A STUDY ON VERTICAL INTEGRATION AND FIRST MOVER ADVANTAGE AS SUCCESS DRIVERS FOR SMALL LAUNCHER COMPANIES

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ABSTRACT

To what extent do vertical integration and first-mover advantage impulse the ventures of small launcher manufacturers?

In the very fast-growing market that is New Space, the development of small satellites implies a high rise of the demand for small launching solutions. This context is a fertile soil for entrepreneurial ventures and therefore start-ups all over the world are going to try to get their share of the cake: 89 small launchers are under development today. Competition is expected to be fierce and it seems natural to see a handful of leaders take up the majority of market shares, leaving the other contenders to die off. To try to understand what the key factors of success are in such a competitive environment, two managerial principles are being studied, ones that seem to have a high potential impact on the future of the ventures participating in this new space race : the vertical integration of the production process, and the first-mover advantage that the early innovators may be benefiting from. The study of the first one showed that vertical integration is a great way to mitigate risk, reduce costs, and have control over the production and R&D processes. Then, the main advantage of first mover seems to be time: by being the leader of its market for a period of time, the company will gain experience, improve its efficiency and will hopefully develop its portfolio and processes. However, trying to differentiate a product from its competitors by innovating is risky, as the firms must stay very much aware of the market needs.

Dans le marché en forte croissance qu'est le New Space, le développement de petits satellites implique une forte augmentation de la demande pour des solutions de lancement adaptées. Ce contexte est un terreau fertile pour les entrepreneurs, et des start-ups se forment autour du monde pour essayer de récupérer leur part du gâteau : 89 lanceurs légers sont en cours de développement à l'heure actuelle. La concurrence va évidemment être rude, et il semble logique que seulement quelques entreprises dominent et obtiennent la majorité des parts de marché, en laissant les autres candidats disparaître. Pour essayer de comprendre lesquels peuvent être les principaux facteurs de réussite dans un environnement si compétitif, nous allons étudier deux principes de management qui semble avoir un gros impact potentiel sur le futur des entreprises qui participent à cette nouvelle course à l'espace : l'intégration verticale du processus de production, ainsi que les "avantages du premier arrivé" dont semblent bénéficier les premiers innovateurs. L'étude du premier montre que l'intégration verticale est un bon moyen de minimiser les risques, baisser les coûts et garder le contrôle sur les processus de production et de R&D. Puis, le principal avantage des premiers arrivés semble être le temps : en étant le leader de leur marché pendant une période de temps, l'entreprise concernée va gagner en expérience et en efficacité, et va éventuellement développer son offre et ses processus. Cependant, essayer de différencier son offre en innovant reste dangereux, et les entreprises doivent rester concentrées sur les attentes du marché.

Innovation management - vertical integration - first mover advantage - small launchers - New Space - industry - entrepreneurship

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INTRODUCTION

In the past twenty years the New Space industry has witnessed an incredible unprecedented growth that can be numbered in the thousands of satellites launched, and hundreds of start-ups created. Indeed, while the aircraft and airline sectors have been severely hit by the Covid-19 crisis, the space industry seems to have only merely slowed its pace down due to the sanitary restrictions linked to on-site work. One of the particularly growing activities in this industry is the development, manufacturing and operation of small satellites, made possible mainly by the reduction of the costs to launch an object into space. In fact, Behrens and Lal (2019) estimate that the smallsat imagery market alone could rise from $15 million in 2015 to $8,8 billion 2030, and Frost & Sullivan (2019) forecast a global launch demand for more than 12 700 satellites between 2019 and 2030.

This very notion of a global launch demand is going to be a key point of interest of this research paper. Although, traditionally in the past decades governmental agencies have overseen most of the work related to the space industry, it would seem that today the growing number of commercial companies and start-ups within the small satellite manufacturer industry is extremely telling of a shifting of gears within the field. Indeed, this tremendous demand for cheap and rapidly ready launch systems prompted a wave of entrepreneurial ventures all around the world. Today, 89 small launchers are under development in 29 countries, and 8 are already operational (New Space Index, 2021). Naturally, one would therefore assume that the competition in this booming market would be fierce, therefore causing, in a few years' time, for a very little number of companies to be proven effective and reliable actors within the small launcher industry. Such a situation therefore prompts questions about the means of attaining competitivity and obtaining market shares for these companies that offer the same type of products. This interrogation, that has served as a basis for our research, will therefore be approached through the innovation management angle by an analysis of two major managerial concepts that we have identified as being key to the resolution of such a question.

Hence, this research will discuss to which extent **vertical integration** and **first-mover advantage** impulse the ventures of small launcher manufacturers.

To this end, a literature review will be conducted to first analyze and better understand the business context, current framework and characteristics of the New Space market rise, with particular interest on the small launcher industry. This will therefore allow to highlight and put focus on the nature of the challenges and the opportunities at stake.

The two concepts of vertical integration and first mover advantage will then be studied and discussed theoretically before meshing together the theoretical and practical observations of our subject of interest in a concluding section that will also serve as an opportunity to highlight parallels between the young New Space industry and 70 year old commercial aviation sector that have known similar pasts.

1. STATE OF THE ART ON SMALL LAUNCHERS

It is not a secret when it comes to analyzing the most recent facts and news about the space launch industry, that the amount of missions related to small satellites have increased immensely during the last few years. It is also not surprising that these small satellites are now much more capable and versatile than ever before, thanks to multiple technological advances that have made them much more appealing to customers of specific markets which before had to look elsewhere for the same needs to be covered by services provided exclusively by larger, legacy satellites. Nowadays, small satellites are now being deployed for missions covering a wide range of services, from communications to Earth remote sensing, besides small-scale missions for scientific and educational purposes from universities and amateur groups, the common characteristic being that these new customers can emerge from non-government-backed nor any other strongly-financed sectors. The current consensus is that this trend will further accelerate in the coming years (Tugnoli et al, 2018). The following sections will describe how the satellite market developed up to this point, and what does the previously mentioned characteristics mean for the present and future of the small satellite launch market as part of the bigger scheme of New Space and the democratization of space.

