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Space Fordism and Europe

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2022 was a record year in terms of space activities, with 180 launches and almost 2,500 satellites sent into orbit around the world.

BACK TO EARTH FOR EUROPE

Yet in the same year, Europe carried out only six launches. And for good reason: nine of the fifteen launches carried out in 2021 involved Soyuz launchers, the remnants of a now defunct cooperation with Russia. European players now have to turn to India to launch the satellites in the OneWeb constellation, which are built in the United States. While Ariane 5 recently made a successful final launch on 5 July from Europe's Spaceport , the delay incurred with Ariane 6 means that Europe will not have an operational launcher before 2024, and will not have the resources to match the launch rates of its American and Chinese competitors. What's more, some of the launcher's carrying capacity has already been pre-empted by Amazon for satellites in the Kuiper constellation, which is continuing the American colonisation of low-Earth orbits (LEO). After having been the leader in the manufacture and launch of commercial satellites, Europe appears to have fallen out of favour. So, what has happened? Is it possible to catch up? And on what terms?

THE RISE OF MASS PRODUCTION SPACE

The problem is both industrial and institutional. Since the 2000s, space activities have entered the era of mass production: until now reserved for a happy few served by an industry of prototypes, space has opened up to vast constellations extending terrestrial information networks. The five hundred satellites in geostationary orbit have been joined by myriads of thousands of low-orbit relay sensors. This paradigm shift, which goes beyond a simple change of scale, has been underpinned by the industrial vision of entrepreneurs such as Elon Musk, Jeff Bezos and Richard Branson.[1], and the rallying of American civil and military institutions to their cause.

When Elon Musk created *SpaceX* in 2002, he was staking his hopes on the fact that the digitisation of the economy would have an impact on the space business. He wanted to democratise access to space by lowering the barrier to entry into the sector - the cost of launching satellites. In the monumental factory at Hawthorne in California, where the production lines encircle the offices, SpaceX organises its system of mass production. It is based on the vertical integration of specific components - 80 to 90% of launch vehicle components are manufactured on site - and so-called "*iterative*" innovation, with more frequent and less expensive tests. Trial and error, and the correction of mistakes, have become an industrial process. In this way, the company is reducing the development time for launchers in a sector where time is not yet of the essence. It is also adopting methods and components from other sectors (automotive, aeronautics) that are well versed in mass production. The digitisation of processes and the use of unhardened, flight-tested components are accelerating the standardisation of machines and components. Here we find the main features of Fordism, the theory of industrial organisation that Henry Ford promoted, which aimed to increase productivity through product standardisation and a new organisation of work that accompanied the mass production of the Ford T. In 2009, much to the dismay of the sector's established players, *SpaceX* marketed its first reliable launcher. The *fordisation*[2] applied to the entire industrial chain, eventually led to the emergence of the first partially reusable launcher, the Falcon 9, operational in 2017.

[1] Three launch companies, Blue Origin (Jeff Bezos), Space X (Elon Musk) and Virgin Galactic (Richard Branson), were each founded two years apart, between 2000 and 2004.

[2] This article summarises an eponymous study undertaken at the end of 2022 by a group of trainee engineers at the Mines Paris – PSL.

Its concept, which reduces launch costs and times by 30% for the manufacturer, is emblematic of the revolution the industry is undergoing.

SPACE IN THE INTERNET AGE

From then on, launching satellites became more affordable. New markets emerged, driven by players from outside the space industry who were quick to take advantage of *fordisation*: satellite construction, infrastructure management, data collection and processing. In 2015, Elon Musk launched *Starlink*, a constellation providing high-speed internet from low-Earth orbit, which he said would "*revolutionise the satellite sector like it had that of rockets*". Other projects followed, stimulated by the digital economy: *OneWeb*, financed with Indo-British funds, Kuiper, launched by Jeff Bezos, Amazon CEO. With the arrival of mini-satellites and the need to expand the Internet, operators are turning to low-Earth orbits (LEO, between 400 and 1,200 km), which offer greater accessibility, resilience, coverage and faster data transmission. And, above all, the means to observe. The geostationary orbit (GEO, at 36,000 km), where space-based telecommunications used to be concentrated and basically only transmitted, is now losing its prevalence. Since orbital positions and frequencies were nevertheless limited, the Americans, Chinese and Europeans realised that they had to enter the race. This marked the birth of *New Space*, which attracted a growing number of private players into the space sector.

Over the next ten years, low-Earth orbits became the base for a data-driven industry, with civil and military operators, as well as local authorities, energy producers and insurers, all vying for the data collected in space. Earth observation, navigation, surveillance, the *Internet of Things*: space infrastructures capture information, connect it to terrestrial systems and integrate it into their traditional functions. Innovation is ongoing throughout this chain. The aim is to provide more accurate, high-resolution images that are transmitted to users faster and more frequently. Satellite constellations are reducing revisit times (frequency of passes over a point), extending coverage and raising resolution. Inter-satellite laser links, which are still in the development stage, intend to avoid terrestrial relays and speed up the flow of information to the user. These innovations are significantly reinforcing the militarisation of space, because information, traditionally critical in warfare, has become a factor in hegemony.

