Title:

European satellite manufacturers, toward an open innovation culture?

By

Bruno CORDIER

Supervised by: Prof. Victor DOS SANTOS

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Table of Contents

Executive summary

For a long time, European satellite manufacturers didn't feel concerned by the disruption observed in B to C sectors such as transport or communication. They believed to be protected by their access to the large military and civil closed markets. They had confidence in their technological competitive advantage, guaranteed by their privileged relationships with public research entities and universities, as well as the granting of State and European strategic investment programmes. All those are characteristics of barriers to entry in this industry. However, world was changing fast, in particular by implementing new open way of doing innovation, while established satellite manufacturers were not evolving as fast.

Today, technology is increasingly expensive and newcomers from the digital world are knocking to the satellite market's doors with their disruptive ideas. In that context, should the established manufacturers adapt themselves to this growing competition by moving to an Open Innovation process? In particular evolving their corporate culture toward an Open corporate culture?

At first sight, the satellite market is flourishing and European manufacturers stand for a strong third share of the commercial markets. But the future is uncertain, as says Jean-Loïc Galle, Executive VP Space Thales "*with the digital transformation ongoing, it's impossible to precisely predict future markets*". Indeed, market is changing. Besides new entrants from emerging countries, "New space" digital entrepreneurs are entering in the business through the small satellites market and huge constellation projects. Since they have already disrupted the space launcher market, are they threatening now the established satellite manufacturers? No yet, but time is short… Prevailing players should transform themselves, by applying the methods of those entrepreneurs. Innovate in a more open way becomes a new imperative, like a mantra, to cope with risk of disruption. Therefore, both CEOs of Airbus group and Thales Alenia Space Open have decided to switch their innovation practices toward the Open Innovation paradigm.

This paradigm has been invented and popularized by Henri Chesbrough in 2003. This model states that none company has internally the necessary knowledge and technology to innovate for staying competitive. It adds that most of the ideas generated internally by a company cannot find a path to market, and therefore are lost on shelves. Consequently, to accelerate internal innovation and expand their market, companies should let ideas freely "fly in" and "fly out" across its boundaries. Chesbrough opposes his Open Innovation paradigm to the so-called Closed innovation paradigm, which reduces firms' capacity to innovate by constantly looking to keep the control on its ideas. By practicing outside-in and inside-out activities, open innovation adepts can achieve significant performances:

- Access to ideas, technology and competence not available internally,
- Reduce costs and financial risks,
- Monitor the risk of disruption in the market,
- Increase its market presence and value,
- Motivate R&D staff and attract new talents.

Wishing to implement Open Innovation, a CEO has to overcome some barriers within the internal organization's culture. First barrier could come from the Top management's mindset: Fear of the uncertainty, blindness, inertia, etc. The two other barriers are the ones Chesbrough calls "virus", the "Not Invented Hers" syndrome (NIH) and "Not Sold Here" syndrome (NSH).

NIH stands for the potential negative bias an employee can have toward the external knowledge and technology: lack of trust and control, risk, outside is second best after inside…, regarding outside-in (license-in, merge & acquisition, alliance, etc.). Only a long-lasting relationship between partners would enable an efficient share of knowledge and technology. It doesn't mean they have overcome their natural bias, they have only had time to build trust in each-others. In case of relationship with a new partner, this negative bias would reappear. It is described as the "Not Invented There" syndrome (NIT), expressing their reluctance to tie link with a new and unknown entity.

The NSH deals with the inability of the Business Unit for allowing a technology it has no use, to find a path to market through external channels (licensing out, spin-off, etc.). Underlying is the fear of losing control on the company's core competencies, lack of alignment with the business model, etc.

To overcome those cultural barriers, the company should act on its corporate culture to open it up. This journey to an open culture has managerial implications:

- involve top management,
- seed open innovation culture within the company by a mix of top-down and bottom-up approaches,
- overcome resistance of middle-management by supporting them and fostering openness,
- Support trust, ownership and accountability of staff,
- Incentivize and recognize open behaviors, dissuade the former ones,
- Use people recognized by their pairs for diffusing the open culture
- Accept a balanced expression of criticism within the organization,
- Simplify the procedures and foster communication among teams,
- Create a "relationship promotor" role among the organization for facilitating the communication between the partners,
- Develop a new approach for IP rights, tailored to the specificity of the relationship,
- Open-up to IP licensing for discovering new partners and increase the value of the market,
- Open to the risk acceptance, for discovering new business models and disruptive innovations,
- Use Public-Private Partnership for sharing risk and uncertainties.

Those managerial changes come along with the development of a talent management of employees. Performed by managers and human resources, it sets how the organization recruit, train, reward, retain and manage competence and skills of their R&D staff, their primary competitive advantage in an open innovation context:

- Recruit the right people, with the right mindset and a fit with the open culture of the company,
- Reward and incentivize system promoting open behaviors,
- Adapt career path to the cross-functional activity and reduce managerial career attractiveness,
- Manage the learning culture and employee's development and skills.

Measuring the cultural change is challenging. Looking at elements as the number of successful innovative projects or the feedback of open innovation initiatives like hackathon could be a first step. The cultural change could be assessed also by looking at how people react in their daily work: the measure of their engagement, accountability, and sense of ownership regarding open innovation.

Open innovation is the transformation of an internal culture, and the development of a process to encourage and promote innovation from every available sources. It's a work on progress, never ending.

Established satellite manufacturers have no choice, either change or be disrupted. It's a matter of time. Their CEOs have initiated the transformation and for achieving the journey, it will require managerial implications as well as a management of talents.

The environment is continuously changing and, since the digital transformation is not yet achieved in the industry, we could expect the Open Innovation's practices to evolve: a larger number of entities in the ecosystem and new means of interactions. Definitely, an open culture can help to cope with the future's uncertainty.

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Introduction

The manufacturing of satellites is a highly strategic activity for states. It is the foundation of space access. Without this ability to design and manufacture satellites, it is useless to have a space launcher. This industry is therefore different from others. The market is an oligopoly characterized by a small number of large manufacturers and customers. There are mainly two markets (sometimes they are mixed), one is the open commercial market, the other is the closed market dealing with civil and military uses. The latter is the larger one with a ratio of 1 to 12, roughly $70b vs. $5b worldwide (Euroconsult & Révillon, 2016). The closed market generates the largest share of revenue for manufacturers. With a market mostly driven by public and military expenditures, rather than commercial private spending, those established European manufacturers can feel protected from market disruption observed in other high-technological fields like transport or communication. They have confidence that their competitive advantage is guarantee by their ITAR-free technology, their knowledge and experience of space environment and satellite. They benefit of a privileged access to public research entities like CNES & ONERA or Universities, and are granted of research programmes through civil or military satellite orders and strategic investment like Europe Horizon 2020. All those are characteristics of very high barriers to entry in this industry.

However, the drawback of entities protected from direct competition is, while the world around is changing fast with the digitalization and openness practices, they didn't evolve as fast. Satellite manufacturers were focus on their customers 'needs and on their own market. Today, technology is increasingly expensive and newcomers from the digital world are knocking to the satellite market's doors with their disruptive ideas. In that context should the established manufacturers adapt themselves to this growing competition by making their innovation process more open? In particular evolving their corporate culture toward an Open corporate culture?

This work adopts a descriptive methodology and is based on primary and secondary sources.

After an outlook on the satellite market, we analyze some of the uncertainties that lead European satellite manufacturers to change their current innovation process toward Open Innovation. Then, describing shortly the Open Innovation principles and its advantages, we explain how corporate culture is the key for overcoming its barriers. Last, we stress an open corporate culture.

1. Open Innovation to cope with risk of disruption

1.1. Satellite market

1.1.1. Outlook

Space equipments

The market presents a wide kind of satellites of different classes and uses. Satellite are differentiated by their characteristics:

- Use: Civil, Military and Commercial,
- Application: Communications, Earth Observation, Navigation, Science, etc.
- Orbit platform: GEO, LEO,
- Class of weight: Nanosat for up to 10 kg, Minisat <500 Kg, large satellite and above 1000 kg, extra-large satellite.

They can have different uses: military, civil or commercial use. A satellite can be single/ dual or triple use (e.g. dual: civil and military use).

Current players

Historically, the strategic development of satellite manufacturers were mainly carried out by the USA, Russia and Europe. Those three regions still today present the largest part of satellite manufacturer locations:

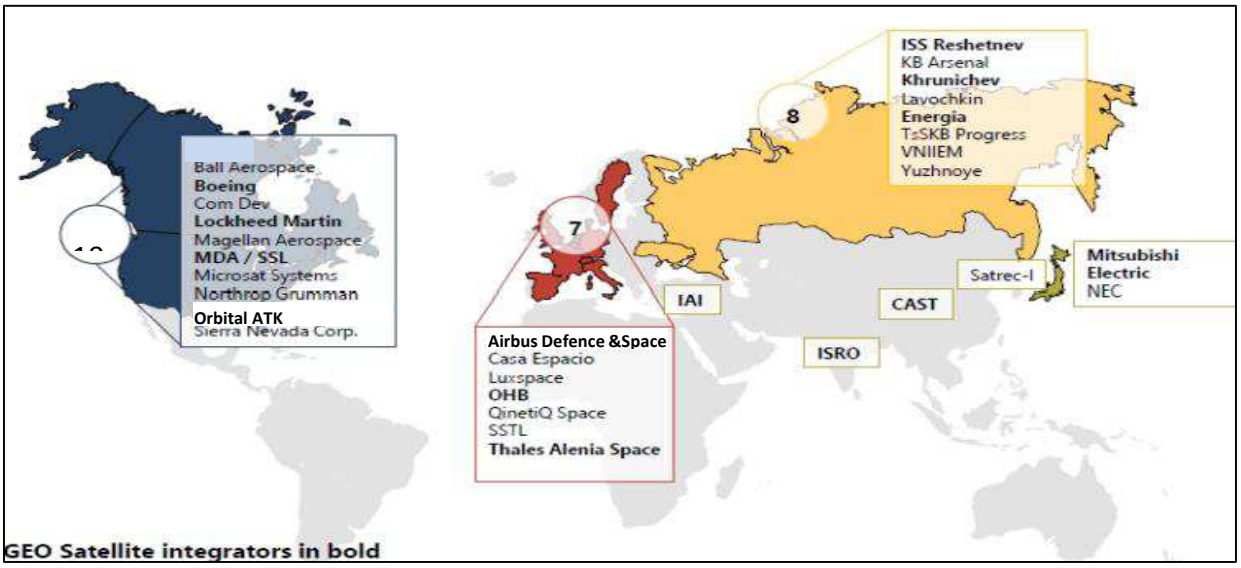


Figure 1: World Map of satellite integrators (Euroconsult, 2015)

Among all those satellite manufacturers, there is an oligopoly of seven main players that manufacture large, commercial, geosynchronous satellite platforms:

Table 1: List of the main satellite manufacturers worldwide

Airbus Defence and Space (Airbus D&S)
•Europe (France/ Germany/ Spain/ United Kingdom)
Thales Alenia Space (TAS)
•Europe (France/ Italy/ United Kingdom/ Spain/ Belgium/ Germany/ Poland)
JSC Information Satellite Systems (ISS)
•Russia
Boeing Defense, Space & Securit
•United States
Lockheed Martin
•United States
Orbital ATK
•United States, merging of ATK and Orbital science (OSC)
Space Systems/ Loral (SSL)
•United States, owned by MDA a Canadian company

State of the market

In the last decade, the market has slightly increased, mainly thanks to civil orders. Governement has launched almost half of the quantity for civil use and a quarter for military purpose. Commercial stands for only a third, mostly for telecomunication. On the commercial market, Europe represents one third of the value, behind US with more than 50% of value of the $31 billion market.

