with collaborators working for the skunkworks (including two main project managers), people from the advanced R&D department at PSA, and members of partner companies involved in the project. More precisely, we interviewed three Hybrid Air managers, six Hybrid Air R&D engineers and

[2]However, since the merger between Peugeot and Citroën in 1976, the car manufacturer has not produced as many radical innovations. PSA cars have evolved from one model to another without breakthroughs (Broustail and Greggio, 2000).

3We accessed some major collaborators of the skunkworks because the project was finished, and because most of them were no longer with PSA. However, for confidentiality reasons, we could not provide the name and exact position of each person, except for the project manager Karim Mokkadem.

technicians, six main organization R&D managers, engineers and project leaders, six main organization managers in functional areas—marketing, business intelligence, human resources, strategy, two Hybrid Air engineers from a partner firm, and two managers from a partner firm. The relatively few respondents (25) must be considered in the context of the small size of the project team (10 people at first, approximately 100 at the end). The shortest interview (with a skunkworks member associated with a supplier partner company) lasted 45 minutes, and the longest (with the manager in charge of Hybrid Air) lasted 80 minutes. The interview approach was open, to give interlocutors substantial freedom of expression, but centered around three main topics: the context in which the skunkworks developed, its functioning, and its outcomes. We also asked the interviewees to focus on facts (Hannah & Eisenhardt, 2018). Second, we collected primary data from recordings and notes taken during conferences, seminars, and workshops in which PSA and Hybrid Air collaborators detailed the content and history of the project. Third, we analyzed secondary sources such as internal reports, press articles, specialist automobile blogs, and YouTube videos of the project. Every innovation in the automotive sector is scrutinized by the whole industry, so using many sources helped us mitigate potential retrospective biases.

We gathered all the information and two researchers working separately coded it according to the chronology of the facts (Eisenhardt, 1989)—context pre-skunkworks, during the skunkworks, and after the skunkworks. We grouped the information according three themes, bearing in mind the consequences for ambidexterity—setting, functioning, and innovation outputs. In addition, we fixed categories based on skunkworks' characteristics—secret, top management support, urgency, and autonomy. Finally, we coded the transcribed interviews and secondary data.[4] The combined analyses by both authors were validated by a third independent researcher, unfamiliar with the case, to help us control for possible subjectivity

[4]Appendix 2 provides examples of our coding method.

biases. No significant interpretive differences arose, and the reliability rate between the two coders was high (92%).

4. Results

4.1. Origins

Hybrid Air arose from several constraints, including those related to environmental issues (Lin & Ho, 2016). Noting the negative effects of internal combustion cars, the European Union (EU) set emission reduction targets for new cars[5]. In this setting, PSA worked on hybridization technologies, by combining more than one form of energy to achieve propulsion. Behind only the market leader Toyota (Prius), PSA was well positioned in this market, with good hybrid engines combining diesel and electricity propulsions. Therefore, the company wanted to build on its leadership and explore further radical innovations of cleaner hybridization systems.

Another constraint that triggered the origin of Hybrid Air was financial: PSA ended 2009 with operating losses of 689€ million. PSA struggled to monetize the production of its urban models and B-segment vehicles, which constituted the largest part of its product portfolio. It also had trouble selling expensive, premium, less polluting cars, making the EU regulatory constraint seem impossible to achieve.

In this context, a small group of engineers from a department in charge of "engines and transmissions for the future" received an assignment to rapidly conceive of an urban, clean, hybrid vehicle that would meet the 2020 regulatory standards and economic needs. The head of the department at the time, Karim Mokkadem, wanted to make the mission a priority. Engineers were encouraged to think "outside the box" and develop radical hybridization

[5] In 2009, a new law (n°443/2009) required that cars newly registered in the EU could not emit more than 130 grams of CO2 per kilometer on average by 2015 and 95g CO2/km by 2020. If they exceeded these thresholds, car manufacturers would have to pay penalties, calculated per car range, on the total number of cars in their fleet. The penalties, of €95 per gram of CO2 above the allowed thresholds, would represent hundreds of millions of euros.

innovations. After six months of intensive brainstorming, the team highlighted the relevance of a disruptive technology concept, based on a compressed air propulsion engine:

"*We had something that seemed to work. The technology could be a very competitive alternative both in terms of cost and environmental performance to the electric hybridization. This was part intuition, but according to our first calculations, it could work.*" (Team leader)

In accordance with formal hierarchical procedures in the main organization, Mokkadem defended the concept in front of the PSA Innovation Committee in June 2010. The committee, organized by the head of R&D, includes the chairperson of the company and top corporate decision-makers. Validation from the committee is always challenging at PSA, but when a concept is accepted, it becomes an "official project" with a dedicated budget. Although Mokkadem was initially sponsored by the head of R&D, the economic difficulties at the time caused disagreement among the committee about the relevance of the concept. Some innovation committee members were reluctant to devote resources to the project, but both the chair of PSA and the executive vice president for R&D gave their approval and support. They also asked for the creation of a skunkworks structure, under their direct supervision. Hybrid Air could not be revealed before it was completed, demanding the highest level of secrecy.