1.1) The rise of the New Space industry

As opposed to a time when only governmental agencies and a few elite companies could afford to put an object in orbit, mainly for telecommunications or for defense purposes, the New Space era refers to the commercialization of orbital access and activities. The early twenty-first century has seen the birth of several private actors in the name of SpaceX, Blue Origin and Virgin Galactic. The first one, per the innovation it brought to the table, is probably at the origin of the state of the space industry as we know it today : by proposing reusable rockets, SpaceX managed to greatly reduce the cost of sending an object to space. Indeed, while the average cost of sending 1 kilogram in low earth orbit was $18 500 between 1970 and 2000 : a price that was driven down 7 times by the entry into service of the Falcon 9, its main product, at $2 700 per kilogram (Jones, 2018). This new affordability of orbit allowed all types of new companies to bloom: satellite manufacturers and their equipment suppliers, mission planning specialists, telecommunications and IoT providers, or specialized operators for earth observation, imagery, or in-orbit experimentation.

Figure 1 - A Falcon 9 first stage landing (SpaceX, CRS-18 mission)

1.2) The small satellite revolution

By the traditional mass classification of satellites, a small satellite is considered as such if it weighs less than 500 kg (Pelton & Madry, 2020). Satellites launched into space with similar mass characteristics are, in fact, not exclusive to New Space nor new at all. The first satellites launched between 1950 and 1960, such as the Sputnik 1 or Explorer 1, were in fact small satellites if they were to be classified by current standards. They were launched in a time when such classification did not exist and was irrelevant, as their size and weight were constraints imposed by the lift capacity of their contemporary launchers. As time passed, technology advanced, and new use cases were found, satellites grew more complex and massive. The trend continued for more than 50 years until ideas for large-scale satellite "constellations" started to be taken into consideration in the late 1980s by using smaller satellites operating at lower Earth orbits that would secure global overage, thought to be more cost-efficient to be designed, manufactured, tested and launched while at the same time taking advantage of reduced signal delays that would come with them being launched closer to Earth. Even though these ideas could not be brought to realization by the companies behind them at the time, mainly for financial reasons (Pelton et al, 2020), the innovation flag was passed on to universities and private research institutes which for the next 30 years designed and built their own space experiments on small satellites that proved to be fully functional. A further interest was brought towards miniaturization and standardization of not only satellites but also of their key components for a further reduction of manufacturing costs, more streamlined and faster production processes, and a drastically different approach to design. This contributed enormously to the New Space revolution and the new "Silicon Valley" mindset that has driven it with a more agile and entrepreneurial take on the space industry through the late 2000s and the 2010s.

Starting around 2012, the number of small satellites launched started to increase, as companies such as Planet and Spire started to develop their commercial satellite constellations within their own start-up frameworks, being joined in the leading positions more recently by SpaceX. 1731 commercial small satellites were launched between 2012 and 2019, of which 899 (a 52% of the total) serve commercial purposes (Bryce Space and Technology, 2020). The Figure 1 below gives an overview of the increment of these launches both in quantity and in their percentage within overall satellite launches.

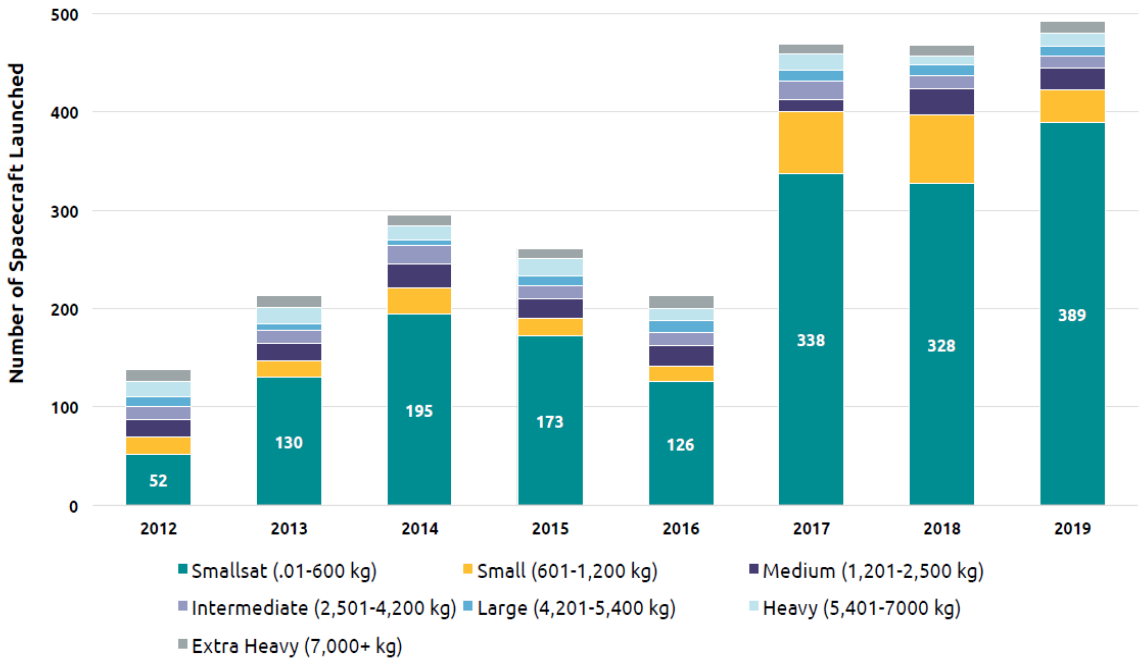

Figure 2 - Spacecraft launched from 2012 through 2019, by mass (Bryce report, 2020)