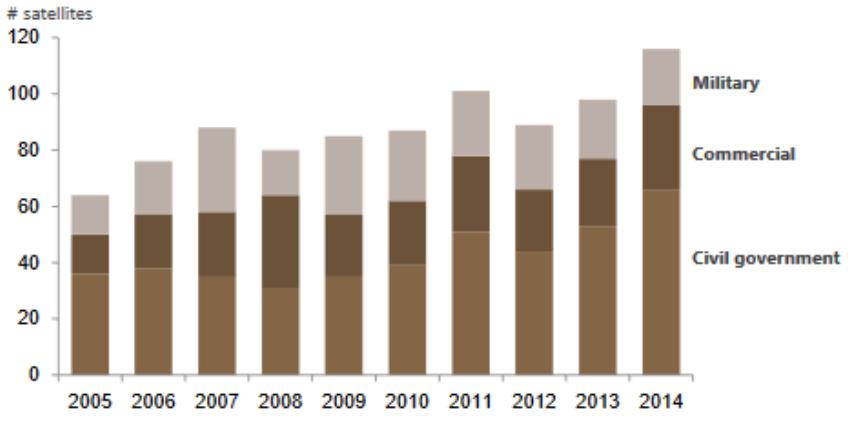


Figure 2: # of Satellites launched 2005-2014 per use (Euroconsult, 2015)

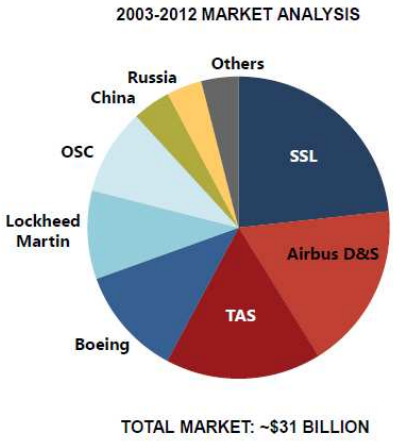
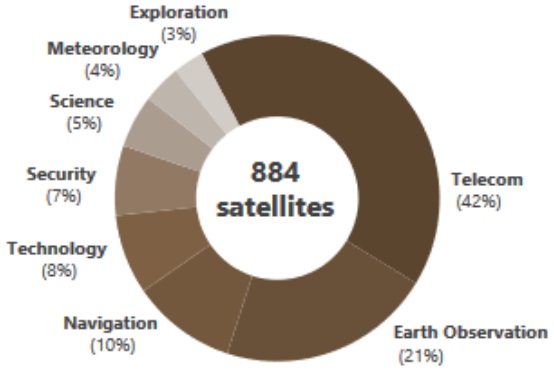


Figure 3: Market Shares for commercial satellites (Euroconsult & Révillon, 2016)



Regarding applications, two third of satellites are used for telecommunication and earth observation.

Figure 4: # of Satellites launched 2005-2014 per application (Euroconsult, 2015)

1.1.2. Trends

An increasing market driven by emerging countries and constellations

According Euroconsult (Euroconsult, 2015), the satellite market is expected to grow by +18% over the next decade, attaining 140 satellites per year on average for both commercial and civil uses (excluding large constellations of satellites).

The civil market is expected to generate $185 billion of revenue, mostly concentrated in the hands of the established satellite manufacturers.

The commercial share will rise to 40% thanks to ten constellations for communication and Earth observation. Civilian use will increase as well with a higher demand from emerging countries.

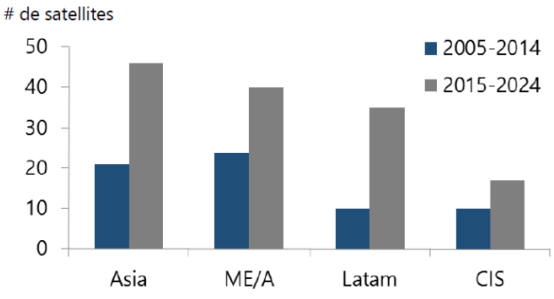


Figure 5: Civil use satellites to be launched in emerging countries (Euroconsult & Révillon, 2016)

Besides this market for large satellites, the next decade will see a jump of +75% of the market value of mini-satellites (< 500kg) driven by the different constellation projects for broadband communication (OneWeb: 648 satellites, Steam: 4000 satellites and Leosat: 120 satellites).

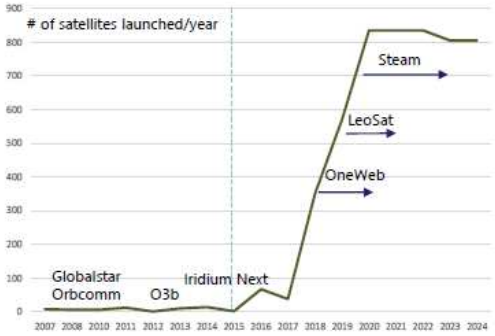


Figure 6: One scenario of deployment of the different constellations (Euroconsult & Révillon, 2016)

Although market forecasts show a positive growth for the next decade, satellite demand stays uncertain in the long term, especially for the commercial market (Euroconsult, 2015). As well is the competition between players. Talking about European satellite manufacturers, Laurent Collet-Billon from DGA says "*In this sector of civilian communications satellites, their main market, the competition is not national or even European, it is global. Competition […] will soon be extended to Chinese players, Indian...*" In addition, according Jean Loïc Galle, Executive VP Space Thales "*with the digital transformation ongoing, it's impossible to precisely predict future markets*" (Galle, 2016).

1.2. Change the way of doing innovation

1.2.1. Factors driving the change

Emerging Players and disruption

Market is changing, emerging countries have an increasing need of satellites but, as says François Auque CEO of ASL "*in consistency with their economy*", i.e. at low cost. Besides the newcomers from emerging countries, competition is taking new dimensions with the players coming from the digital world.

Industrial companies have observed the digital transformation disrupting most of the B to C sectors like transportation, banking, telecommunication, etc. They thought being protected by the higher capital intensive value chain of their BtoBtoC business. Today, this is less and less the case. In the space launcher industry, the revolution has started with SpaceX. Satellite manufacturers could feel still protected by the "space" knowledge required for succeeding in their business. But it's a question of time.

This so-called "New space" is entering in this sector starting from scratch. Those entrepreneurs try to rethink and simplify the whole satellite, system and components. They have an ability to think differently, to apply a holistic approach and a proven management culture coming from the High-Tech sector. Those strengths give them the agility and mindset of a start-up for innovate with the aim of reducing dramatically the costs of access to satellites. Those new entrants are, for the moment, focused on the market of small satellites, e.g. ThrustMe in the propulsion system, Open Cosmos offering comprehensive low-cost access to space, SpaceX planning to launch a large constellation of mini satellites. Miniaturization of satellites and the use of COTS as well as the economy of scale enabled by large constellations, has opened up and democratized the access to space. We will not wait long before seeing them posing a threat to the established manufacturers (Systems/Loral, s.d.). Their digital culture enables them to decide and act differently from the established actors (Dordain, 2016).

GAFA are investing satellite for their business and the use of Space Data, e.g. hardly all of UE Copernicus data users are GAFA. Satellite manufacturing market presents new opportunities created by, according Carolyn Belle NSR Senior Analyst, "*growth in end user applications, fueled by constant connectivity requirements, Big Data, and strained security environments*" (NSR, 2016). The small satellites, used in mega constellations of tens to hundreds, are the future of those applications and source of synergies with others sectors.

To succeed, established manufacturers need to start thinking and managing like their entrepreneurial competitors. They have strengths and experience that a newcomer lacks. This is one of the reasons explaining the success of Airbus D&S regarding the OneWeb bid. And what about the numbers of startups knocking at the door of established space equipment manufacturers?

But, as says Jean Loïc Galle, Executive VP Space of Thales, "*Space sector is conservative. A satellite couldn't be repaired in space, quality and reliability are key success factors*" (Galle, 2016). The competitive advantage giving the quality and reliability is therefore to have internally a superior technology, e.g. the adoption of HTS and electric propulsion –which increases the on-orbit capacity – are the latest radical innovation in the sector. Competition for lowering the cost of satellites has led to civil entities like ESA to finance innovation programmes like Neosat whose objective is to reduce cost of satellite in orbit by 30% for the telecommunication market (Anon., 2016).

New entrants will leave no other alternative for established players than either failing or adapting themselves.

The whole value chain can be disrupted

Besides being disrupted upstream in the space equipment and transportation, the satellite value chain is also disrupted downstream. Buyers of large commercial communication satellites are facing increasing competition from alternative technologies such as fiber and wireless. In addition, the close future will see ideas for providing Internet connectivity in remote geographic areas, such as high-altitude drones and balloons operating in the stratosphere, becoming reality. Such example could be illustrated by the project of Facebook of connecting African countries to internet with drones…

Big data can disrupt satellite use as well e.g. for Weather forecast, the idea of using the weather data generated by flying aircraft for getting a precise local weather forecast.