4.2. Skunkworks settings

When Mokkadem came back from the innovation committee with the go-ahead of the top management for Hybrid Air, on the condition that it would operate as a secret autonomous project, members of the first research team were surprised:

"*When they told us that Hybrid Air was being made a skunkworks project, I was surprised. I, we, did not know the meaning of skunkworks. I learned that during World War II, Lockheed Martin used skunk as the name of the R&D department responsible for designing and developing the P80 plane in the greatest secrecy, designed to counter the German Messerschmitt*" (Chief engineer).

Except for the R&D director, who came from the aeronautics industry, nobody even had heard of skunkworks: "*I went online and learned that it was not only a smelly animal*" (Engineer). Such a secret project had never before been implemented in the company. Thus, creating Hybrid Air skunkworks represented a clear organizational disruption, for which no one was prepared.

In a remarkable period of just three months, Hybrid Air leaders chose an unused secret location, far enough away from other PSA facilities (about 30 km from the Parisian headquarters).

Then Mokkadem composed a new dedicated team, knowing that the legitimacy of the project would depend heavily on its quality. He wanted to poach the best collaborators, well recognized in their field, explaining:

"*I will not be able to perfectly defend the object, but I will defend the quality of the team I put in place*" (Mokkadem).

From there, a disruptive recruitment process, unlike conventional approaches at PSA, was explored. On orders of the top management who protected the skunkworks project,

"*Each of the directors from the different R&D departments was asked to make expertise available, even if it disrupted their department; this project was a priority, even though they could not know what it was*" (HR Hybrid Air manager).

Next, because of secrecy, "*instead of communicating about the job, as is usually done, we had to communicate about those who already had contractually committed to involvement …. It was simply good faith, trust and reputation that resulted in us getting people on board*" (Hybrid Air manager).

Six months after the innovation committee first met, the skunkworks was set up. In two years more than 100 people from the main organization and from external partners (Bosch, Faurecia, Plastic Omnium), came together in a cross-functional platform, representing

competencies in vehicle integration, powertrain development, marketing, and after-sales support.

Considering the time constraints, the head of the team gave the team full freedom to organize itself, such that it benefited from a short, efficient decision-making process. Agility was key, supported by the absence of hierarchical controls and constraints usually imposed on processes at PSA, even in exploration phases:

"*There was not really a formal supervision, but instead a kind of comprehensive self-supervision was put in place. We did not want the teams spending their time writing reports for the decision-makers*" (Manager).

"*There was no longer any hierarchy between Mokkadem and the R&D corporate director, whereas usually they were separated by two levels*" (Chief R&D engineer).

As a result of this disruptive, autonomous, and agile decision process, the budget management process changed too:

"*After the innovation committee, they asked us: What do you need to continue? We prepared a budget without too much detail because in skunkworks you manage your budget as you like. It was completely new for us*" (Team leader).

However, time constraints were tightened for the skunkworks:

"*We had to move much faster than a traditional innovation and development structure operating in the automobile industry ..., we had an upper time constraint. For example, the acoustic problems identified during testing by the innovation committee had to be resolved within six months*" (R&D engineer).

Short-term challenges were always the priority and were neither separated nor compartmentalized but instead discussed at a group level:

"*As soon as a problem had to be addressed, we stopped, and all available skills were focused on resolving the problem. When the number of team members increased, the teams were restructured but always in a way that retained their agility"* (Engineer).

When the moment came to work with external partners to solve technical issues, Hybrid Air also had to radically reinvent supplier relationships; the purchasing department's standard and long procedures would be inappropriate. Furthermore, secrecy conditions had to be imposed on external partners:

"*The skunkworks mode was needed on both sides of the partnerships. Bosch put in place a secret team in the same way, but it remained at Bosch.*" (Team leader)

All these organizational settings led to a level of agility never obtained by the main structure.

