



SpaceX and Disruptive Innovation: The Emperor's New Clothes? *

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The subject of technological innovation in the space sector is generally approached from two known angles. A first angle consists in underlining the importance of innovation in the space sector as the means par excellence to ensure the continuity of the multiple services, which, in their turn, guarantee the survival of all the sectors of activity of our societies. The second angle is part of a discourse of a strategic nature. It is therefore a matter of considering space as an instrument serving modern military operations, supporting nuclear deterrence or enabling to keep a watchful eye on the various regimes, agreements and treaties ought to prevent the occurrence of conflicts or settle the consequences of their cessation.

Here, I would like to look at innovation in the space sector from another perspective. To this purpose, I will demonstrate how the new space entrepreneurship (more commonly qualified by the generally accepted Anglicism *New Space* and particularly embodied by SpaceX that is strongly developing across the Atlantic) is part of a fratricidal war between historic leaders of the sector and new entrants, and, at the same time, the instrument guaranteeing renewed technological domination on a global scale.

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An Alternative Way of Doing Things in Space?

This e-Note will not expand on the origins – both near and far – of *New Space* in the United States. This subject would rather find its place within the framework of a paper devoted to the sociology of technological and industrial players. However, since retracing the epic that is regularly distilled to us by the actors of this ensemble (SpaceX, Blue Origin) comes to nothing, it is important to situate it in the US ecosystem, which is simultaneously political, industrial and technological.

The *New Space* phenomenon in the United States did not appear *ex nihilo*. And it is no coincidence that its arrival occurs especially in the United States. By the end of the Cold War, the United States found itself confronted with an unprecedented challenge that could be summed up in a simple question: how to enable the conversion of an entire military-industrial complex shaped to the prevention or the conduct of a major and global war? This question was of particular concern to the aerospace sector, whose order books had been filled by government requests throughout the Cold War. Since the affront suffered because of Sputnik's feat in 1957, the American industrial fabric had been entirely devoted to a global technological competition against the Soviet Union.

The 1990s therefore called for many changes. The objective was, no more and no less, to transform the formidable American technological tool into an instrument of commercial dominance. The Clinton administration initiated this 'new' commercial instrument as of the middle of the decade, offering the private sector, DigitalGlobe in particular (since 2017 known as Maxar Technologies), the possibility to commercialise high resolution satellite images. From the beginning of the 2000s, a few entrepreneurs from outside the space sector, who had emerged from the digital revolution, decided to take advantage of events and American institutional support. In the United States, the idea of private industrial initiative being the lifeline of space policy had long been prevalent, but it materialised after several events, the first being the retirement of the *Space Shuttle program*. The *Columbia* incident of 2003 definitively drew a line under this initiative, which, over the years, had proven particularly costly both in financial terms and in human lives. In 2010, the Obama administration officially buried the shuttle programme. The programme – which was supposed to not only facilitate access to space but, even more so, to make it more affordable, – had completely failed; a record that the veneer of American technological marketing – the idea of selling a *story* – strove to cover up.

Four years preceding Obama's decision, two new projects were launched in 2006 through calls for tenders: the *Commercial Resupply Services* (CRS) and the *Commercial Crew Development* (CCD). These two projects formed the *Commercial Orbital Transportation Service* (COTS) programme for which a dedicated office, the *Commercial Crew and Cargo Program Office* (C3PO), was established. With the end of the shuttle programme, and the pending arrival of a replacement system to resupply the ISS, the United States and Europe depended on Russia and its Soyuz launcher. However, the prohibitive launch costs imposed by Russia (increasing from \$25 million in 2006 to \$81 million in 2018), prompted the US and its partners to search for new solutions².

It is important to specify that, until the advent of *New Space*, the space sector represented an extremely powerful and structured organisation, to such an extent that the prospect of the arrival of new entrants seemed almost improbable. Newly investing in the space sector is one of the most risky ventures given the numerous existing barriers. To enter the space domain, new entrants have to surmount many technical and organisational complexities, overcome prohibitive investment costs, and confront the uncertainties associated with the development of new technologies, etc. In addition,

² Alessandra Vernile, *The Rise of Private Actors in the Space Sector*, Vienna and Switzerland, European Space Policy Institute (ESPI) and Springer, Springer Briefs in Applied Sciences and Technology, 2018.