Those innovations are disrupting the satellite and space data value chain at a local scope, not a global one. According to Jean Loïc Galle, "*Today space data have less and less value alone but are still highly valuable in combination with others source coming from those disruption innovation such as drone observation*" (Galle, 2016).

1.2.2. Toward Open Innovation

Management of technology is changing

In the technology development, things are going faster and faster. The digitalization has shorten innovation cycle in such a way that it reconfigures the whole value chain. No company today is able to produce internally all the knowledge and technology needed for a breakthrough or disruptive innovation. Technology has become global (PAUL TROTT; DAP HARTMANN, 2009) and is more and more complex, needing deep knowledge of different fields, not solely in companies' core competencies.

External pressures from the market and shareholders

In the same time, to keep ahead of the competition, companies should reduce their time to market by reducing product development cycle time. Looking at the success of the digital sector, space industry is looking with interest at their way of doing innovation.

Consequently, financial market and shareholders are getting access to the board of directors for pushing innovation at the strategic agenda of the company.

Internal factors

Internally, factors like having an innovation driven CEO or a newly elected CEO, could sometimes be the signal to change. In parallel employees are daily exposed to the digital transformation of the company, and experience at home quantity of disruptive innovations through the social network, the telecommunication, transport, etc. There is therefore a kind of readiness of employees for embracing the change for a new way of innovating.

An imperative to innovate in a more open way

A survey was held by AT. Kearney for European innovation Management Academy to a sample of executive managers from large industrial groups (See Annex 1). This survey highlights that managers expect an increase of revenues from their innovations activities .Those activities are becoming more

and more global and collaborative with an increasing numbers of partners. More and more, large groups will collaborate with SMEs, start-ups, research institutes and academia. They think also that their current innovation structure is not adapted to this change (WIPO, 2016) and therefore should evolve in the nearby future. As said John Rakow, former senior vice president for business and legal affairs at Space Loral: "*the established manufacturers already have the talent necessary to innovate. They simply need to have the […] cultural environment to set them free*" (Systems/Loral, s.d.).

This is what open innovation is about. Henry CHESBROUGH invented the Open innovation paradigm in 2003. He has been very successful in popularizing the notion of technology transfer and the need to share and exchange knowledge. This concept, by its simplicity and by opposing two innovation paradigms, the closed and the open one, has reached new audiences like CEOs of technology-intensive companies.

Open innovation is now the mantra of Space companies all over the world. Airbus Group has recently appointed Paul Eremenkoa as CTO. He was formerly heading Airbus' A3 Innovation Centre and worked at Google, Motorola and DARPA. TAS has created an innovation cluster within its organization, with Open Manager role. The boards of directors have given the signal that it is imperative to innovate in a more open way.

1.3. Open Innovation concept

The innovation model in the 90s was a user-centered approach model. In this model, the Lead-users, customers and suppliers are integrated in the innovation process. This model has evolved to an ecosystem of innovation process: collaborative projects and alliances, enabled by the digitalization that allows real time collaboration between various entities.

1.3.1. Description

Open Innovation is about integrating different resources and capabilities that originate from a variety of internal and external sources. Innovation is less and less performed in-house, in a closed and integrated way. It becomes more "open", involving many external actors in the different steps of the innovation process (Hussler & Burger-Helmchen, 2011).

Outside-in and inside –out knowledge

Henri Chesbrough says that to stay competitive companies should "*use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. Open Innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology*" (CHESBROUGH, et al., 2006). In the Open Innovation model, ideas (technologies and knowledges) can freely "fly in" and "fly out" of the funnel that runs from ideation to

market. In comparison, in the closed model the company can only innovate with the technology and knowledge it controls. A successful innovation can only come from its own ideas.

This could be visualized by a funnel containing holes. Those holes illustrate that exchange of ideas is done all along the way. However, the innovation trajectory is linear.

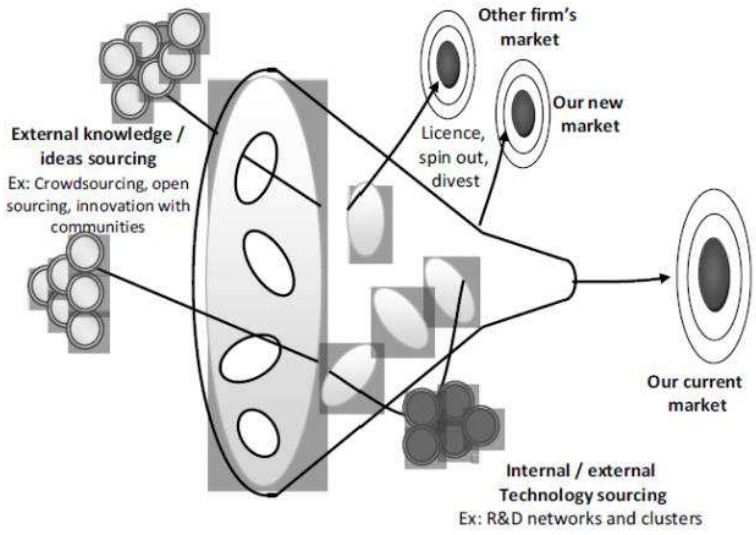


Figure 7: The open innovation funnel (Hussler & Burger-Helmchen, 2011)

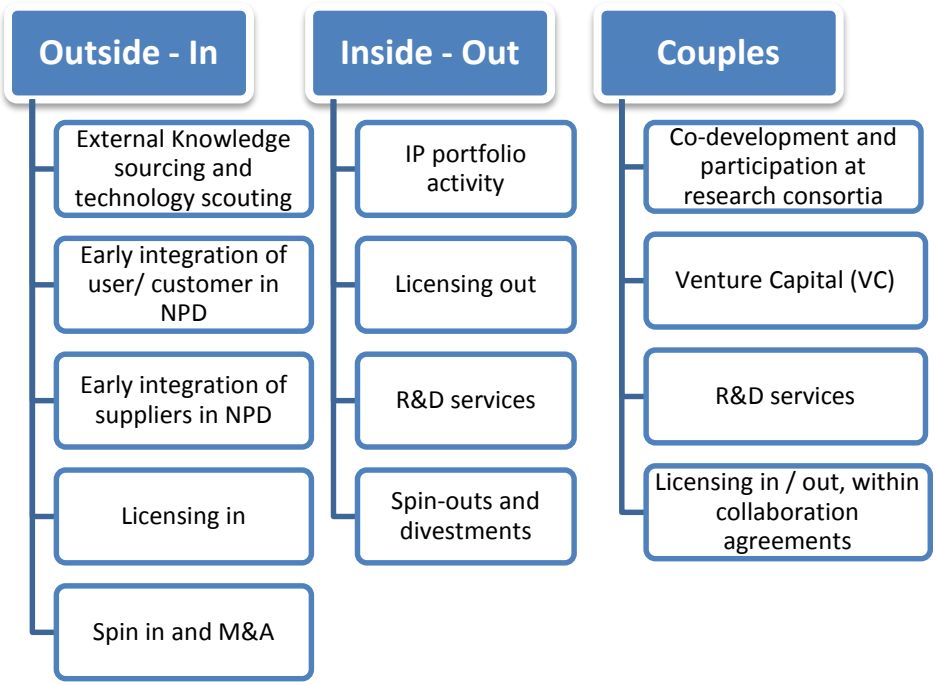
In the closed innovation paradigm (see table 2), companies must generate their own ideas and then develop them, build them, market them, distribute them, service them, finance them and support them on their own. This paradigm counsels firms to be strongly self-reliant, because one cannot be sure of the quality, availability, and capability of others' ideas: "*If you want something done right, you've got to do it yourself*" (Chesbrough, 2003). To the contrary, the Open innovation principles start from the idea that a company has not all the needed knowledge for innovating but states that this knowledge is may be available outside the boarders of the company. It therefore an advantage to be able to integrate it, at a lower cost and quicker than if the company was expected to develop it. Open innovation practice are facilitated by the use of ICT.

Table 2: "closed innovation" principles and "Open innovation" principles (Chesbrough, 2003)

Closed innovation principles	Open innovation principles
•The smart people in our field work for us •To profit from R&D, we must discover, develop, produce and ship it ourselves •If we discover it ourselves, we will get it to market first •If we are the first to commercialize an innovation, we will win •If we create the most and best ideas in the industry, we will win •We should control our intellectual property (IP) so that our competitors do not profit from our ideas	•Not all of the smart people work for us so we must find and tap into the knowledge and expertise of bright individuals outside our company •External R&D can create significant value; internal R&D is needed to claim some portion of that value •We don't have to originate the research in order to profit from it •Building a better business model is better than getting to market first •If we make the best use of internal and external ideas, we will win •We should profit from others' use of our IP and we should buy others' IP whenever it advances our own business model

In addition to the two unidirectional flows outside-in and inside-out, knowledge flow could be coupled when doing a collaboration on a technology development for instance.

Table 3: Associated activities within Open Innovation core processes (Fabiano Armellini, Catherine Beaudry, Paulo Carlos, 2015)



1.3.2. Why would satellite manufacturers use Open Innovation?

Collaboration is not new in this sector

Chesbrough presents the open innovation paradigm by opposing it to the apparently old paradigm of closed innovation, even if most of the principles were already implemented many years ago by companies, e.g. bilateral (or multilateral) collaborations, external knowledge scouting, IP licensing, etc. But it allows to encourage and simulate all those companies to continue (PAUL TROTT; DAP HARTMANN, 2009). In space sector, alliances and cooperation are quite common.

The best examples are satellite manufacturers themselves, historically formed from merges and acquisitions of different companies e.g. TAS is a Joint Venture between Thales and formerly Alenia (now Leonardo), Airbus D&S is a merge between Aerospatiale, Matra, etc. Collaboration with university, public space research entity like ESA, Onera and CNES is active since the beginning of space program. Public programmes for innovation like program H2020 lead to build consortium of companies working together, like the NEO platform (Anon., 2016). But, whatever the knowledge relationship, keeping the control over its technology is critical for actors of this industry.

Benefits of using OI

Among all the benefits and strategic values a company can get from deploying OI, we can list the following main advantages (Letizia Mortara, Johann Jakob Napp, Imke Slacik and Tim Minshall, 2009)

and associated practices (Giorgio Petroni , Karen Venturini & Chiara Verbano, 2011). When looking at this figure, we can observe the large number of outside-in activities and the absence of inside-out activities. Satellite manufacturers are usually fond of getting the external knowledge or technology they need but reluctant to share with others their core competencies.