"*We always made sure we kept that agility. … It was a phenomenal cohesion, a real team. We trusted one another and developed a team spirit*" (Engineer).

Although organizational outcomes are difficult to evaluate globally, the members of the Hybrid Air team, which had never tried skunkworks before, remain adamant about the success of their organizational exploration. As a team member explained:

"*The entire group took the freedom to organize itself, because being a 'skunk' forces you to manage and control everything by yourself, and it works!*" (Engineer).

4.3. Technical exploration success

The entire team was mobilized to achieve the technical objectives:

"*How can energy storage be more efficient? Storage compression and air are cheap*" (Engineer).

Once the technological rupture was validated through an analytical, outside-the-box, conceptual approach, a systematic, rigorous, empirical prototyping method followed.

"*We were no longer trying ideas out of the box; we were looking for solutions*" (Project leader).

Over the course of two years, the project team developed, tested, and optimized four generations of prototypes, in a mixed approach with back-and-forth analytical and empirical phases.

"*So, we built a first prototype, which was nothing like the final vehicle we presented*" (Engineer).

Finally, Hybrid Air engineers proposed dozens of patents with more than 80 applications. A Citroën car fully equipped with Hybrid Air technology was realized, and the secret came to an end on January 22, 2013, during PSA's Innovation Day. During this event, dedicated to presenting major innovations for the car of the future, the complete board of the company, hundreds of business and political decision-makers, economic and institutional partners, and journalists learned about the game-changing technologies and major innovations developed by PSA. Hybrid Air was presented as an exploitable breakthrough technology, a major step toward reaching the 2020 standard, and an important innovation in the automotive industry. It was described as "revolutionary" and relevant enough to be introduced to the wider public at the next Geneva automobile trade fair, three months later. At Citroën's stand at that trade fair, the French minister for industrial renewal acknowledged the initiative as an important advance toward the strategic objective of producing a French car that consumes 2 liters of petrol for every 100 km of travel. In parallel, PSA's CEO announced the planned launch of Hybrid Air models by 2016.

4.4 Obstacles to exploitation

While the exploration phase was successful, the exploitation phase encountered obstacles. Hybrid Air did not lead to technical exploitation and achieve full ambidexterity at the firm level, for three main reasons: absence of business model, no reintegration by the main organization, no support by the new top management.

First, the cost of the Hybrid Air module was estimated at around €2000, incompatible with the objective of providing a "highly competitive alternative [technology] to electric hybridization, both in terms of cost and environmental performance" for an urban vehicle. The breakeven point would occur at 500,000 cars (urban, small vehicles)—a huge figure for a manufacturer like PSA, which produces fewer than 2 million cars annually. Some additional development was needed to reduce the price, but the time was missing*:*

"*An idea can be found in a second, a technical solution in a few months, and a business model in a few years ... .It takes time to make money and PSA didn't have any*" (Manager from partner firm).

Therefore, the final exploitation appeared conditional on finding another company in the automobile sector that could act as a partner, absorb the additional costs, and help achieve economies of scale once a breakeven point had been reached:

"*We needed a partner to maximize volume effects. That is where we stood, and we couldn't get past the final development phase as long as the economic aspect of volumes had not been resolved*" (main organization's engineer).

In addition, the skunkworks team did not provide a business model based on a complete market analysis as the BMW's *Project i* skunkworks did. The objective of *Project i* was to explore materials needed for production, from technologies to new vehicle architectures. The agenda included the development of sustainable mobility concepts, new sales channels and marketing concepts, along with acquiring new customers. Ulrich Kranz, *Project i* director reported in *Automotive News Europe* (May 2013):

"*At first, we launched an intensive research phase that dealt with mobility questions and customers' future needs. Where do we need to delve deeply into the issue of sustainability? How well will customers accept a new product and a new technology such as electric mobility*?"

The Hybrid Air team did not anticipate the change in technological paradigm that was taking place towards the abandonment of heat engines:

"*The problem with Hybrid Air is that the guys did not realize that the world was changing and that hybridization of engines was no longer the way of the future. We had to go to the electrical*" (Main organization collaborator).

Without a major marketing function within the skunkworks and very little contact with the outside world, "*Hybrid Air has evolved outside of life*" (External partner engineer).

Second, the Hybrid Air team not its achievements have not been reintegrated into the main organization because of "not invented here" syndrome.