1.3) The small launcher market

As it can be inferred from the previously described trend, the launching solutions required to get those small satellites in orbit had also to grow accordingly, not only reacting to the increasing demand but also adjusting and implementing the New Space mindset into their innovation strategies in order to come up with more efficient launch vehicles that could be tailored to the specific needs of the new, smaller payloads. This led inevitably to the birth of companies providing distinct launching solutions in the form of small launchers. Before the first small launchers came to the market, putting a small satellite into orbit would require buying a secondary slot on a heavy launcher, meaning that the company would necessarily have to wait for a large satellite to fill the main slot. The fast-rising pace of the industry and its very lucrative potential led to a new race where the contenders have two main challenges: profitability and reliability, with the constraint of being rapidly ready. While technologic innovation such as reusability, 3D printing, or alternative fuels can really play in favor of the first constraint, it must not have a negative impact on the second one. With 8 small launchers operational in the world, and 89 in development in 29 countries (New Space Index, 2021), the competition is sure to be fierce for a market that is expected to grow from $3.6 billion to $15,7 billion with a compound annual growth rate of 20.1% between 2018 and 2026 (Narune & Prasad, 2019).

The small satellite market in general experienced a 23% Compound Annual Growth Rate from 2009 to 2018 and a growth rate is forecasted to keep on growing until peaking at 48% in 2024 (Euroconsult, 2019). This considers the rapid deployment of the first generation of mega constellations, driven by OneWeb, SpaceX's Starlink and Amazon's Project Kuiper. Furthermore, an estimation of more than 8 500 small satellites launched is given for the time period between 2019 and 2028. As of now, there has not been a consensus on the development of the market development regarding payload segments. Over half of the new small launcher companies are developing their rockets with payload capacities ranging from 150 to 500kg, while some others aim to carry less than 10kg. The wide range of developing design strategies

leave in evidence how uncertain is still the expected development of the market and which of the specific categories of small satellites will grow the most or become niche markets. Additionally, the proposed launch solution costs also vary widely: While as mentioned before, SpaceX with a Falcon 9 can carry payload at 2 700 USD/kg, the average of dedicated small launchers stands between 20 000 and 40 000 USD/kg, explained by why launch flexibility, and not costs, is the main advantage for companies proposing small launchers. A good analogy is that small launchers are to legacy launchers what taxis are to buses: the legacy model constitutes a shared ride, for a lower price, when the new small launcher companies offer convenience and tailored service for a higher price (Niederstrasser & Madry, 2020). It is for this very same reason, that one of the main development drivers for innovation in the small launcher industry belongs lo lowering production costs by means of business strategies and technological advancements and offering high launch frequencies and capacities in order to remain profitable and competitive.

2. THEORETICAL LITERATURE REVIEW

The undeniable boom of the sector and the success of its most outstanding players are certainly a result of a vast amount of different interrelated factors, with varying levels of impact. Amongst the many theories and concepts that could be used to explain the issue, two were chosen to frame the strategies of the companies and structure this research: The concepts of vertical integration and first mover advantage.

2.1) Vertical integration

This type of management strategy for businesses follows the traditional definition of a supply chain in which it is associated both with an upstream and a downstream direction of flow for supply and demand, normally flowing from raw materials in the upstream side into the end customer in the downstream side. Any company that stands within an specific part of the chain, will then be following a vertical integration strategy if it controls upstream entities and/or downstream entities within its supply chain, meaning that it will acquire or merge with either suppliers, distributors, or both. In its traditional economic definition, it is merely the combination, under a single ownership, of two or more stages of a supply chain that are usually separate (Buzzell, 1983) On the other hand, a company that is following an horizontal integration strategy is said to own or control entities that stand in the same place as them within their value chain, meaning that it will acquire or merge with a similar company, normally a competitor.

One or the other strategy might be executed depending on the specific interests of the company and what its business strategy currently is. Generally speaking, the horizontal integration approach is considered when a company wants to increase its market share, seek new markets, approach new customer segments, reduce competition, reduce production costs, engage economies of scale and increase its revenue. This strategy would normally lead, if exceeded in reach, to a monopolization effect on its market and an increased bargaining power over its suppliers and customers that can affect the current balance of the supply chain (Edwards, 1953).

A vertical integration strategy, defined by means of its function, is a way to coordinate the different parts of an industry supply chain when bilateral trading is not beneficial (Stuckey

and White, 1993). It seeks mainly: to reduce transaction costs, by means of reducing the buying, selling and/or handling costs between the stages; to guarantee supply and reduce delays, especially for critical materials or components; to improve coordination and information sharing between production, logistics and/or R&D departments; to join and strengthen mutual technological capabilities; and to raise the entry barriers for new competitors, if vertical integration itself becomes necessary for companies to be competitive. (Buzzell, 1983). Offsetting these benefits are costs and risks associated with the capital investment needed for the integration of the newly joined operations and a reduced flexibility for adjusting to new market conditions.