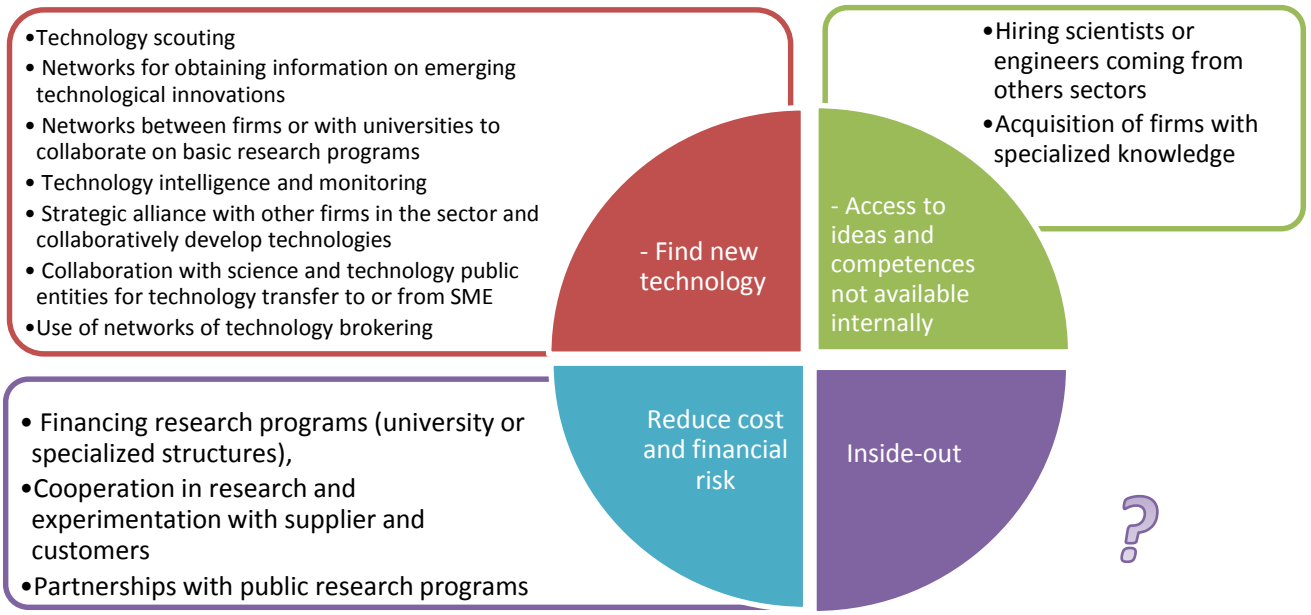


Figure 8: Typical Open Innovation advantage and practices observed on space equipment companies (Giorgio Petroni , Karen Venturini & Chiara Verbano, 2011)

Indeed, licensing-in new technologies can accelerate the new product development of a company. Depending solely on internal R&D resources would lead to loss opportunities as well as spending more time and money to re-invent a technology existing outside, with a risk to obtain a lower performance and quality.

By opening their boundaries for collaboration and accessing new technology without having paid the development cost, neither the research and ideation activities expenditures (considering at minima a ratio of ten research projects to one project actually developed), we can assume a company would do a lot of savings on its R&D activity. But, when looking closer to the licensing-in costs, the higher transactional costs (see appendix 2), it seems that the benefits is not so high, especially when coopering with a new relationship. Having a longer relationship with an external entity allows a reduction of transactional costs, since the partners have learnt to work together in an efficient manner.

The development of scouting activities adds a broad horizontal knowledge to R&D engineers. Thus, added to their initial deep skill in their initial area of expertise, they develop a “T-shaped competence” (Tobias C Larsson; Isaksson Ola; Vinit Parida; Pejvak Oghazi, 2011). By working in conjunction with employees of external entities, they tend also to develop their interpersonal skills which could then benefit the whole organization.

Open innovation allows also to stop adhering to the dominant technology the industry has created by incremental innovations (Foray, 2002) from its creation and on witch all companies are converging (standardization, industry norms, etc.). This convergence makes actors unable to see the real innovation that can revolutionize the sector. According Larry Page, co-founder of Google, companies decay slowly over time because "*They tend to do approximately what they did before, with a few minor changes. [….] incremental improvement is guaranteed to be obsolete over time*".

2. Cultural barriers to Open Innovation

People and organizational culture are the most important factor increasing innovativeness (SZYMAŃSKA, 2016). Along with support from top management and structural change, the creation of an OI culture is a key enabler for Open Innovation. It's also, in the same time, one of the main obstacle to its implementation (Letizia Mortara, Johann Jakob Napp, Imke Slacik and Tim Minshall, 2009).

2.1. Corporate culture

2.1.1. What is corporate culture?

The definition of what is corporate culture is not easy. It could be described as the identity of a group in what its members share in common: values, norms, attitudes, artifacts and behavior patterns. (Herzog, 2011). Artifacts include any tangible and identifiable elements in an organization such as furniture, dress code, traditions, corporate rules for travel, office in open space or not…. They are the visible elements of the company culture that can be identified by people from outside of the firm. Behavior patterns are usually unconscious for people within the organization. Values and norms deals with how do members represent their organization to themselves as well as to others, like a slogan, a vision, a value of how should act members of the organization, etc. (see Figure 10).

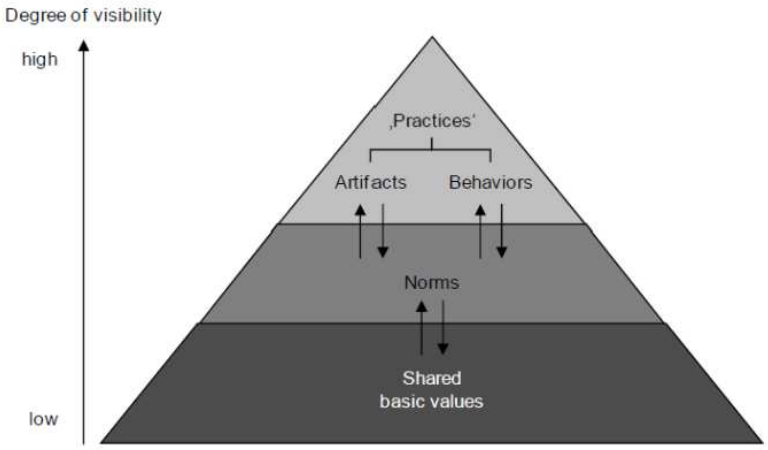


Figure 9: Levels of corporate culture (Herzog, 2011)

Organization culture has two aspects, one is something the organization has, and the other is something the organization is.

The first aspect can be manageable directly and therefore can be aligned with corporate strategy. For instance, select from outside members presenting the appropriate culture the management is seeking for, or act on norms, practices and values of the organization. The second aspect of organization culture deals with more with symbol and unconscious process on which management has not direct impact. (Herzog, 2011)

The corporate culture, the culture a company is pushing in its workplace, promotes a certain kinds of behaviors in the organization (SZYMAŃSKA, 2016). It is also expressed by routines, procedures, rules and practices. All this part of company culture used for structuring and organizing the work. When Edgar H. Schein is defining the culture as the *"pattern of shared basic assumption that the group learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems*" (Schein, 2010), he makes clear the conservative function of the corporate culture. Indeed, this function is to learn lesson from the past, in order to prevent an issue or a dysfunction to occur again in the organization. It allows to capitalize it in the procedures and rules. This structuring role becomes a barrier when it's question to change. It could fail any innovation that would be perceived as against it, while the reason at its origin has vanished or is not justified anymore (Foray, 2002).

Therefore the culture of a company could be a constraint and a barrier to the implementation of the Open Innovation. Before acting on the corporate culture for supporting the change, the Top Management should first remove its own barriers. Then they would be able to face the two other cultural barriers. The ones Chesbrough calls "virus": the "not invented here" (NIH) and "not sold here" (NSH) syndromes (Chesbrough, 2003).

By shifting to open innovation, and in a similar way as implementing an innovation, there is value destruction. Previous culture (norms, behavior, etc.), some competencies, practices, some tools, systems… become obsolete and useless (Foray, 2002). It is therefore necessary to rid-off them for preventing any interference or nostalgia.

2.2. Barriers from the Top Management

The difficulty to change a large organization often comes from the way its management work and think. It can be caused by:

- The lack of diversity: when all managers have the same profile (e.g. engineer), same professional culture and issued from the same kind of schools, they tend to have the same idea, the same background of reference and then develop a kind of auto-censure,
- The success of the company: as long as results are not catastrophic, the need of change is not perceived by the direction,
- The fear of uncertainty: manager may feel that the uncertainty brought by an innovation can destabilize the company's organization or strategy,
- Inertia of the organization, resistance to change from the organization, from members of the top management but also from the middle management.

The CEO should therefore carefully plan and adapt his actions to those constraints, in order to get a supportive management. As innovation is linked to uncertainty, implementing a new innovation process requires an ability to manage uncertainty and risk (Romelaer, 2002).

2.3. NIH syndrome

The not-invented-here (NIH) syndrome is connected to a lack of trust in knowledge or technologies coming from outside the organization. Since they cannot control the external knowledge or technologies, members of the organization could not be sure of their quality, performance, and availability (Chesbrough, 2003). It's a negative bias. It is deeply integrated in the behavior of members of the company who view internal knowledge or technologies as superior to the ones existing outside the company.

Table 4 lists the main causes of viewing external ideas and technologies as a threat rather than a chance:

Table 4: Main causes explaining NIH syndrome (Herzog, 2011)& (Chesbrough, 2003)

(Letizia Mortara, Johann Jakob Napp, Imke Slacik and Tim Minshall, 2009)

Fear
• Lack of trust • Negative or no experience use of external technology • Knowledge leakage • Lack of controlgreater dependence on a partner's ability to provide the expected technology's quality, performance, and availability • It reduces the work load of their colleagues and justify potential reduction of internal resources, • It reduces the frontline role of internal researchers in the innovation process • An attitude of xenophobia: it's different from us
Outside is second best
• Innovation success has been achieved in the past without using external technology, it will be sufficient for future innovation success to rely only on internal technology • A team may think to be the best in their area of specialization, due to recent or long record of commercial successes • An incentive system that focuses on and strongly rewards internal technological development • Lack of time to evaluate external technology and assess risks. • Need to manage risk in R&D project: less time • External source: more risk perceived, need effort to translate and integrate its knowledge, • An exaggeration of the potential on internal knowledge and idea • A less obvious fit of external knowledge with the company's needs

Those concerns may be valid or resulting of the cultural bias. Therefore, a clear balance between the potential benefits against risks should be performed in regard on the sole business objectives. When

coming from a cultural bias, it could be just the consequence of the degree of comfort the management has with a given technology (Joe Tidd and John Bessant, 2009). It's a question of familiarity with the use of a technology or the confidence that the company can succeed in developing a new technology.