"*We tried to be proactive on the subject by involving people in their decision to continue the project in the company. We asked them what they wanted to do, but we realized that they did not want to continue*" (Chief R&D engineer)

Hybrid Air members became "skunks" to others, who avoided them, perhaps out of jealousy:

"*They think they are smarter, then they should stay in their corner*" (Engineer at PSA).

"*Hybrid Air, when they came back, we weren't offered to have lunch with us. ... They didn't say or give anything to us when they were there,*" (Main organization collaborator).

This negative attitude towards knowledge (ideas, technologies) derived from an external source is typical of the "not invented here" or "shared" syndrome (Burcharth, 2014). Over time, the Hybrid Air collaborators felt less connected to the main organization. When the skunkworks ended, Hybrid Air collaborators had to go back to their former position in the main organization or find a new position in their original department. However, one collaborator from an equipment manufacturer associated with Hybrid Air told us that it had been very difficult for most of the members to go back to the main organization:

"*Skunkworks projects leave traces that can be hard to cope with, threatening the feasibility of exploitation at the wider organizational level. I found it difficult to communicate with my colleagues about what I experienced*" (Equipment manufacturer member).

Similar to other high volume car manufacturers, PSA was hierarchically organized, with matrix structures that matched functions (purchasing, quality, marketing) to car projects. For exploitation at a firm level, excellent management control and cost analysis skills become nearly as critical as style in the design phase; it is necessary to know exactly what people are doing and how much it costs. Therefore, reporting functions are key, and people spend hours formally reporting on everything they do and observe. Hybrid Air collaborators did not feel comfortable with those activities anymore; they saw them as a waste of time and effort. Through Hybrid Air, employees learned how to work in conditions of freedom and autonomy for urgency, with agile management practices that were very different from those that dominated PSA at that time. They felt part of a unique group ("*we became like a family*") with a distinctive identity relative to the one they held at PSA. The distinctiveness of their mission reinforced their identity, integration with the team, and adherence to values based on solidarity and trust. A member of the team commented on the meaning of a poster at the entrance to the site that read "*Here the possible is done, the impossible is in progress, give me 48 hours for a miracle*":

"*If we stuck it on the door, it was not only to show that we were doing miracles, it was also a way of reminding us that here we did not do things like there*" (Chief engineer).

This double tension between the employees of the main organization who rejected Hybrid Air collaborators and the latter who no longer accepted the processes of the central organization was an obstacle to reintegration and knowledge transfer.

Human resource managers asked what former Hybrid Air employees' preference was, and many realized that they did not know how to reply:

"*I understood they could not reintegrate into the traditional bureaucratic organizational framework. Some of them told me that, after such an adventure, they could not just go back to the same things they used to do*" (HR manager at PSA).

Seemingly only a continuation of a secret, small, autonomous structure pursuing additional explorative innovation objectives would have enabled many Hybrid Air members to continue their careers at PSA:

"*If I could continue to work in a kind of 'skunkworks way,' I would stay*" (Hybrid Air engineer).

Ultimately, most of them left:

"*Fortunately, I found a position in an innovative firm where I could benefit from what Hybrid Air gave to me*" (Hybrid Air manager).

The project's leader, Karim Mokaddem, left PSA in September 2014 to join a technology investment fund, and many have said it was a loss of competencies:

"*I think one day PSA will regret having made Karim and his gang leave because they are talented people*" (Automotive expert - consultant).

The third main obstacle to exploitation is related to the top management support. Hybrid Air skunkworks was placed under the unique responsibility of the PSA chairman and R&D director, who gave it its "raison d'être," legitimacy, and budget. However, in March 2013 the R&D director left PSA for Eurocopter and a few months later the PSA board nominated a new chairperson (Carlos Tavares) with the mission of ensuring the economic and strategic revival of the company with a positive cash flow, 2% operating margin, and no debt. This new chairperson, *"cool towards the new technology* [Hybrid Air]"[6] designed in 2014 a radically different product strategy for the company, with fewer resource allocations to hybrid cars and increased investments in fully electric vehicles:

[6] Duff, Mike (January 26, 2015). "Deflated: Peugeot Citroen Shelves Its Air Hybrid Technology." Car and Driver. Retrieved 2018-10-29.
https://www.caranddriver.com/news/a15357550/deflated-peugeot-citroen-shelves-its-air-hybrid-technology/

"*Disappointing news from France: PSA Peugeot Citroen has put an indefinite hold on the development of its promising-sounding Hybrid Air powertrain, apparently because the company has been unable to find a development partner willing to split the huge costs of engineering the system. And now the dream seems to be over.*"[7]