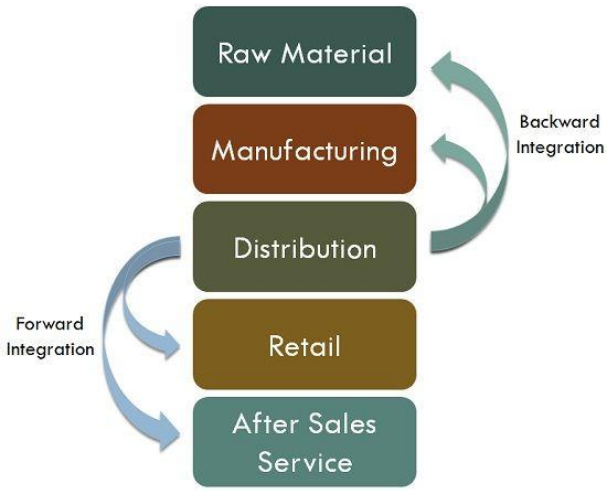

Figure 3 - Vertical integration example (https://businessjargons.com/vertical-integration.html)

Indeed, such above mentioned advantages in a non-vertically integrated scenario would indeed profoundly depend on the communication of information between a company and its supplier (Arrow, 1975). However, the sharing of key information and data is very often simply impossible when the supplier is not owned by the company. Indeed, as this hypothetical supplier has its own business, competitivity and agenda to keep track of it cannot be fully transparent about internal proceedings, problems, data and ways of working as these could potentially put their own livelihood at risk.

Another main incentive to vertically integrate is to then delete the uncertainty and informational asymmetry on price and availability of the upstream goods, as well as the encumbrance of contracting and procurement processes (Denis et al., 2020). When every cost-impacting or time-impacting factor is known to the manufacturer, it is easier for it to forecast, adapt, and manage its capital and resources. Having this control allows the firm to optimize its R&D processes by providing the entirety of the goals and the constraints without being burdened by secrecy and confidentiality, and it also allows it to smoothen production processes when technical interdependencies are unavoidable, as Armour and Teece (1980) pointed out in their article Vertical integration and technological innovation. When such interdependencies occur, it is easy to see how a manufacturing firm, for instance, can save time and money by undertaking large scale process cycles that will serve several stages of the production of its product. This however would not be possible if producers and suppliers were distinct entities. Therefore, vertical integration can be a very powerful competitive weapon, as long as a smooth coordination and an efficient cooperation between the strategic business units of the firm implementing it are maintained (Harrigan, 1984).

For the context of this study, the most important advantage of vertical integration resides in the more tightly integrated stages of production, assembly, and R&D, meaning that the information flow is smoothened across those and all steps of the value chain. Any new adjustments and upgrades required can move forwards and backwards faster and be fulfilled almost simultaneously at all levels by means of these joint efforts, setting up the base for fast technological innovation to occur, a topic which will be the main discussion point dealt on over the next section establishing the link between this business strategy and the success of small launchers.

2.2) First mover advantage

It seems rather natural to say that the first entity to successfully enter a new market, to produce a new product or service, or to use a new process should benefit from a significant competitive advantage purely by being the first (Lieberman & Montgomery, 1990). Indeed, in any field, the development and "use" of any new innovative process, technique or means of production necessarily ensures a learning process before these novelties can reach competitiveness. Companies that start off and go through this learning process earlier on can therefore reach competitiveness, success, and non-cluttered markets earlier than later arriving companies in the market. Such a process can figuratively be represented as a curve that therefore allows to clearly depict the existence of what we call the "first mover advantage", as well as its persistence and evolution in time. Indeed, trailblazing innovative companies who have experienced this "learning curve" earlier on will necessarily develop a form of "head-start" on any competitor who simply follows suit later in time. The work of Robinson and Fornell (1985) leaves no doubt of the existence of a first mover advantage : their experiments show not only that the first mover statistically usually has more market shares than the others, but also that simply being amongst the early comers will allow to have more market shares than late movers.

Although first movers can indeed profit from multiple advantages, these however are not timeless or foolproof. In fact, Robinson and Fornell (1985) also point out that this advantage seems to inevitably deteriorate with time: indeed, with pioneering also comes the challenge of protecting innovation. Theoretically, with good patent protection, a first-mover could hold its advantage for the whole patent life, and create a monopoly around the product and its market. In reality however, studies show that a majority of successful new products or processes are imitated in less than four years: on one hand, innovative processes are often less protected by patents than a product would and on the other, innovative products run the high risk of reverse engineering (Kerin et al., 1992). It is obviously less costly in time and money for competitors to imitate innovation rather than climbing the learning curve by themselves (Mansfield et al., 1981), even if not directly copying the innovation, but by somehow getting inspired and inventing around the first-comer solution. Therefore, the uncertainty of the first mover advantage is linked to the unpredictable time during which it will last. This is namely due to the level and strength of the entry barriers set by the commercial, technological or industrial context at the time and the technology at stake: the patents, the secrecy, the learning curve.

The challenge for pioneers and first movers is thus to erect durable entry barriers : by the time other companies or manufacturers have reached the profitable side of the learning curve, the first mover will hopefully have capitalized on its time ahead of the pack, and in the best case scenario, will have developed its product to stay one step ahead. Patterson (2013) talks about temporal strategic barriers that would allow the first-mover to keep its head-start

and avoid competitive confrontation, thus creating an opportunity for itself to strengthen its position by learning, progressing and ideally solidifying the barriers.

Furthermore, innovative companies and entrepreneurs also correlatively undertake a lot of risks. Indeed, not only do they have to face a steep learning curve and have to invest more money than the followers will to imitate their innovation, but there is also no guarantee that their new proposition will find an audience and a sufficient market, nor that they will benefit from any kind of advantageous market share on the long run. Thankfully however, earning a larger market share is not the only advantage at stake for first-movers. Moving early means learning early, and experience offers other advantages like cost reduction due to refined production processes, hence allowing more profit margin on the final product (Chen et al., 2019). Although, as mentioned earlier, the immateriality of experience and processes make them hard to protect, therefore only ensuring a significant advantage as long as the mastery of process or technology at stake is kept secret.