This point is key for satellite sector, since in space a satellite cannot be repaired, quality and reliability are the first requirement for technology. The NIH syndrome is therefore very strong in the domain of their core competencies. This said, they are more open in new technology that are not in that domain, e.g. for the manufacturing process or the digital transformation of the company such as Factory 4.0 initiatives.

NIH and collaboration with SMEs and startups

A particular aspect should be noticed regarding the collaboration between a large company and a small one. The large one could find unsure a relation with a new SME. Since it would require several years of collaborative working, it is not sure the SME would keep its financial health and stability during all this period of time. Therefore the large company could be tempted to acquire the small one, for reducing the risk. (Tobias C Larsson; Isaksson Ola; Vinit Parida; Pejvak Oghazi, 2011). Acquisition is one kind of outside-in activity. In the knowledge based economy, it is frequent for large manufacturing firms to acquire small successful startups (Hussler & Burger-Helmchen, 2011). But cultural barriers could remain. Large companies are less agile than startups or SMEs, they take longer time to decide and act.

There is often a multiplication of contacts in large company, heritage of the scientific work division: each employee has a specific task or responsibility whereas employee of SMEs have a larger scope of responsibility. As a result, the ability to build trust between the two entities is a key factor for overcoming cultural barriers or difficulties. In the relationship between a large company and a SME/ startups, it is crucial to respect an equilibrium. The large company should take attention to not exerting a too asymmetric influence, due of the difference of size, regarding financial support and co-creation process (Accenture, 2015).

However trust is already existing when a large company is working with a well-known partner. Both partners have learnt to work efficiently together with a mutual understanding. In this case, and in an analogy to the NIH syndrome, the "Not Invented There" (NIT) syndrome refers to the difficulty of working with a new partner when a company has established relationships with others (Letizia Mortara, Johann Jakob Napp, Imke Slacik and Tim Minshall, 2009).

Satellite manufacturers have usually long lasting relationships with SMEs. However administrative tasks and workload of R&D staff has led TAS to involve the purchasing department for interfacing between them and SMEs. In addition, a specific program is implemented to help for building trust and confidence between the two entities. Similarly, collaboration with startups is held by the innovation cluster. It interfaces between TAS' R&D and the startups, making smoother the relationship between the two asymmetric entities.

If NIH and NIT syndromes regard negative attitudes towards external technology sourcing, firms may also have negative attitudes towards the external commercialization and use of their own technologies.

2.4. NSH syndrome

For this business counterpart to the R&D NIH syndrome, CHESBROUGH refers to the expression "*not-sold-here (NSH) syndrome*". NSH syndrome refers to an attitude of a Business Unit to refuse to commercialize a technology that doesn't fit the business strategy or business model and therefore cannot be valued in a new product development. By doing so, Business Unit condemns this technology to be stored on shelves instead of being valued outside the company. As "*If we're not selling it in our own sales channels, we won't let anyone else sell it either*" (Chesbrough, 2003).

There are two main reasons explaining this behavior. First, management fear to lose control on their core competencies. They believe it could create or strength competitors by allowing them to use their technology (Chesbrough, 2003). Secondly, they may judge that it's not aligned with their business model. Or that it's not in their priority to sell their own technology. Indeed, it requires at the beginning to invest time and money as well as to get specific resources for the challenging management of Intellectual Property rights (IP). Managers need to get a specific mindset to see the potential value of this treasure.

In the space industry we have the opposite cases. For instance, one is a Joint-Venture and has based its IP on a protective purpose. Selling outside its technology is not considered at all. The other belongs to a large aeronautic group that has initiated an IP market for years, with a dedicated team and website, but at the group level. The aeronautic sector has engaged the open innovation transformation sooner than the space sector. Being part of that such group is therefore an advantage since any solution to a threat identified in one market, e.g. aircraft, could benefit to the other divisions of the group. That said, even if the system is implemented at the group level, having the complete conversion of the space division's middle management is an issue. Externalize its technology is still a challenge for space industry, especially when it deals with defence companies who are wary of information leak.

However, selling its own technologies to third parties via an alliance, a spin-off with or without venture, or a license could benefit to the company, among those benefits of inside-out, we can find:

Table 5: Potential benefits of inside-out activity (Chesbrough, 2003) (Chesbrough, 2006)

Market presence	• The firm may be able to set industry standards based on its own technologies • Licensing allows to get a feedback from the market • Find a business model unlocking latent value from a technology
Financial	• Gain access to external technology, for example via bi-directional technology transfer and therefore reduce the investment for developing costly technology • Can improve the return on investment of R&D costs by selling license • Value can be captured by the BM built around the licensed technology
Employee motivation	• Improve motivation of their R&D staff to generate new idea and technology (instead of discouraging them by keeping on shelves their idea and considering them not valuable) • Aligning incentives for greater use of ideas receiving credit from licensed revenues • Improve company's reputation and attractiveness to potential talents

One of the main fear of open innovation is the potential danger of knowledge leakage, this is the information sharing/knowledge loss dilemma. Being open to knowledge sharing with their partner organizations raises an increasing awareness to the risk of leakage of commercially sensitive knowledge.

In addition to the fear of losing control or being stolen of core competencies, one reason of NSH syndrome could be solely that the innovation is not linked to the company's core competency or aligned to the company's business model. The assessment of the potential of the technology could be biased by the business model of the company. As a result management could undervalues it and not senses its underlying potential. This can also challenge the relationship between R&D and Business Unit, since the budget of the first is considered as a cost center for the last (Chesbrough, 2006).

Inside-out is a critical issue for space industry, especially since it is mostly founded by public money. In a context of lower budget, it's politically and strategically interesting to show how non-space sectors could benefit from the large investment made in space technology, through technology transfers.

For instance ESA has a team of brokers in charge of transferring space technology developed through ESA funding to non-space sectors. It relies also on "ESA BIC" –Business Incubation Center-, a network of accelerator of startups using space technologies for non-space uses. CNES has also initiated a promotion of its patents towards non-space sectors, as well as an open contest initiative, "Act In Space", sponsored by space equipment manufacturers like Airbus D&S, whom objective is to promote space technology transfer to startups on thematic linked to social responsibilities. R&D staff involved in those initiatives can, in addition of working with people having different background and feeling valorized by seeing their idea re-used with success in other industries, open their mind and help them to think out of the –traditional space- box…

Therefore, if the company has an effective business model for the technology, then the business unit should fund its development to the market. Else, either the firm can chose to extend its market if it has

the resources for -e.g. TAS with the Stratobus autonomous stratospheric airship-, either the company can license or partner through a Joint-venture with an external company that market the technology. In any case, the new technology value is recognized and recompensed.

Another argument against NSH syndrome is the fast pace environment of innovation. In this context, competitors will find sooner or later a similar or better technology (Chesbrough, 2003). Thus, the technology the company refuses to externalize could be quickly obsolete and the organization would lose all the investments made. And to reduce transaction cost, company can use or create (as doing by Airbus group) markets for technology on which they can trade technology and knowledge. As an illustration of the growth of the open innovation phenomenon, the number of licensing agreements is bursting worldwide and this trend is likely to continue (Hussler & Burger-Helmchen, 2011).

In space industry, it seems that scientific and public entities are more committed in the outbound flow than private companies. In those companies we can find both strong NIH and NSH syndromes, with the latter even more evident Chesbrough stated in 2006 that among worldwide companies, "*75% to 95% of patented technology simply lie*" (Chesbrough, 2006).

This could lead to an imbalance between inbound and outbound open innovation flows. However, both are needed to fully exploit its potential. A way to address this issue could be to set a relationship governance structure and management instruments or to do a tradeoff on the level of knowledge sharing the company is ready to have in alliance activities (Herzog, 2011).

In technology intensive company such as satellite manufacturers, technology orientation can be considered as a cultural aspect by itself, leading R&D to be more innovative "technology push rather than "market pull". Increasing the collaboration between Marketing and R&D would improve the alignment of R&D innovation outputs with the Business Model of the company.

3. To an open corporate culture

Open Innovation requires a more open and more collaborative corporate culture: co design with customers/ idea conquest, collective intelligence, entrepreneurship… People should learn to think « Open » by default instead of « closed » a priori in their daily work. A culture that mobilizes the collective intelligence of all stakeholders of the enterprise's ecosystem at the service of its innovation process (Duval, 2016). Open innovation culture is first an innovation culture, they therefore share some characteristics. The main differences between open and closed innovation culture are about the capacity to overcome NIH, NSH and risk adverse behaviors. Achieving an open corporate culture implies of course some changes on the way the company is managed. It leads as well to accept to consider risk and to have a new eyes on the Human Resources.

3.1. Managerial implications

3.1.1. Involvement of the Top management

Changing to an Open innovation culture requires a direct involvement of the Top Management. This Top-down initiative is needed to give to all employees the signal of the change of culture. It's a starting

point for the organization. It is therefore, officially promoted to work with external entities in a wider volume and in a more open way than what was done until now.

3.1.2. Seeding the Open Innovation culture

Next is to seed the Open innovation culture within the whole company, and in each subculture of different departments, sites or even teams. The idea is to find ways to make those cultures and subcultures supporting the open innovation process: explaining the "Why" before the "How", communicating a lot and relying deeply on volunteering. It could be performed by setting a specific team in charge of seeding OI in the company's culture in a kind of Top-down approach (Herzog, 2011), or by inspiring a bottom-up approach or a mix of both of them.

TAS proceeds in such way. It has implemented an innovation cluster (Top management signal), in charge of innovative projects, combined with an internal network of innovation referents in charge of seeding innovation culture in the daily work of the R&D staff. Innovation is therefore everywhere. Innovation is incarnated by the Top management and the innovation department has only a role of facilitator.