R&D in space usually requires a considerable amount of time and money; hence, entrants need a proven long-term financial stability. Considering these conditions, one can more easily imagine how the emergence of new space entrepreneurship at the eve of the 21st century shattered the certainties of a sector dominated by large groups. However, this new space entrepreneurship, often presented as the result of a revolution initiated by the private sector alone, owes its existence as much to the American authorities as to the tenacity of a few visionary techno-evangelistic leaders.

Thinking about *New Space*

The expression *New Space* is infelicitous, designating a phenomenon that is far more complex than it appears.

First of all, it is a mistake to think that *New Space* may form a homogeneous set of actors. It would be more appropriate to speak of a multiplicity of ecosystems impacted by emerging new challenges in the space domain. In fact, space has been undergoing multitudinous transformations and upheavals for more than twenty years. Yet, one could not deny that new players (often coming from innovative ICT companies) have emerged. However, these are not the sole disturbances that have taken place during this period: new powers, new challenges, new risks, new approaches, new needs have also surfaced. Space has become an extremely evolving technological, ecological and sociological environment³.

It must also be added that, as surprising as it may seem, SpaceX is not the perfect embodiment of the *New Space* philosophy, at least as it is conceived in the United States. In many ways, the 'SpaceX' model, as implemented by its co-founder and CEO Elon Musk, differs from the practices of many *New Space* companies. For example, *New Space* enterprises, in their vast majority, would prefer to find on the COTS market technologies for which they do not possess either the expertise or the technical and human resources. SpaceX has adopted the exact opposite philosophy: conceiving their own subsystems because they do not consider the ones available on the COTS market to be satisfying enough.

Second, *New Space* is quite a misnomer, for it implies that there would be an 'Old Space' with old-fashioned habits. This vision does not take into account the ambivalence of the relationships between the 'new players' in space and the long-established industries (or presented as such). The expression *New Space* implies, in a way, the existence of a fundamental rupture between an old and a new vision of space. However, as we will see, the links between *New Space players* and the so-called 'historic' industries are far more complex and, to some extent, a bit more ambivalent.

This is the reason why many experts prefer to replace the expression *New Space* by a new one based on a contraction in accordance with the spirit that is supposed to guide the members of this group. This contraction is *Alt.Space*, which refers to a group of companies and entrepreneurs determined to adopt different and alternative solutions in order to "do things in space"⁴. If *New Space* were best defined by the quest for alternative ways to develop space capabilities, then it would be interesting to examine how 'innovation' – often presented as 'disruptive innovation' – is envisaged by *New Space* companies and, more particularly, SpaceX.

³ Gil Denis, Didier Alary, Xavier Pasco, Nathalie Pisot, Delphine Texier, & Sandrine Toulza, "From New Space to Big Space: How Commercial Space Dream is Becoming a Reality", *Acta Astronautica*, Vol. 166, January 2020, p. 432.

⁴ Ibid., *Acta Astronautica*, Vol. 166, January 2020, p. 432; See also Michael Lewis, *The New New Thing: A Silicon Valley Story*, WW Norton & Company, 1999.

Disruptive Innovation as a Game Changer

Innovation is by far an abstruse term and its apparent familiarity can be deceptive in many regards. Innovation is more a notion than a true concept. It designates more precisely the introduction of something new and its incorporation into what already exists. Therefore, innovation must be distinguished from creation, which refers to the act of giving existence, of drawing from nothingness. It also differs fundamentally from invention which relates, for its part, to the action of creating or discovering something new. Paradoxically, innovation, while introducing a 'change' into what already exists or subsists, presumes a sort of 'conservation principle'. Innovation thus remains a product of what already exists, although not strictly resembling it.

Innovation, unlike progress, presupposes the existence of a crisis. Maybe we could try to find in this interpretation the main criteria that help explain the progressive substitution of the idea of progress for the notion of innovation. Through the introduction of what seems to be 'new' and because of the interaction between this novelty and pre-existing concepts, innovation generates a 'conflictual situation' for it disturbs the established order.