As Suarez and Lanzolla (2005) explain, "*First-mover status can confer advantages, but it does not do so categorically. Much depends on the circumstances.*". Indeed, the advantages are not guaranteed and we can find examples of late-coming competitors becoming leaders of their market in all time periods : Gillette overtaking Wilkinson in the razor blades market or Facebook taking over the world of social networking instead of MySpace are two of them. The probability of benefiting from a first mover advantage depending on the circumstances mentioned by Suarez and Lanzolla are detailed in the table below.

The Situation Your Company Faces	First-Mover Advantage		Key Resources Required
	Short-Lived	Durable	
Calm Waters	**Unlikely** Even if attainable, advantage is not large.	**Very likely** Moving first will almost certainly pay off.	Brand awareness helpful, but resources less crucial here
The Market Leads	**Very likely** Even if you can't dominate the category, you should be able to hold onto your customer base.	**Likely** Make sure you have the resources to address all market segments as they emerge.	Large-scale marketing, distribution, and production capacity
The Technology Leads	**Very unlikely** A fast-changing technology in a slow-growing market is the enemy of short-term gains.	**Unlikely** Fast technological change will give later entrants lots of weapons for attacking you.	Strong R&D and new product development, deep pockets
Rough Waters	**Likely** A quick-in, quick-out strategy may make good sense here, unless your resources are awesome.	**Very unlikely** There's little chance of long-term success, even if you are a good swimmer. These conditions are the worst.	Large-scale marketing, distribution, production, and strong R&D (all at once)

Figure 4 - Probability of a first-mover advantage (Suarez & Lanzolla, 2005, The half truth of first-mover advantage)

Four scenarii are detailed in this table depending on two factors that are the pace of market evolution and the pace of technological evolution; Calm Waters being the case in which both are slow, and Rough Waters the one in which both are fast. As this table therefore shows,

there are a plethora of various factors and resources that can play key roles in a project's success depending on the context and the environment : distribution channel, R&D, resources (financial, skills, materials), marketing… In a fast-moving market, the perfect company would have mastered every aspect of its development, however the reality is so that everything has a weakness and the leader of today can disappear tomorrow. This uncertainty and fragility will be further discussed in the next part of this document.

3. CRITICAL DISCUSSION

3.1) Vertical integration in the small launcher industry

The space industry is going through a transformation process in its structure, in which more business-driven projects are being deployed, led by commercial companies receiving private financial backing from funds that trust the potential profitability of their endeavors. Most of these companies are new entrants to the market, either startups or other already established IT companies looking to expand their business into space, which have managed to secure these funding opportunities by coming up with innovative business strategies in which innovation is key, allowing them to disrupt the market with solutions that have, as well, an innovative industrial approach component to it, such as having implemented vertical integration within their supply chains (Tugnoli et al, 2018). As it was mentioned in the section before, vertical integration has a set of advantages and disadvantages that had already been proven while being applied for years in several other industries and markets, varying from one to another, but it seems as if its particular impact in product innovation has been one of the constant positive influences of this strategy on the companies implementing it. As far as 1983, Buzzell had found a correlation between businesses that were highly integrated with a higher output of new products, independently of whether or not a major technological change had occurred and neither if the company had a smaller or larger market share. It is then not odd to consider that a decision to follow vertical integration might benefit companies in the small launcher sector as well, owning much of a supply chain as possible and seeking to manufacture and assemble to the furthest extent a product in-house without having to depend on an external supplier for its components.

There are reusable launch stages, new materials, lower cost ground operations, between many other technologies currently being deployed in the launchers industry, but the linking factor between all of these developments is vertical integration, which leads these technologies to move at a much faster rate from a prototype to a fully functional, proven and affordable commercial product. The upper hand is then gained by companies fully grasping these advantages to come up with faster and affordable solutions to the small satellite launch market, having products that are purposedly designed for manufacturability and that are easy to reproduce (Logue & Pelton, 2020).

3.2) A case of success

When citing the case of Rocket Lab, a company which has truly embraced vertical integration as part of its strategy, analyzing the causes and the effects of their approach seems to unearth a valid correlation with the theory. With the development of their Electron launch vehicle, the company managed to enter the market with disruptive innovations where possible, including additive manufacturing, all-carbon composite construction, proprietary Rutherford

engines powering both first and second launch stages (built also by additive manufacturing) and custom avionics flight hardware. All of these technologies correspond to components and critical systems of the launcher, which would normally sit in upstream positions in a traditional supply chain. By assuming a vertically integrated strategy, the company guaranteed these technologies to work with their downstream stages and to fully coordinate their business strategy with their production approach, leveraging on their manufacturing capacities to grant added value to the customers. As an example, they managed to complement their launch offering with customizable missions suited to individual customer's needs, granting full flexibility in terms of time and place to reach a certain orbit, a feat that can only be successfully implemented if the manufacturing process can be fully controlled and easily adjusted on the go to be able to fulfill multiple requirements in a streamlined manner, which is, at the very same time, a direct consequence of additive manufacturing and the capability to be able to design, develop, test and manufacture in continuous innovation cycles. Last but not least, by owning its own Test Cell and Launch Complex in New Zealand, the company fully extends its downstream capabilities to the launch end and further widens the flexibility of their launch services to their customers by not depending on launch availability of current commercial launch pads, even though they still have agreements with them to offer geographical convenience.