Culture change is a major issue in the implementation of OI. It means usually doing things differently, sometimes in direct contradiction to behavior that was allowed and accepted before. As seen, changing those behavior patterns requires first the direct involvement of top management. This leads to a shift of culture, where working with external entities becomes accepted and promoted throughout the organization (Letizia Mortara, Johann Jakob Napp, Imke Slacik and Tim Minshall, 2009). In addition to the top management, the middle management –the operational level- should be converted.

3.1.3. Role of middle management

Managers should behavior in an open way, similarly to what is asked to the R&D staff: empower initiatives and base the relationship on trust (Herzog, 2011). But middle management often struggles to make the tie between the strategic orientation coming from the top and the operational level reality with its problems to solve and milestones to achieve. This leads to a kind of inertia. First, the needed time for organizing the change and implementing the tactic defined. Secondly, as we have seen, there could be some cultural resistance from managers, time could be wasted before all managers realize and endorse the fact the change will last. This behavior depends of the culture and personality of the managers. Some are not supporting the change, by inability to change or weariness of changing too often (Alter, 2005).

Among those who don't support the change, some act as if they do, playing like a comedy in which they feel, as people, perfect strangers (Alter, 2002). Be able to notice them and to support them to embrace the change in their journey toward open innovation is a challenge but it's critical. If not, they would contaminate their team and increase the risk of failing the implementation of OI. Middle management is a key actors for the spread of Open Innovation culture and should be recognized as such (training, engagement, personal objectives, etc.).

3.1.4. Supporting the change among the employees

Business today tends to value employee creativity, but in the same time, it rationalizes, standardizes and limits the activity with processes 'frameworks. The method of implementing open innovation

through process and procedure has its limit, since this tactic tends to promote opposite behaviors at the operational level, e.g. standardization and creativity.

Therefore, if management has means to change the corporate culture by evolving values, norms and behavior patterns, at the end, to be efficient and durable, Open Innovation culture should be owned by employees. Each employee should take ownership and accountability of Open Innovation in its own practice and mindset. A key success factor of the OI implementation is the way employees take ownership of the OI and adapt it to their needs. Ownership makes implementation of OI viral, employees use it efficiently for their activities. They make proposal to improve it, to adapt to the specificities of their job… Even though the signal should necessary come from the top, a mix with the bottom-up approach is necessary to make OI implementation successful (like any innovation practice) (Anon., 2013). It is done for the users, by the users.

Another important element is to endorse first Open innovation practices by people recognized as inventors by their pairs (not managers), in order to legitimate them (Linhart, s.d.). Those employees are able to contaminate the more reluctant, when mixing team or hold initiatives where the both population would work together.

TAS has set a network of those innovation enthusiasts, one in each team, where they can share and communicate success stories. The open-challenge hackathon gathering people from all the company is a kind of initiative that can allow participants to disseminate their enthusiasm on innovation to their colleagues, when back into their teams with concrete results. Once again, OI implies sharing, collaborating, etc. all related to share emotions (Anon., 2013). Be able to share emotion is therefore a soft-skill required for recruiting a new R&D member in an OI organization. Thus, the culture should support cooperation and communication work rather than a restrictive and control one.

An important issue to consider here is what could effectively enable or motivate individual's innovation behavior. It could be usefull to create specific teams or projects which are allowed to work outside the traditional norms and rules. They should be encouraged to take risks and move towards higher degree of externally oriented collaboration for innovative development. If failure occurs, it should be acceptable and seen as learning lesson. Interestingly, management can encourage creativity and openness by constructively challenge one's ideas and opinions. A culture allowing the expression of such criticism is a prerequisite (Herzog, 2011). But, in the same time, the organization should take care of not rejecting or ignoring innovative idea that could be misjudged by negative bias. Anybody can have those bias when assessing other's innovative proposal (Foray, 2002). This can be achieved through team members' diversity regarding their educational backgrounds, mutual openness to ideas, or shared commitment to the innovation project. However, managers should find the right balance between support and criticism, be too much supportive or too much critic impact the performance of the team.

3.1.5. Sustaining the change

Having a flat hierarchical organization and managers dedicated to a role of leader and coach would help to sustain the open culture. Indeed, a simple organization helps people to collaborate. A manager in its role should support his staff for making them accountable of their work, relationship network, and personal knowledge management.

Regarding structure, even though they are not creating the open culture by themselves, processes are needed. They support the organization by guiding people in their work. About open innovation, several

processes can be seen as being crucial, such as technology scouting or out-sourcing R&D activity. Several other processes can also be essentials, such as IP management process and strategic technology planning process. (Tobias C Larsson; Isaksson Ola; Vinit Parida; Pejvak Oghazi, 2011). Organization should be aware and vigilant to keep those structuring elements light and "alive". Defined by the users for the users and with the minimum requirements needed. The idea is more to point out who to ask or where to see, rather than giving a rule that could be quickly obsolete or incomplete. The aim is to foster relationship and communication between teams.

3.1.6. R&D organization

Collaboration and communication between teams and through the boundaries of the company depend of the organizational structure of the R&D. By historical reasons, but also for achieving a better efficiency and facilitating the integration of the tacit knowledge, companies tend to specialize their sites and to concentrate their main R&D centers in one country.

This leads to isolate those knowledge and technology centers from global networks (Joe Tidd and John Bessant, 2009). Contrary to this concentration model, an integration model presents different units spread internationally and contributing all together to the development of projects. It enables to offer a larger range of capabilities and perspectives even though it increases coordination and transaction costs. Usually a hybrid of those two models comes naturally, resulting of historical, economical and political trade-offs (Joe Tidd and John Bessant, 2009).

European satellite manufacturers have remote locations, Airbus group in silicon valley (USA), or alliance, TAS in Singapore allowing them to tap into local skills, knowledge and culture while keeping their R&D concentration in strategic location (for project efficiency).

3.1.7. External relationship and IP

Among this organization, a specific role should be created in order to promote the inter-firm collaboration. This "relationship promotor" establishes links between partners of the innovation process in order to overcome any resistance to the collaboration: reduces the unavoidable asymmetric information, supports communication, helps in case of conflict, etc. (Herzog, 2011). When there is a large difference in structure, such a large company partnering with startups, or when the partner is a new one, he can have a role of interface in the relationship, adapting the communication to what can handled each of the two entities. Regarding the external partner, he stands for how the company is represented in the relationship. It means the engagement of the large company in the partnership.

Regarding IP, in a collaborative innovation where the knowledge flows in two directions, the traditional approaches "invention – protection – development – commercialization" makes no sense. None of the two partner can assume the control of the intellectual property of the technology developed in partnership, at the risk of having one partner refraining its involvement. A new approach should be implemented, with a trilogy of targeted responsibilities: development, ownership, and use (Anon., 2013). The three different scenarios range from the traditional development done by the supplier with ownership kept by the customer, to an ownership granted to the supplier with the customer keeping the control of the use, and a last scenario setting a shared ownership between supplier and customer. These differentiated approaches allows a better balance between supplier and customer involved in an open development, as well as a better fit when dealing with intangible products of the digital world.

Concerning the inside-out aspect of the open innovation, satellite sector is very conservative. Most of the patents are done in a defensive mode, for preventing competitors to accede to their knowledge and technology. Usually, getting a larger share of the market requires to open its IP practices, in order to obtain the optimum value of the market (Foray, 2002). By opening its IP to licensing, a company gets not only the earning of the licenses but can expect as well to increase the value it can get from the market.

Besides valorizing the IP rights, licensing allows to make ties with new partners and explore new business models. Taking the example of Airbus group. It proposes many technologies and processes available for licensing to outside users. This activity constitutes an important source of new business development and therefore, this process is strongly supported by the Airbus group CTO and the top management.

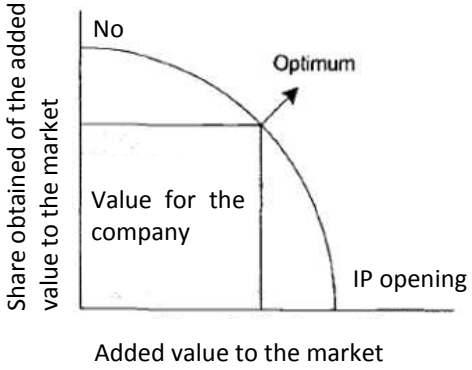


Figure 10: Optimum value of the market by licensing IP (Foray, 2002)

Any patent added to this portfolio is first vetted and approved for external use. Airbus group has set an IP office managing this inside-out activity and interfacing between the company and the potential licensees (Anon., s.d.). Airbus is looking for "*industrial cooperation rather than just opening up a database of patents for sale,*" according to Mark Fraser, formerly Director of Research and Technology at EADS North America. The advantage for the licensees is that those technologies are proven or have been validated by Airbus (Airbus, 2016).

3.1.8. Risk culture

Supporting an openness deals also with uncertainty, risk taking and failure tolerance. An open company should make its culture evolving towards a more entrepreneurship-friendly one, making it more agile, enabling to take their decision fast and open to risk. It's about getting closer to the managerial practices of a startups. Initiatives allowing the development of an intrapreneurship culture such as sending employees to work inside startups or to spend time with startups incubated within the organization, can help to achieve this culture shift (Accenture, 2015). Obviously this program cannot be realized for all employees, only the ones volunteering and have intrinsic motivation, are to be selected. It seems also important to note that companies need not to develop this behavior in every department of the organization.

Taking risk doesn't mean to ignore them, nor calculate them. It could lead to develop a disruptive or blue ocean business models. For instance, new business model like constellations requires a dramatic cost reduction to make it possible. The use of COTS as well as serial production allowing economy of scale, drive down the manufacturing costs. The trades-off to the low-cost is the quality and reliability (comparing to a typical LEO/GEO satellite) of each mini-sat. COTS intrinsic reliability is lower than traditional space component and serial production implies less control than the unitary manufacturing of typical GEO/LEO satellite. A mini-satellite of a constellation is largely simpler than a GEO satellite. But, thanks to the quantity, if one entity fails, it can be replaced by a spare satellite already in orbit or launched on a short notice, or its functionalities can be simply assured by the others satellites of the constellation (redundancy).

Therefore although the reliability of each entity could be less than a traditional satellite, the reliability of the function –provided by the whole constellation- could be the same or, at least, traded-off with the low-cost benefit. Definitely, taking risk doesn't mean to fail, but to explore new idea and business model and assume the risk/ benefit trade-off.