5. Discussion

Several lessons emerge from the Hybrid Air case regarding our research question on whether skunkworks facilitate ambidexterity in large organizations. The case shows the effectiveness of the skunkworks structure for exploring a radical technical development, but it also shows the failure of its exploitation, and thus of ambidexterity. It reveals the obstacles that blocked its exploitation by causing a "Robinson Crusoe effect," a metaphor illustrating the situation of a person (or a group of people) who would be sent alone, by a high-ranking sponsor, to a secret island located far from a continent to urgently explore survival technics in an unknown territory. During his mission, Robinson invents all kinds of products and methods and learns a lot but, upon returning to the continent after several years, he is no longer anyone. He has been forgotten by his loved ones, he cannot reintegrate into society, his knowledge and creations are not understood or relevant to the concerns of the moment. Hence, he does not transmit anything from his experience. The Hybrid Air case illustrates this phenomenon: a successful exploration (with the creation of valid prototypes, patents, award at the PSA's Innovation Day, Geneva auto fair presentation, acknowledgement from the minister of industry, and support from the top management for a launch in 2016) but no effective exploitation.

[7] op. cit.
https://www.caranddriver.com/news/a15357550/deflated-peugeot-citroen-shelves-its-air-hybrid-technology/

We first discuss whether this phenomenon is triggered by the effects of the very inherent characteristics of that "genuine" skunkworks (secrecy, urgency, and the unique sponsorship of top management), then the two options that would limit the Robinson effect.

5.1. Do secrecy, urgency, and unique top management support facilitate ambidexterity?

Secrecy was the first injunction imposed on the Hybrid Air team. Karim Mokaddem said he could not reveal any details, even to his wife and children: "They thought I had become a spy." Secrecy definitively facilitated the Hybrid Air team's autonomy to explore "outside of the box" techniques, methods, and routines. As an engineer told us: "We succeeded beyond expectations because we discovered the power of agility as a keystone … [and] because of secrecy, there was no one to tell us what not to do." However, the case study indicates some negative consequences of secrecy for ambidexterity at the firm level.

First, the strict secrecy created a communication barrier that did not encourage market and business model orientation. Even if after-sales specialists had been integrated into the team to work on system maintenance issues, no marketing team in charge of testing potential customers had been assigned to the project because of secrecy. The expression "we were progressing without the world," pronounced by the chief engineer, says a lot. It brings to mind the quotes mentioned by Gwynne (1997) about skunkworks' failure at ATT in the 1980s ("the technology was too advanced and too secret. We were basically too isolated") and at American Express ("85% of the problems stem from the lack of inclusion of the right people to tackle all issues"). Hence, absolute secrecy is the main cause of non-transition to market.

Second, secrecy isolated and created difficulties when it came to reintegrating the Hybrid Air employees into the main organization. They had become skunks for their former colleagues, who no longer even wanted to have lunch with some of them. Hence, the Hybrid Air collaborators had no opportunities to transfer their knowledge: "As the press talked about Hybrid Air as a success, we were proud; but, internally, no one came to ask us how we had

managed to be so fast" (Engineer). The combination and transfer of resources and skills are, however, essential for the development of radical technological development routines (Sheng, 2017) and ambidexterity (Raisch & Birkinshaw, 2008).

A common point between Hybrid Air and Lockheed Martin is that both skunkworks' engineers not only had an exploration mission, they had to urgently deliver a solution. Both succeeded: The aircraft manufacturer delivered a plane in only 143 days; Hybrid Air prototyped and patented a new technology by moving "much faster than a traditional innovation operating in the automobile industry" (Engineer). The Hybrid Air experience illustrates the idea of Bommer et al. (2002), who see skunkworks as a way to quickly develop solutions by bypassing some of the time-consuming bureaucracy and allowing the team to make ad hoc fast decisions.

However, the case also indicates some negative consequences of urgency on ambidexterity at the firm level. The organization of the project did indeed save time but, in the end, "time was missing" to validate the industrial conditions of the technical choices and the business potential. Our observations relate the time constraint, combined with that of secrecy, to the Achilles' heel of the skunkworks as a trigger for ambidexterity: the lack of business model or analysis to assess the market and economic conditions. However, researchers who have examined the conditions for the success of skunkworks (e.g., Gwynne, 1997; Bommer et al., 2002; Single & Spurgeon, 1996) showed that it is necessary to ensure that the voice of the customer is an integral and critical part of the project agenda—as much as the technical requirements. As a skunkworks manager at Ford emphasized: "you can't just send [the technology] over the wall … If your eye is not on business from the beginning it won't work" (Gwynne, 1997). This was exactly the approach followed by BMW and its i Project when they took the time to launch an intensive research phase to understand customers' future needs. Taking the time necessary to develop a market orientation favors exploitation by

reducing “engineering costs by working on the right problems, i.e., on what customers want” (Spingle & Spurgeon, 1996).