A supply chain structured in the previously described manner almost fully morphs into a pure value chain, in which all its steps add true lean value to the order fulfillment, even omitting engineering & design stages for each new mission to be deployed. The output is, launcher companies become an almost-make-to-order launch provider that guarantees the fastest path to a high quality finished product with the lowest amount of risk (Cappaert, 2020), by having an optimal lead time, standardized and reliable manufacturing processes, and full control over its own innovation cycle and prototype scalability. Is in this very domain that the new entrants to the launchers market, such as Rocket Lab, defy the traditional structure that for years had been present throughout the supply chain of legacy launchers, shared with and built upon the foundations of the supply chain of another traditional industry, which is aviation. Each launcher, much like an airplane, had to be almost handcrafted and assembled carefully with a non-failure approach, in which each failed test would cost not only enormous amounts of money, but also enormous amounts of lost time and a reduction of the positive perception of the launching system and the company itself. The vast difference in reliability is evidenced in their launch success rate, which will be discussed in depth in the subsequent section as it is widely linked with first mover advantage.

It would be worth mentioning a quote from Tom Ellis, CEO of Relativity Space, a company also implementing additive manufacturing, pointing out that the company "is creating rockets with less than 1,000 total components by viewing 3D printing from a top-down angle" enabling them "to actually build each rocket from raw material and fly it in 60 days. And then 60 days later, do a better version and 60 days later, a better version than that". This is, in a nutshell, the effect of innovation and technological advancements enabled by vertically integrating upstream stages. Statements and mindsets like this will prove to be highly crucial within the competitive landscape, taking into account the forecasted volumes of launches that are expected to be done in order to get the first mega constellations up to orbit and running before 2024. This means that the next 3 years will see either a consolidation or refusal of the current small launchers projects and prototypes and leave in evidence the first sketch of how the launch market will look like for the next decade.

3.3) The implication of first-mover advantage in the development of small launchers

Environmental change is an opportunity to be the first mover (Kerin et al., 1992) and as the first part of this document described, the environment changed dramatically in the early twenty-first century, creating a new product category and a market being up for grabs. Companies like Rocket Lab that saw this environmental change and the rise of small satellites started innovating on this segment 10 or 15 years ago, when most of the legacy players like Lockheed Martin, Orbital ATK or ULA did not follow the opportunity. The development period for this kind of product is particularly long: it's then safe to say that the companies that entered the segment early are going to benefit from an advantage as the competition will take several years to catch-up. That can give the early mover time to build a reputation, earn experience through repeatability, smoothen their production process and their internal organization, or even develop additional products to propose a more complete solution to clients. That is for example the case of Rocket Lab, that has already launched 19 rockets deploying 104 satellites into orbit when promising new entrants like Firefly Aerospace, ISAR Aerospace or Relativity Space are still prototyping their respective launchers, reaching the very end of their development phase. The head-start that Rocket Lab earned for itself allowed them to continue developing their offer with a modular satellite bus that can be tailored to each client to accommodate their payload, components and satellite subsystems to help clients build their spacecraft, and they are even developing a new, heavier launcher. Therefore, it is safe to say that this company perfectly managed to take advantage of their first mover advantage, using their time and resources to develop their offer around the launcher itself.

The market share advantage is obviously something to go after, but the size of the small satellite market, even if growing, is never going to be very large : the real size of the potential market is an uncertainty (Denis et al., 2020). A product appealing to the general population has a much wider audience to capture, locking the biggest market share in is going to be the main goal. In our case, the learning and the experience is a crucial asset for the small launcher manufacturers. The investment at stake is enormous, the payloads are often worth tens of thousands up to a couple million dollars and the loss of such objects is a huge setback both financially and timewise. Hence, a spot on a vehicle that has been proven to be reliable is very valuable and having had the opportunity to build and test prototypes, go through some trial and errors processes to deliver a safe and reliable product in the end, at the cheaper price possible, seems to be the winning course for the companies entering this market. Being the first or one of the early movers will give a precious head-start to the new entrants. The comparison between Arianespace and its Vega, and Rocket Lab's Electron is interesting to mention here : Vega, the small launcher developed by the European giant Arianespace took its first flight with a payload in 2012 and has today a success rate of 88% over 17 flights (Meddah, 2020). Rocket Lab offered its first ever rocket Electron for business in early 2018, and it has, since then, had a success rate of 94.4% over 18 flights (Spacelauchreport, 2021). By proving its product to be efficient, reliable and rapidly ready, Rocket Lab earned a significant place in the small launcher market : Electron is scheduled for 13 more flights in 2021 as of today, when Vega is scheduled to launch 6 times between today and 2025. The Figure X below is a representation of the head start Rocket Lab built itself, compared to the development stage of a few of its future competitors. It highlights the period of time during which this company benefits from a first mover advantage. The details about the building of this graph, the different stages and the data used can be found in Annex 1.