Finance likes risk but at costs for the company. Risk is first about financing. For reducing the space "risk-adverse" culture of its R&D, TAS has started to promote risk taking on projects which are not aligned with the business models. It is a way to learn from potential failure without impacting the company finance, reputation and development. Learning from failure develops a learning culture, and yet, accountability of employees. Developing first a demonstrator or "proof of concept" allows as well to "fail fast and learn hard" while limiting the financial impact.

Risk culture needs also to learn to adapt to the situation. It's a shift from a causal model, where everything is planned, to an effectuation culture, where the first product developed may be not the right one but a base to quickly evolve, by loops.

An organization, a project of a new product, seeks to reduce risk, to reduce uncertainty regarding product development or new technology. Financing uncertainties is in contradiction with the company's financial control and planning. But open innovation is also sharing risk with others, in the aim of finding the innovation or business model that will give a competitive advantage to the company.

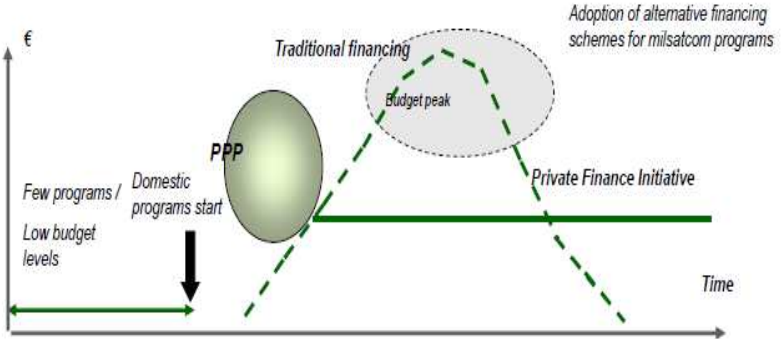


Figure 11: Concept of Public Private Partnership financing (Euroconsult & Révillon, 2016)

The Public-Private Partnership (PPP) allows to reduce financial exposure and to share financial risk. For instance, the first prototype flight platforms of Spacebus Neo (TAS) and Eurostar Neo (Airbus D&S) are planned for launch in 2019 for in-orbit demonstration under a public–private partnership to be established with satellite operator (Anon., 2016).

External technology could be seen as riskier than internal technology by a company. It presents higher uncertainties on the level of control but also on the assessment that the technology will fulfill its needs. There is asymmetric information between the seller and the buyer of a new technology, the seller has a higher knowledge than the buyer. The company buying the technology needs the capacity of first, assessing and then absorbing the transferred new technology or knowledge -tacit and explicit- in a manner (time, cost) compatible with the new project. (Herzog, 2011). This capacity should be present in the organization and skills of its employees, to make the risk acceptable. A mistaken technology

assessment may result in additional cost, leading time, even a failure of the project and consequently, a reinforcement of the NIH syndrome.

Finally, innovation depends on having a supporting organizational context in which creative ideas can emerge and be effectively deployed. Building and maintaining such organizational conditions are the critical role of management. It involves organizational structures, work organizations, training and personal development, learning, reward and recognition systems and communication. To make that happens, the entire organization needs to change, to transform themselves. And to make this capacity durable, the enterprise by itself should become "open" (Anon., 2016).

3.2. Talent Management

An open culture is first supported by the people. Employees by their beliefs, behaviors and shared values are acting to make the corporate culture open. Innovation, openness, capacity to change, soft-skills and technology assessment skills are diversely distributed among employees and teams. For instance some may welcome the change, some may resist to it. OI non-adopters may have not the adequate mindset to see the value of open innovation for their work or dislike to change their working routines. There is a high risk that those individuals enter in conflict with the new culture and organization, as well as with OI adopters. The team implementing OI in the company, as well as the HR, should take adequate measures to prevent this situation and to support those people in situation of difficulties (Ammon Salter; Paola Criscuolo; Anne L.J. Ter Wal, 2014).

Therefore, to make the open culture happens in a sustainable way, the organization should evolve their traditional Human Resources Management toward a Talent Management. Talent management includes. Those changes impact the recruitment, the incentive and reward process as well as the career path. The aim is to sustain a learning organization where employee take ownership and accountability of the open innovation process, in order people can feel as "I own the place and the place owns me" (Rao, 2014).

3.2.1. Recruiting the right people

Although management cannot shape the personality of an R&D employee, it can influence the recruiting process for recruiting only employee that fits with the necessary proactive, creative, and results-oriented personality for Open Innovation initiatives (Herzog, 2011). Specific skills associated to knowledge capacity such as assimilating and diffusing knowledge are key.

In addition to those soft-skills, the recruitment should favor diversity in the profile, experience and gender of applicants. Regarding the profile diversity, it is necessary to consider if not foreigners (could be an issue regarding national defence confidentiality requirements), at least international profile, i.e. people having work abroad and having developed inter-cultural skills, international networks and context awareness. The recruitment of more entrepreneurial profile in addition to the traditional analytical attitude and behavior would help to overcome NIH syndrome (Tobias C Larsson; Isaksson Ola; Vinit Parida; Pejvak Oghazi, 2011).

Recruiting is the primary source of outside knowledge in the organization: attract talent by organizing apprenticeships, theses, supporting research doctorates, or even financing university chairs and

research positions (Giorgio Petroni , Karen Venturini & Chiara Verbano, 2011). Like all knowledge intensive sectors, this is a process well known and used by the space satellite sector.

Besides any knowledge and experience an employee can bring to a company, it is necessary first to check the fit between employee's value and the open culture, in order to sustain the culture change (Letizia Mortara, Johann Jakob Napp, Imke Slacik and Tim Minshall, 2009). Else, it would lead the newly recruited employee to produce conformist behaviors and play a role he doesn't believe in and consequently doesn't invest in (Alter, 2002). Without investment and ownership, the open culture doesn't exist.

Usually, there is a good fit between open culture and entrepreneur. They are facilitators and natural leaders who can involve others and communicate their enthusiasm (Letizia Mortara, Johann Jakob Napp, Imke Slacik and Tim Minshall, 2009). Therefore those skills and attitude should be favored and rewarded.

3.2.2. Rewards and incentives

Reward and incentives start with a clear expectation of people doing open innovation. The organization should clearly state them in the job description and objectives of each employee regarding open innovation. It is commonly accepted that company's strategy should be translated at all levels of the organization, including in employees 'objectives. In the space industry, "innovation" is increasingly present in the description and objectives of jobs whom innovation practices are key. That is a prerequisite, but insufficient to move towards open innovation and fully exploit its potential. The strategy of open innovation taken at the top management level should be translated into the personal objectives of people who's in charge of doing it: the employees, in particular R&D staff. Then, roles should be clearly defined and employee should know what is the meaning of what they do (the "why"), for fostering accountability.

In the change of cultural mindset, one of the most important item is how the organization recognizes open behavior and performance through reward and incentives (Letizia Mortara, Johann Jakob Napp, Imke Slacik and Tim Minshall, 2009). The usual practice of reward of R&D staff does not value collaboration, building of networks and exchange with outside. Once it is allowed to use what is done outside, new behavior patterns need to be rewarded and the old ones not promoted. The formerly criticized behavior of spending time to go around for establishing its knowledge network should now be promoted and the working alone competition should be casted off. So, per some aspects, the behavior to reward could be seen as exactly opposite to the previous –current? - system… Reward systems could be expanded to incorporate acknowledgements and rewards for individuals that successfully initiate, manage and implement external engagements (Ammon Salter; Paola Criscuolo; Anne L.J. Ter Wal, 2014).

To support company's business model, the objective of R&D is to solve technical problems or find innovative technology whatever the source is, in an "Invented Anywhere" approach. Incentive and reward system should therefore be based on this ability solely (Herzog, 2011). The organization should then value and reward a successful expertise in the employee's capacity to evaluate external technology and knowledge that can support this business model (Chesbrough, 2003). Consequently, the firm should implement disincentives for innovation avoidance, i.e. monitor and measure progress,

and reward good use of Open Innovation practices but not the use of traditional closed innovation activities (Letizia Mortara, Johann Jakob Napp, Imke Slacik and Tim Minshall, 2009).

In a more open company, scientists and engineers can feel uncertainty since their specialized knowledge is becoming less valuable and therefore may look to leave the company. The incentive and reward system should support the change in their role in the organization and their acquisition of the needed soft skills. Another source of potential turnover comes from the openness with outside, employees are more aware and in contact with other companies, culture, etc. The organization should then develop a robust reward and career path system to keep talents.

3.2.3. Career path

With Open Innovation the career path becomes inadequate: the traditional dual ladder system cannot meet the expectations of scientific and engineers: from a social and cultural point of view, a managerial career is still more attractive than a technical one, even when the technical positions are equivalent to the managerial ones in terms of salary, status, and organizational prestige (Giorgio Petroni , Karen Venturini & Chiara Verbano, 2011). Therefore, it is necessary to break the traditional promotion to manager and to increase the cross functional jobs, in a flat hierarchical structure.

3.2.4. Learning culture and knowledge management

Open culture transformation needs support in term of training and personal development programs. Individuals have to learn how to be efficient in open innovation and to know procedures like IP management that clarify what can or cannot be shared with external parties (Ammon Salter; Paola Criscuolo; Anne L.J. Ter Wal, 2014). Open innovation requires employees to develop new set of skills and competence. Among them, R&D staff needs for development of their soft-skills in order to be able manage relationship in an efficient way: communication, motivation, initiative, willigness, abilty to read and manage other's emotion, multi-cultural openness, receptiveness to innovation.

That implies more team management practices, team working and flexibility., wich are tipicaly the opposite to a closed innovation culture, based on men of genius whom organization let them work alone (Petrou, 2015). In a knowledge- based society, it requires also Digital age literacy (ICT skills): skills to use digital tech and access and interpret information.

Most of them would need to be trained to effectively identify and utilize external knowledge (Tobias C Larsson; Isaksson Ola; Vinit Parida; Pejvak Oghazi, 2011). Assimilating external knowledge requires absorptive capacity (Wesley M. Cohen and Daniel A. Levinthal, 1990) which is the acquisition of knowledge by itself by an organization but also its ability to exploit it. This capacity is function of the level of prior related knowledge and the ability of "learning to learn".

The organizational culture should therefore foster and reward the diversity of knowledges as well as the accountability of R&D staff to develop their learning orientation through, for instance, their personal knowledge management. This could be done in particular by exploiting the possibilities of the digital tools, e.g. WEB 2.0. The pace of innovation and changes mean that people need to upgrade their skills throughout their career.