Finally, the unique sponsorship of PSA’s top management has been a trigger to exploration success at the skunkworks level and an obstacle for ambidexterity at the firm level. Hybrid-Air had top management’s support for setting exploration in exceptional conditions: resource allocation, a blank check to poach the best collaborators and seek external partners, authorization of total autonomy from systems and procedures. This is consistent with skunkworks literature (Gwynne, 1997; Bommer et al., 2002; Single & Spurgeon, 1996). Without this top management support, there is no secret and no authorization to violate “business as usual” or specific budget rules.

However, this support is also a weak link because, if it breaks, the skunkworks is put into danger. Its disappearance will be more likely since it cannot value any proof of its existence, its achievements, or the merits of its approach. This is exactly what happened to Hybrid Air when the chairman changed. Unknown to the main organization and therefore unable to be defended by influential people, and without reasoned proposals on the feasibility of an industrial and commercial operation, the Hybrid Air team lost the support of the new top management. The change of general management and the preparation of a new strategy limited any internal discussion on Hybrid Air commercial failure.

Figure 1 illustrates the interplay between the three characteristics of skunkworks, and factors of ambidexterity failure due to non-exploitation:

Insert Figure 1 about here

5.2. Two options to overcome the Robinson Crusoe effect

Based on the literature on the conditions of success of skunkworks, two major options to overcome the Robinson Crusoe effect emerge from the Hybrid Air case. The first relates to

the role—or rather the roles—of the general management, the second to the need to integrate an or exploitation function in skunkworks.

The role of the PSA top management was to protect the skunkworks; this was an essential condition, but it neither supported the exploitation of the skunkworks' results (as the BMW management did on its i project) nor managed the continuity of the approach by legitimizing a skunkworks culture (as at Lockheed Martin). PSA lacked a general management taking on the support role to guide the central organization's takeover of the project and the cultural impetus within the mainstream organization so that the Hybrid Air collaborators did not become "skunks" and lived and learned experiences were shared. Using our Robinson Crusoe metaphor, we suggest that the expedition sponsor should not only sign the mission order and allocate the necessary resources, but must also prepare Robinson's return to the continent.

The second option relates to the link between exploration and exploitation. The case shows insufficient preparation for exploitation due to the impossibility of testing the market without betraying the secret, the lack of time to make a business model quantifying the economic profitability of the technology, and the absence of marketing collaborators in the team. But were there other possibilities? One option would consist—as some companies that also work in (however, most of the time non-secret) skunkworks have done—of including the exploitation mission in the skunkworks. In this case, the teams create all the conditions of the ambidexterity internally, and ambidexterity takes place at the project level itself. This option meets Bommer et al. (2002)'s recommendations.

6. Theoretical and managerial implications

6.1. Theoretical contributions

This study has three main academic contributions. First, it provides a profound description of how a skunkworks has been implemented in a large organization. Second, in such a context, it

provides a theoretical justification for using secret satellite structures to deal with organizational tensions related to ambidexterity. Third, it puts forward "the Robinson Crusoe effect," underscoring the major barriers to the transfer of technological exploration achievements between a skunkworks and the mainstream organization (Figure 1).

Previous literature has scrutinized how organizations might undertake explorative and exploitative learning successfully (e.g. Gibson & Birkinshaw, 2004; Stettner & Lavie, 2014). Our findings provide a new insight on an approach based on secrecy to achieve exploration. The Hybrid Air case highlights an organizational solution for exploration. In particular, in detailing the advantages of operating in secrecy, this case contributes to the open vs. secret development dilemma. Our findings are in line with previous evidence about specific situations in which staying closed might be positive for exploration (Manzini et al., 2017). Open innovation literature may be booming (Laursen & Salter, 2014), but researchers should not ignore the clear evidence of the benefits of undertaking development in secret, whether through bootlegging (Globocnik & Salomo, 2015), corporate protection (McDermott & O'Connor, 2002) or secret skunkworks (Bessant et al., 2014).