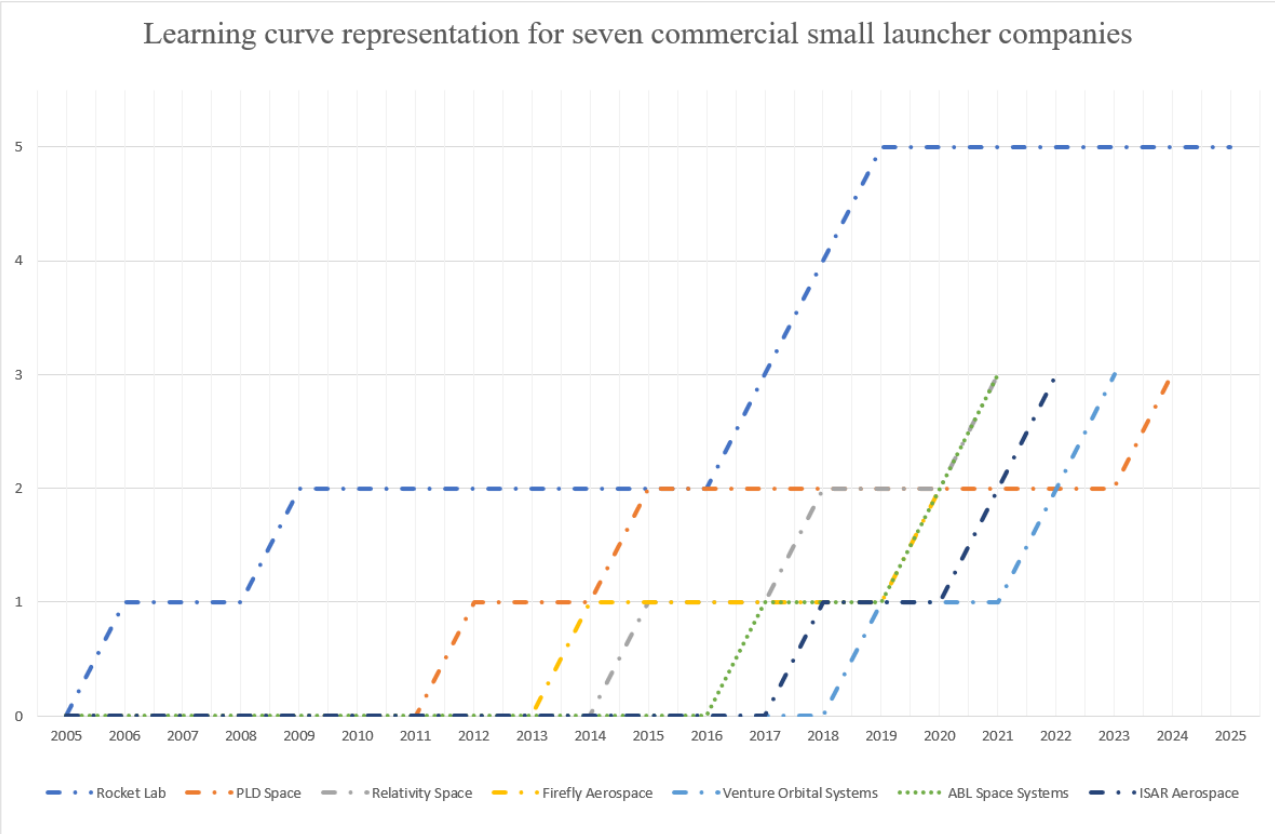

Figure 5 - Learning curve representation, assessed upon the maturity of the product of seven small launcher companies (as of April 2021)

Rocket Lab has indeed reached a fairly high point in their learning curve before the entry into service of most of their competitors' products, that are still being developed around the world. This head start has provided them with a comfortable backlog of scheduled flights ensuring resources to develop their processes and products to continue staying one step ahead. However, this example shows how a newcomer start-up, being a first-mover by its business model and production processes, imposed itself as a leader in a market that a legacy giant was struggling to get into. How long can it hope to keep this leader role before history repeats itself and a start-up under development today comes into the market and takes its place?

3.4) The example of the commercial aircraft industry

SpaceX was the first player in the rocket industry to develop a reusable rocket which has therefore allowed them to earn the trust of most entities in the space industry, all the way from commercial satellite operators to NASA. It has, and therefore continues, to clearly benefit from the First Mover Advantage within the launcher industry. It is today one of the companies who has launched the highest number of rockets yearly in the world. In the small launcher market on the other hand, having been one of the first movers Rocket Lab is still the leading actor in its market and continues to benefit from its First Mover Advantage. It is undeniable that it is the key player in their domain today: gaining experience with every mission, it has put 109 satellites in orbit with 19 launches.

However, as previously discussed, competition in the small launcher industry is rapidly developing, we can thus ask ourselves whether the advantages that result from being a first move will necessarily last, and to what extent is this advantage really guaranteed?

Throughout history, there has of course been an extensive number of examples of companies that were not able to hold their leader status and their first mover advantage. The small satellite industry being a relatively young entrepreneurial field, it is for now difficult to veritably assess the evolutions and fluctuations of the first mover advantage of the key players within this domain. Ergo, in order to illustrate the potential limits of the theoretical framework of first mover advantage, a clear subject came to mind: commercial aviation. The new entrepreneurial gold-rush we are witnessing today in the New Space age is reminiscent of the one of the aviation industry at the end of the Second World War. The democratization of air travel in the second half of the twentieth century reminds us of today's newfound affordability of placing objects into orbit. Between 1925 and 1975, over a mere fifty year window, the aircraft passenger capacity and the speed of aircrafts had multiplied by 20 (Mowery & Rosenberg, 1981). The war indeed allowed for a few aircraft manufacturers to gain experience and grow significantly, these were namely the iconic Boeing, Convair, Lockheed, Douglas and McDonnel. This strong experience developed during wartime allowed them to therefore develop into the commercial aviation industry. A first striking fact however is that although these were the big names in the era of commercial aviation, they are not the names that come to mind when talking about the pioneers of aviation except for Boeing. Companies like Loening, Keystone or Curtis-Wright had already been building planes between the two world wars, and yet none of them are still around today : some may still be somewhat alive through merger and acquisitions, but they left their identity and the aircraft market when they were the pioneers of their industry.