Generally presented today as technological improvement of existing material conditions, the notion of innovation was built on an economic conception of social relations. By 1912, Joseph Schumpeter had established innovation as one of the main dimensions – if not the main dimension – of capitalism. The Schumpeterian approach of modern capitalism is nowadays overused. Yet, innovation, as conceived by Schumpeter's theory of economic cycles, is very instructive for it helps explain the processes by which a young – or not so young – company like SpaceX (and other companies belonging to *New Space*) operates. A closer look at the notion of innovation leads us to allege that *New Space* does not seem so... new. Indeed, if *New Space* has emerged, it is essentially due to the US government's decision to open the space domain to the commercial market, thus creating a 'new economy' mainly derived from military technologies for which outcomes were defined by a context characterised by disarmament. However, in such an economy, which is essentially based on a cyclic process in which an increasing number of newcomers compete while developing their expertise and skills, profits move progressively towards zero. It is in such (critical) moments that innovation acts as a groundbreaker.

Five main types of innovation can be distinguished, according to Schumpeter:

1. the production of a new good;
2. the appearance of a new source or a new raw material;
3. the development of a new production method;
4. the establishment of a new productive organisation;
5. the opening of new outlets.

The *New Space* phenomenon can be associated with innovation schemes of types 3, 4 and 5. The new space entrepreneurship owes its existence neither to the production of a new good (satellites and launchers are by far long-established and proven technologies), nor to the existence or the appearance of a new raw material. The principle of reuse (applied to the boosters), even if it is based on the mastery of a complex recovery process, is in no way a 'novelty': remember that the *Space Shuttle Program* was entirely based on this reusing approach, which was expected to generate economies of scale in line with the increasing number of missions. Innovation driven by *New Space* rather relates to the development of new production methods, atypical productive organisational schemes and – as confirmed by the launch of programmes such as *Starlink* – the development of new commercial outcomes.

Though it could be asserted that *New Space* entrepreneurship – and first of all SpaceX – is guided by, let us say, a Darwinian approach to innovation, it should be reminded that SpaceX has always taken care to identify among its competitors the resources – both technical and human – that could increase its leadership in its core business. In other words, the *New Space* entrepreneurship sees innovation as a real warlike process at least for two reasons: first, because SpaceX appropriates an invention that has previously been developed by other players – precisely those players SpaceX wishes to overthrow; second, because SpaceX intentionally introduces uncertainties and struggles of influence on the market. Disruptive innovation is nothing less than the destruction of the previous order – on which it is nevertheless based –, while established actors perceive this same disruptive innovation as deviance.

A Libertarian Façade

Disruptive innovation carried by *New Space*, and in particular by SpaceX, is aimed, first of all, at transforming manufacturing processes and organisational methods of space in the United States. However, it is important to underline the specificity of this phenomenon in the United States.

Historically, the organisational model of the American space industry was based on the search for major technological gains over several generations in order to exceed the capacities of an adversary, and this by resorting exclusively to public funds. This innovation model took place during the Cold War period and has persisted since the 1990s in both the space and military fields. This development strategy – also called *Offset Strategy* by the United States – had a single objective: outclassing a proven or designated adversary – or an economic competitor (even an ally!) – in the long term. However, costs associated to this Offset Strategy were dissuasive and could only be supported by actors possessing a scientific, industrial and technological base that had reached a certain critical mass. In addition to the financial costs to be borne by both the manufacturer and the public authorities, this innovation method involved a socio economic charge that was often ignored and yet decisive for the industrial landscape. The search for disruptive innovation at any cost carries the idea that that the company offering the most avant-garde technological solution would win the market. Once this contract was awarded, companies having lost the call for tenders often found themselves in a situation of virtual bankruptcy and few of them managed to recover from such a failure. That innovation model gave birth to the *US Space Shuttle Program* in the 1970s.

However, this logic of innovation (namely, the permanent search for technological upgrading) gave rise to a paradoxical phenomenon. Reaching a technological level far superior to what other players could offer did not guarantee long-term profitability. At many occasions, the technological leap made by competing companies proved to be devoid of economic utility to such an extent that less efficient technology proved to be just as attractive for profitable exploitation by market agents.