Exploration can be successful: Using skunkworks represents an adequate option for large firms that seek disruptive technological developments. Developing a disruptive project is a challenge that motivates scientists, engineers, and knowledge workers, and these creative employees are happy to experiment and learn throughout the project (OECD, 2018; Dul & Ceylan, 2014). The organizational solution to meet the project's technological objectives entailed a small, secret, munificent satellite that granted autonomy at the job level and independence from day-to-day problems, along with support and protection from top management. This situation encouraged creativity and organizational learning (Dul & Ceylan, 2014)—a favorable organizational context in which to develop a disruptive technology.

Despite its effectiveness in terms of radical technological development, the satellite may be poorly aligned with the mainstream organization (like Robinson Crusoe's island with the mainland). Structural separation encourages radical innovation, but some structural integration is required to progress along the development process and support the adoption and commercialization. Hence, the exploration outcomes from the skunkworks could not be exploited by the mainstream organization. We show that it was those foundational characteristics of the skunkworks (secrecy, total autonomy, recognition of only general direction from headquarters) that created a "Robinson Crusoe effect" (Figure 1).

From a knowledge management perspective, two transfer problems are remarkable. First, because the technology transfer was done only at the end of the project, there was no proper coordination between the skunkworks and the mainstream organization. Second, Hybrid Air facilitated creativity and problem-solving, but these innovation skills developed at the skunkworks were not transferred to the mainstream organization.

6.2. Managerial implications

In terms of managerial decision-making, this case study offers important implications for organizational learning, innovation, strategy, and organizational design. A secret, munificent, small skunkworks satellite could offer a solution to the classic innovation–size dilemma. However, decision-makers must recognize its perils. In particular, the "Robinson Crusoe effect" could ruin the implementation phase and eliminate the potential for high returns. Managing a skunkworks can be extremely difficult, but it is also promising, in that we find all the advantages of a small satellite organization (project team) supported by the resources of a large organization. Furthermore, a secret project can protect the technological development from competitors, avoid internal pressures from the large organization, avoid a loss of reputation if it fails, and decide the appropriate moment to reveal the innovation, which can be especially relevant in relation to stakeholders. Overall, skunkworks may represent a good

solution, but managers should not expect more than exploration if the organization does not prepare for the "Robinson Crusoe effect." Strategies for reintegrating the skunkworks, its employees, and its outcomes into the mainstream organization should be established in advance. This finding provides a new insight on the conditions under which organizations might benefit from or be hindered by a particular exploration–exploitation balance and domain (Lavie et al., 2010).

7. Limitations and Further Research

Undertaking a deep, single-case study enables us to describe and inquire in detail, over a substantial period of time, about the motivation and effective role of secrecy for managing an ambitious exploration project, namely, the creation of a new satellite structure to undertake a radical technological development. However, this research method limits the generalizability of our findings. Continued research is required to find quantitative empirical evidence of the advantages and disadvantages of managing secrecy to achieve technological exploration in skunkworks. However, studying skunkworks is very difficult insofar as their characteristics compel researchers to examine imperfect data. In our case, the analysis of the process is a posteriori and informants remaining in the company were not completely free to talk—they asked us to respect their anonymity vis-a-vis their colleagues.

Future research could tackle the issue of knowledge transfer effectiveness in the context of skunkworks since, in this case study, we have pinpointed two knowledge transfer problems from the secret satellite structure to the mainstream organization: (1) technology transfer process and (2) individual and team-based creativity and problem-solving skills transfer.

Finally, this case study also raises important questions about human resources management in organizations that pursue ambidexterity. Further research should investigate issues linked to

the reintegration of people who have been part of a skunkworks back into an ordinary structure.

8. Conclusions

Our study indicates that skunkworks represent a useful organizational solution to manage exploration and to quickly and effectively transform inventions into patents and prototypes, in the same way a Robinson performs outstandingly well on his desert island. However, in our case study connections with the mainstream organization weakened as the project continued, and this growing distance became a problem when it came to exploitation. The mainstream organization could not implement the disruptive technological development nor integrate skunkworks employees back into their previous roles. The “Robinson Crusoe effect” thus emerged because secrecy, urgency, and the support of general management created a particular situation that constituted a barrier to the ambidexterity of the mainstream organization (Figure 1). Like Robinson, the skunkworks could not transfer the results of its exploration even if it helped disruptive technologies to emerge.