Convair's case is namely interesting as it theoretically stuck to the definition of first-mover described earlier in this paper: by innovating to propose a new product. In the second half of the XXth century, Douglas Convair, Boeing and Lockheed raced each other to capture the growth of this new commercial aviation industry. In order to differentiate itself and outrun its competitors, Convair undertook the challenge to build the world fastest jetliner in the late 50's. The firm had to innovate to great extent to cope with the technical constraints of such a plane, developing for example the world's first turbofan engine. It could be assumed that Convair would have capitalized on such technical advancements: it earned experience and engineered new techniques, providing a unique and improved product. However, with this new product the company has been out of touch with the market needs, which is one of the main risks faced by innovative firms and went out of business shortly after.

Figure 6 - Convair 990 (By San Diego Air & Space Museum Archives - https://www.flickr.com/photos/49487266@N07/22104275384/, Public Domain, https://commons.wikimedia.org/w/index.php?curid=82257393)

Just as discussed in the previous section of this document, one of the risks undertaken by the first-movers and the innovators is to not find a market for their new products, and this doomed Convair from the start, as there was no real incentive to build a faster airliner. This example shows that a first-mover advantage is not guaranteed. Airbus on the other hand, did not forget to focus on the market it was hoping to take over. In the early 1970's, the A300 was developed with a plethora of technological innovations, but it was precisely designed to disrupt the American market. The new European manufacturer knew a slow start but its strategy was the right one: it competed with Boeing, Douglas and Lockheed until becoming one of the two heads of the world duopoly we know today (Eriksson et al., 2016). When innovating with the hope of being the first mover and therefore benefiting from a leader's position, it is crucial to not turn a blind eye to the surrounding influential factors.

Hence, the first-mover advantage is important as it gives a precious head start against competitors, but companies must keep an eye on the market needs, as history has shown. Rocket Lab is a good example of a company innovating with a focus on the market demand. The company implemented an efficient vertical integration, made a good use of the technological advancements of its time like additive manufacturing and composite materials, all the while addressing a very promising market.

Only time will tell if the company's first-mover advantage will be kept and consolidated: the price to pay to launch a kilogram in low earth orbit with Rocket Lab's rocket is not among the cheapest of the market. So far, the firm is the only mature one in its segment, but when mature competition will come flooding the market, prices will be driven down and Rocket Lab will have to continue innovating to be ready to face its upcoming competitors, for example by working on the reusability of its boosters.

CONCLUSION

The fast-growing small satellite market is a very good incentive for the development of start-ups providing small launching solutions within the New Space sector. To understand the success of young leaders in this new space race, two managerial principles that are vertical integration and first-mover advantage, have been outlined.

The former seems to not only ensure a reduction of costs and a saving of time by eliminating several processes such as contracting and procurement, but it also allows for a significant decrease of the uncertainty of supply and also provides the company with control over its capital and production processes.
Therefore, vertical integration is indeed one of the main differences of operation between the New Space companies and the legacy players of the industry.

The study of the latter principle, the first mover advantage, has shown that even if the advantages are not guaranteed, being the first to capture, capitalize upon, and use an opportunity is often source of positive entrepreneurial outcomes for a company. While deep pockets are needed to fund an R&D process that can be hazardous, a successful innovation grants the company a head start on its competitors in terms of market shares. Today, Rocket Lab development being significantly ahead of its competition, it can display a stronger backlog than traditional actors of the market would. Their impressive stance in today's small satellite launcher market can therefore be explained by the reputation the company was able to build for itself during a time where it wasn't challenged by competitors. Indeed, as long as the first-mover effect lasts, the company continues to gain experience, earn the client base's trust, make a return on investment and should then develop its product portfolio as well as its industrial processes in order to raise the entry barriers and stay one step ahead in its market. The next challenge for the company will then be to make this period of time as long as possible and capitalize on this advantage to maintain this head start.

Evidently, the implementation of the two above mentioned strategies does indeed involve a form of risk-taking; the firm has to master the whole value chain, cope with potential loss that would have impacted the supplier of the company in a more traditional setting and venture into unknown territories being the first mover.
Yet, the execution of these managerial strategies seems to be highly paying off for first movers such as Rocket Lab.

However, as the aircraft industry has showed, a paradigm shift and novel technological innovations could very likely arise and thus spur the rise of new entrants within the small satellite industry. The use of cheaper alternative fuels, or the development of the competition in countries with a cheaper workforce could very possibly turn the tables of the current industry leader board. Therefore, as demonstrated, small launcher manufacturers have indeed been strongly and successfully impulsed by vertical integration and first mover advantage. It is therefore now their responsibility to use these tools that have clearly solidified and consolidated their success in the industry, as stepping stools to continue reaching for greater opportunities all the while keeping an eye on the possibilities of tomorrow.

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FIGURE TABLE

ANNEX 1

This graph represents the advancement of the development of a few small launcher manufacturers. For clarity of reading purposes, only a few companies have been chosen to appear on this graph. The numbers on the Y-axis of the graph correspond to different arbitrarily chosen stages of the development of a small launcher company. The correspondance is the following:

- 1 : Foundation of the company
- 2 : Prototyping. The dates for this stage correspond to the year the company started large scale testing of critical components, such as engines or fuel tanks.
- 3 : First flight of the launcher, without a commercial payload
- 4 : First commercial flight.
- 5 : Tenth flight. This stage represents the maturity of the product, as it has flown ten times with a commercial payload.

The dates from 2021 and beyond are estimated and presented here according to the data provided by each company, their estimations and their scheduled flights. All data has be retrieved from the corporate websites of the mentioned companies.