The disruptive innovation proposed by *New Space* is no longer based on the achievement of a major qualitative technological leap (in the material sense of the term), but rather consists in promoting the evolution of innovation according to users' needs. In other words, we could say that disruptive innovation is less about developing better products for existing users than offering these same users the means and products that, although not at the cutting edge of technology, meet expected needs while providing cost advantages. This development method lays the foundations for a new cycle of hardware evolution, the results of which are used by other and more demanding users who, for their part, will not hesitate to pay more for the acquisition of a more sophisticated system. Simply put, disruptive innovation aims to offer basic technological products that meet the 'primary' needs of certain users with a view to gradually improving these products in order to provide them in the long

term to more demanding users who will agree to pay a higher price for these improvements. The *business model* of a company such as SpaceX is therefore founded on the complete reversal of priorities by focussing on customers' needs before listening to the designers of the technologies. Furthermore, on an organisational level, SpaceX's comparative advantage is that it has sought out skills outside the company. The company has thus given up on internally building up its pool of skilled professionals to poach those who existed either among its competitors, or even within NASA or other sectors of activity (such as automotive or digital sectors).

Contrary to a popular misconception, SpaceX's first objective has never consisted in attacking its European competitors. It is a huge mistake to think that SpaceX wishes the downfall of the Ariane programme. SpaceX fought its first battles within the American technological and industrial ecosystem, in particular by entering into direct competition with the launch giant, United Launch Alliance (ULA). ULA is a joint venture established between Lockheed Martin Space Systems and Boeing Defense, Space & Security, which has strong links with the US Department of Defense when it comes to its programmes. The aggressive pricing strategy put forward by SpaceX was therefore, initially at least, developed to challenge this dominance. The military certification issued to SpaceX by the Pentagon in 2015 represented a real victory for the company since, in doing so, it succeeded in breaking the monopoly previously held by ULA for classified launches⁵.

Like a majority of companies emerging from *New Space* entrepreneurship, SpaceX was able to take advantage of the reorientation carried out by NASA in the mid-2000s. Confronted with the question of replacing the *Space Shuttle Program* that was used to resupply the ISS, NASA was looking for a solution that could relieve the United States of the discomfort of resorting to the Russian Soyuz launcher. The idea of the American space agency was to entrust the private sector with the initiative of developing appropriate programmes, a mission it had taken on until then. When NASA asked the private sector to send proposals for solutions allowing the future refuelling of the ISS, SpaceX took the opportunity to offer a solution at a price far below the prevailing market costs. While at first NASA refused to consider the offer made by SpaceX, a year and a half later, it ended up accepting the newcomer's solution.

Very quickly, NASA understood how a company such as SpaceX could constitute, in the long term, a considerable asset in the war that the agency aspired to wage against the leaders of the space sector in the United States. NASA was the first to manage to save SpaceX and its innovation model from bankruptcy in 2006. By including in 2006 SpaceX (alongside Boeing and Orbital ATK) in its selection of companies from the private sector for its Commercial Orbital Transportation Services (COTS) programme, NASA fostered a quasi-symbiotic relationship between the public sector and private initiative. The goal of this decision was to encourage the historical leaders of the sector to review not only the tariffs in force, but even more so, their organisational structures and managerial methods. In other words, if SpaceX did indeed break down the organisations and industrial processes in force, it was with the full support of the so-called 'old bureaucracy' and NASA, which took the opportunity to put pressure on Boeing and Lockheed Martin. In doing so, however, NASA had no intention whatsoever to break up its industrial fabric, but tried to make it evolve in order to prepare it for future challenges on the international level. It is also essential to underline the changes to which disruptive innovation, as exercised in the US space sector, is leading. While, as previously indicated, the historical leaders of the space sector in the United States relied above all on projects aiming to allow a major (particularly costly) technological leap, SpaceX, for its part, bet on the development of new economic models. This context allows us to better understand the connection between Tesla and SpaceX. Numerous transfers of engineers from Tesla to SpaceX were initiated for the implementation of new methods of project management. Moreover, SpaceX's *modus operandi* is entirely focussed on the conduct of one or more given projects. As soon as the company has reached its objective, the dedicated teams will be dissolved.

⁵ « SpaceX : sixième mission de sécurité nationale », *Air & Cosmos*, n° 2743, 9 July 2021, p. 33.

Finally, one has to add that the emergence of the *New Space* players, generally coming from the digital world, is by no means the product of coincidence. We are witnessing, to a certain extent, a merger of sectors. For nearly twenty years now, most of the activities in the space sector no longer come from launchers or the construction of satellites; they have revolved around the space services market. The world of aeronautics, space and information and telecommunications are merging. A satellite has become, in a way, a device among others, with which it is now possible to communicate as if it were a computer, with the particularity that this 'computer' is located in orbit.