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Appendix 1: Some definitions of skunkworks

Source	Definition
Single & Spurgeon (1996, p. 39) No secrecy	**Method** of managing the innovation process, characterized by extremely efficient use of time by a small group of creative engineers
Gwynne (1997) No secrecy	'A skunk works is a protected and culturally antithetical **body** for the purpose of innovation' (Gwynne, 1997, p. 19). Small **groups** of scientists, engineers and other personnel who tackle specific problems and try to commercialize the solutions
Rogers (2003) No secrecy	It is an especially enriched **environment** that is intended to help a small group of individuals design a new idea by escaping routine organizational procedures. The Research and Development (R&D) workers in a skunkworks are usually specially selected, given special resources, and work on a crash basis to create an innovation
Brown (2004) No secrecy	A true Skunk works is an isolated and highly skilled **team** designed to accelerate the research, but especially the development of innovative product/ services. The team typically works outside the bounds of the parent's rules and regulations and under time pressure special teams of passionate intrapreneurs, who are isolated from the rest of their business, given resources and relatively free reign to innovate and develop.
Auerswald (2012) **Secrecy**	A **team** set apart from a larger organization and given license to work on its own terms. The protoypical Skunk Works was Lockheed Martin's Advanced Development Projects (ADP) unit, a **group** characterized by autonomy, secrecy, and an elite identity. Its unconventional approach not only yielded the design of the U-2 spy plane and other famed aircraft, it inspired hundreds of other companies to create, or at least to tolerate the creation of, similarly (un)structured innovation units.
Bommer et al. (2002) No secrecy	''Skunkworks'', a concept developed by Lockheed Martin, usually consist of a small hand-picked **team** that is formed and removed from the ongoing part of the business. The team is given complete responsibility and operates in an autonomous fashion for developing a new product or process. The major phases of the project are usually specified by the team, rather than by some bureaucratic authority. Thus, the team determines its major milestones and manages itself against those. The team is also given the freedom to determine its own procedures to accomplish its assigned mission, and is usually fully dedicated with control over its resources. In the skunkworks approach, the project management team was engaged early for customer collaboration and buy-in of concept development. Project goals were jointly determined and concurrence gained on the additional pre-engineering phase.
Fosturi & Ronde (2009) No secrecy	Skunk works **model of innovation**, which consists in isolating the team of researchers from the influence of the rest of the organization

A quick survey of available literature suggests that skunkworks projects are mainly R&D/innovation-related groups that feature some combination of the following

characteristics: general lack of management control or oversight, lack of formal rules and procedures that govern internal group processes, a relatively small group whose members display a high degree of passion for innovation, an emphasis on radical innovation, and a clear goal orientation. In defining the concept, many authors thus end up emphasizing just one of these characteristics but still seemingly capture the essence of what we mean by skunkworks (Bessant et al., 2014; Brown, 2004; Gwynne, 1997; Single & Spurgeon, 1996). However, the notion of secrecy, present in the original definition and project, is not provided in many definitions, as the skunkworks' concept has been enlarged.

Appendix 2 - Example of the coding scheme for the theme "functioning", the category "autonomy", and three codes "reporting", "control" and "decision making".

Themes	Categories	Codes	Illustrations	Sources
2.Functioning	2.2 Secret	(…)	(…)	(…)
	2.3 Top support	(…)	(…)	(…)
	2.4 Speed constrain	(…)	(…)	(…)
	2.5 Autonomy	2.51 Reporting	*But it was only concise reporting because it was impossible that the teams spend their time doing reporting.*	HA manager (a)
			We did not want the teams spending their time writing reports for the decision-makers, and we succeeded.	HA manager (a)
			The only thing expected by the top management was that the issues raised were resolved	HA engineer (c)
			(…)	
		2.52 Control	*There was no longer any hierarchy between Mokkadem and the R&D corporate director, whereas usually they were separated by two levels".*	HA chief R&D engineer
			There was not really a formal supervision, but instead a kind of comprehensive self-supervision was put in place.	HA manager (a)
			Beyond these slices of successive prototypes, about every 6 months, a complete self-control was put in place.	HA manager (b)
			The decisions were made by the skunk and the hierarchy was informed by Karim Mokkadem	HA manager (b)
			(…)	
		2.53 Decision making	*As soon as a problem had to be addressed, we stopped, and all available skills were focused on resolving the problem.*	HA engineer (b)
			This decisional autonomy is something that happens once in a career.	HA manager (a)
			This decision-making method has been very effective to solve problems.	HA manager (a)
			(…)	

Figure 1: The difficult transposition from exploration to exploitation