The employee's role is changing from the expert in inventing everything on its own, to an expert in integrating and combining from outside. One critical mechanism in this process is the conversion of tacit to explicit knowledge, transferring know-how and tacit knowledge between actors. This could be

facilitated by establishing long-term links with every partner and limiting the diversity of contributors, which becomes a paradox regarding the willingness of openness (Hussler & Burger-Helmchen, 2011).

Competence becomes collective, nobody has the complete knowledge to achieve his work. That leads to develop network of cooperation, as part of job task (Alter, 2002).

Building a culture supportive of knowledge management involves to transform deeply the organization, by a systematic development of organizational structures, reward and recognition systems, training policy and accounting and measurement systems.

3.3. Measuring the success of the Open Culture on the organization

The issue with changing culture is how to measure the change? It is necessary but this is a challenging task to demonstrate its effectiveness. Especially because each entity has its own variation of the corporate culture, e.g. the different sites of TAS have each of them a difference that makes them unique and Companies have to identify new key performance indicators (KPI) of the open innovation processes. An Open Innovation manager in a satellite company told me that the effectiveness could be seen in regards of elements like the success of the innovation projects, the feedback of open innovation initiatives like hackathon, or the implementation status of OI means deployed.

Measuring the change could also be done by measuring the resistance to the change. Resistance could be hardly not noticeable. Employee may play the role of complying with the new directives and procedures. But as they don't believe in, they won't get involved in. An adequate criteria to see how well an innovation culture is working is therefore to look at how employees are involved in (Alter, 2002).

The engagement of employees, how they feel more accountable, how they feel having taken ownership of open innovation in the daily work is the source of an open culture.

CONCLUSION

European satellite manufacturers are on their journey toward Open Innovation. To achieve their transformation, Not Invented Here and Not Sold Here syndromes would have to be overcome.

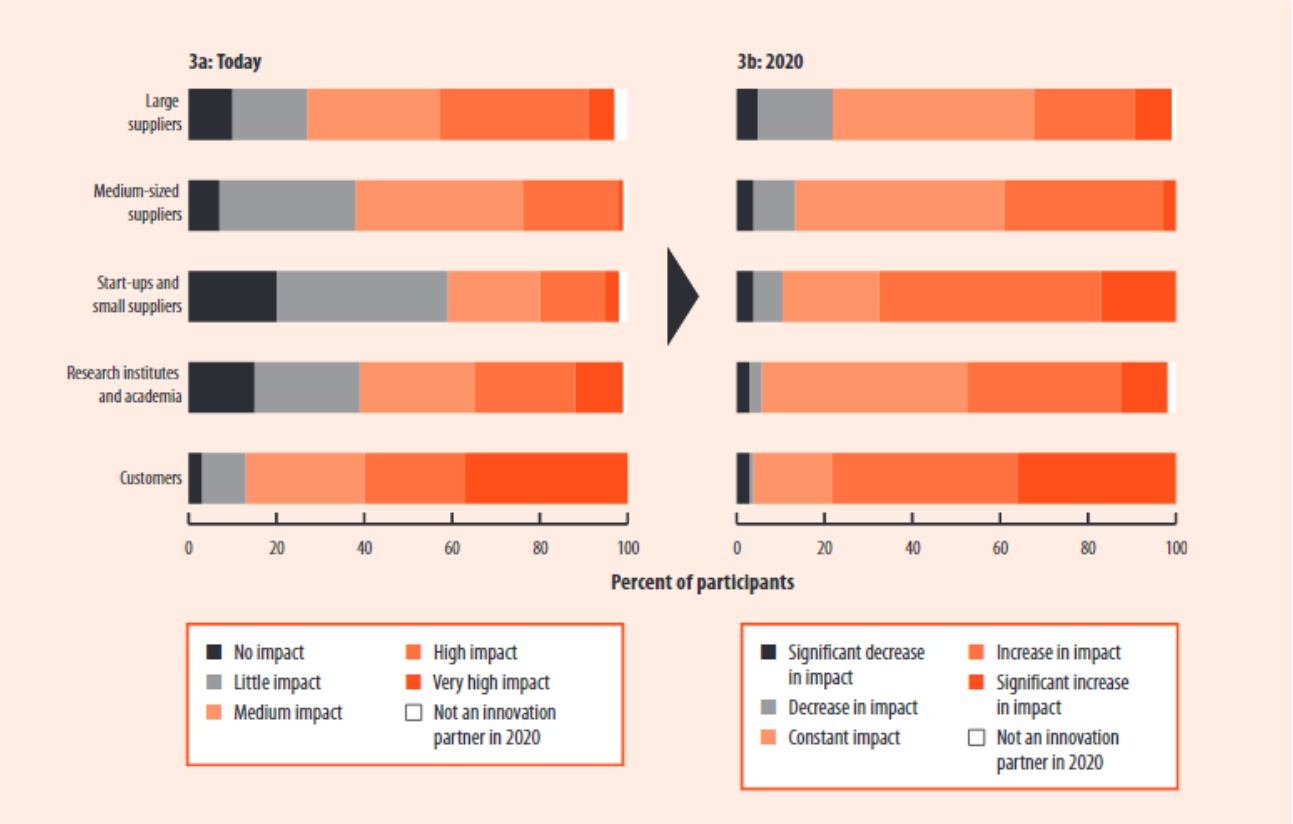
They have no choice, either they evolve, either they will be disrupted. It a matter of time.

Open innovation is the transformation of an internal culture to an open culture, and the development of a process to encourage and promote innovation from every available sources. It is not something you can achieve overnight. It is not a single event, but a process and a culture that must be sustained in order to grow. Open Innovation is a work on progress.

The key is to have the users -the R&D employees- taking ownership of it. The human resources should be more supportive toward the middle management. They should evolve the recruitment criteria, the incentive and recognition programs, as well as career path, to make them consistent and aligned with the open innovation principles. The implementation of a learning culture supporting the open innovation would complete the transition to a Talent management organization. In such environment, employees are able to take ownership and accountability of Open Innovation culture, making it successful and sustainable.

Indeed, as environment is continuously changing and since the digital transformation is not yet achieved in the industry, we could expect the Open Innovation practices to evolve. The number of entities in relationship is expected to increase also in their diversity: Startups, SMEs, suppliers, customers, competitors, public institutes, states, consumer groups, freelance… as well as robots and computer with artificial intelligence, etc. The available or required means to communicate will change accordingly. While being not the “panacea”, an agile open culture can definitely help companies to handle an uncertain future.

Annex 1 European Innovation Management Academy survey



Source: A.T. Kearney and IMP³rove – European Innovation Management Academy.
Note: The figure depicts responses to the query 'How would you rate the impact of each of the following innovation partners?'

Figure 12: Impact of various groups of innovation partners (WIPO, 2016)

2016 A.T. Kearney and its subsidiary IMP'rove – European Innovation Management Academy surveyed more than 100 executives of large international organizations from the Americas, Europe, Asia, and Australia The sample comprises executives representing manufacturing (19%); energy and process industries (17%); consumer goods and retail (15%); communications, media, and high tech (14%); financial institutions (10%); automotive (10%); and other industries (14%).

Cost sharing

Annex 2 Comparison of cost between closed and open innovations

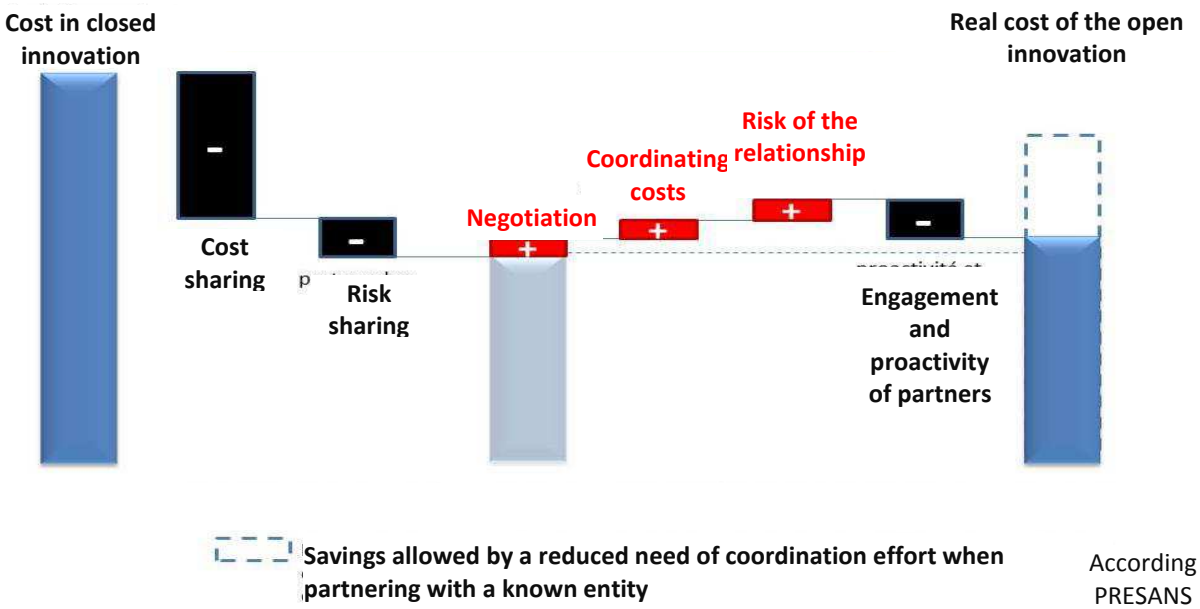


Figure 13: Comparison of cost between closed and open innovations

List of Figures

List of Tables

List of Annexes

List of Acronyms

BtoB	Business to Business relationship
BtoBtoC	Business to Business to customer relationship
COTS	Components On The Shelves
DARPA	Defense Advanced Research Projects Agency
DGA	Direction Générale de l'Armement
GAFA	Google, Amazon & FAcebook
GEO	Geostationary Earth Orbit
HTS	High-Throughput Satellite
IP	Intellectual Property
ITAR	International Traffic in Arms Regulation
LEO	low Earth orbit
NIH	Not Invented Here
NIT	Not invented There
NSH	Not Sold Here
OECD	Organization for Economic Co-operation and for the Development
OI	Open Innovation
SME	Small and Medium Enterprise
TAS	Thales Alenia Space

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