Conclusions and Observations

Far from representing a homogeneous block, the *New Space* phenomenon raises many questions.

The first one concerns the reality of the disruptive nature of innovation, as conveyed by a company such as SpaceX. This innovation mainly covers the methods of governance and project management rather than technologies. The principle of 'reuse' is not so much a technical feat as it is the only method for Elon Musk's company to maintain an aggressive price level for its launches. It is important to insist on the fact that the profitability of the solution of 'reusing' requires significantly more launches and therefore a massive order book.

This is undoubtedly the reason why SpaceX is accumulating a great number of contracts with the American public authorities, NASA and the Department of Defense, at the risk of distancing itself from a libertarian vision of innovation. In addition to serving the ISS with the automatic cargo vessel CRS-22, SpaceX has placed a second telecommunications satellite in geostationary orbit for the operator Sirius XM, placed in medium orbit a new GPS III satellite on request of the United States Space Force (USSF) and installed two Mandrake 2 technological demonstrators on behalf of DARPA⁶ for communications via optical links. Since 2017, no less than seven American classified missions have been entrusted to the Falcon 9 rocket. An eighth mission of this type was entrusted to Falcon Heavy⁷.

The disruptive innovation model therefore presents certain weaknesses that push a company such as SpaceX in a frantic race for launches. First for the needs of its own programme, *Starlink*, then in order to meet American public orders. There is, nonetheless, a fear of saturation of certain orbits and the risk of frequency interferences. Disruptive innovation therefore presents an indirect but real danger by casting a shadow of uncertainty over the future of space sustainability.

The question now being asked is, given its characteristics and limitations, whether the organisational model developed by SpaceX can be transposed into the European space sector. A similar question concerns the principle of re-use of launchers. Can we imagine Europe evolving towards the design of reusable launchers in the near future?

Recently, the French Minister of Economy, Bruno Le Maire, set the future objectives of Europe in space by announcing the development of a reusable mini-launcher by ArianeGroup, with a launch target in 2026⁸.

⁶ Defense Advanced Research Projects Agency

⁷ « Lanceurs : centième succès d'affilée pour le Falcon 9 », *Air & Cosmos*, n° 2738, June 2021, pp. 30 – 33.

⁸ Florian Maussion, « Espace : ArianeGroup va à son tour construire un mini-lanceur réutilisable », *Les Echos*, 6 December 2021, cf. [Espace : ArianeGroup va à son tour construire un mini-lanceur réutilisable | Les Echos](#).

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It is not certain that the principle of a reusable launcher provides the most appropriate solution for the European space sector. Certainly, the number of launches operated by SpaceX seems impressive, but it is largely driven by its *Starlink* programme. In other words, SpaceX's success in the launch sector is the result of the progress of SpaceX's *Internet by Satellites* programme. Nonetheless, a more detailed examination of the performance of SpaceX's activities reveals that fundamental differences exist between launches operated by Europe and those carried out by SpaceX. During the last 53 months, SpaceX's Falcon 9 launcher has operated around a hundred flights, while its European competitor has only counted 19 flights. This comparison seems, a priori, to attest to the overwhelming superiority of SpaceX. If we examine the number of satellites sent to geostationary orbit (the strategic orbit for the telecommunications systems on which our societies depend), it appears that, since 2017, the Ariane 5 launcher has been able to place 31 GEO satellites in orbit, while SpaceX was only able to place 21 satellites of that same category⁹.

The Ariane model therefore has specific features different from those of SpaceX. However, by trying to compete with SpaceX on reusable launchers, Europe runs the risk of witnessing the American authorities further increasing their financial support for SpaceX's activities; a scenario that would undermine the commercial viability of ArianeGroup, making SpaceX's model the Emperor's new clothes of US worldwide technological dominance. Moreover, for a European reusable launcher to be economically viable, order books need to be filled with a high and lasting level of orders. In conclusion, the reusable launcher is one technological solution among others. But it is not the only one.

⁹ Ibid., *Air & Cosmos*, n° 2738, June 2021, pp. 30 – 33.



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