Downstream, numerous companies are emerging to exploit data and offer new services. Since the late 2000s, entrepreneurship has been stimulated by private investment ($15 billion for *spacetechs* worldwide by 2021), leveraged by public funding. New entrants are exploiting Earth observation data for military, agricultural, resource management and other purposes. The proliferation of debris caused by the growing number of space objects is creating new markets for in-orbit services that also promote the development of a more sustainable ecosystem.

THE CHALLENGE OF DUALITY

While the space sector is becoming increasingly privatised as *fordisation* progresses, public-sector players - the vectors of national sovereignty - remain omnipresent. Without NASA's decision to delegate the costs of maintaining and keeping its programmes in service, Elon Musk's space ambitions would have remained a dead letter. In 2008, with the financial crisis threatening all its assets, SpaceX won a record $1.6 billion contract from the US Space Agency to supply the International Space Station (ISS). A providential order, followed by many others.

Year after year, public support also reflects the very strong civil-military duality of the space industry. NASA has always been close to military institutions. The *Department of Defense* (DoD) and the National Security Agency (NSA) have been joined by the *US Space Command* and the *Space Development Agency* in 2019, which deal directly with NASA and the National *Space Council*, but also with private players. Forged by the doctrine of *US Space-Dominance*, these institutions are the keystone of the American space ecosystem. The numerous collaborations between the DoD and NASA (in the field of launchers, GPS, Earth observation, etc.) bear witness to the gains made by exploiting the sector's dual synergies and their contribution to the strategy of American domination.

The growing reliance on the private sector also explains the success of this institutional cocktail. As early as the 1980s, the United States introduced a series of reforms designed to encourage competition between manufacturers and boost productivity. The most important of these, the

Commercial Space Launch Act of 1984 and the *Space Act* of 2015, opened up the launch market to the private sector and facilitated partnerships with the federal government. In 2018, the new *Space Policy Directive* (SPD-2) makes it even easier to grant launch licences to private operators. The monopoly of a technical champion is no longer an option: the agencies want to have a pool of competitive and resilient companies at their disposal. By moving towards the purchase of services rather than resources, they can contract with a larger number of players and support the development of the ecosystem. This strategy is reflected in the US budgets devoted to space: almost $50 billion by 2020, half of which will be spent on military activities, i.e. almost ten times the budget for European space programmes. This windfall is all the more critical given that public investment, particularly of military origin, in a space sector that is seeking economies of scale, acts as a lever on private investment. Public procurement subsidises R&D, testing and fixed costs, enabling mass-produced companies to sell at marginal cost. By supporting tooth and nail the fordisation of a competitive space sector, American institutions are deploying an industrial ecosystem at the service of their hegemony.

THE RIGIDITIES OF THE EUROPEAN APPROACH

Europe's space institutions are finding it even harder to present a united front. The historical mechanisms that underpin them, developed over the course of European integration, have become obsolete. After the war, the pioneers of German ballistics were exfiltrated to the United States. Space technology re-emerged in Europe in the 1960s in the nuclear powers France and the United Kingdom. As civilian applications developed, these countries saw space as a tool for pooling resources and bringing Europe closer together. With NATO's military protection relieving Europe of its sovereign defence, the European Space Agency (ESA) was created in 1975 on an exclusively civilian basis. This made it possible to extend to the Community, and then to the European Union, the agency mechanism associated with space activities. However, the ESA has nothing in common with the European Union: Canada, Switzerland and the United Kingdom are all members. The European Commission did not set up its own space agency until 2021. This is the EUSPA, which now manages the Galileo satellite navigation programme. Military programmes are being left to the discretion of individual states and their national agencies. The result of all this is that European space policy is a patchwork of agencies, saturated with transaction costs. Its architecture is no longer adapted to the pace of space activities.

To build its programme based on scientific cooperation and Europe's autonomous access to space, ESA has imposed standards structuring the European space ecosystem. The rule of fair return set out in the Agency's founding treaty stipulates that every euro invested by a State in a space programme on a voluntary basis must be matched by a euro of industrial contract on its territory. This rule has led to the specialisation of national industries: for example, the famous Franco-German compromise divides the construction of optical and radar capabilities between the two countries and recognises France's expertise in launchers.

Although initially successful - by the end of the 20th century Europe was the leader in the construction and launch of commercial telecommunications satellites - this arrangement was designed for a prototype industry, not for the advent of *New Space.* This arrangement is the present cause of the loss of status. Firstly, on the strength of their geostationary success, the Europeans missed the technological breakthrough in low-Earth orbit. And yet there was no shortage of experts in this sector. The reason is in fact Schumpeterian: the industrial organisation in place, based on multiple agency relationships, is not adapted to low-Earth orbit equipment. In particular, because the "fair return" principle is opposed to vertical integration, it is very difficult to challenge the system and sub-system certification logic imposed by this organisation. Designed to last a thousand years and to respond to development times that are almost as long, the European space framework is rigid. It is striking to see the extent to which the issue of manufacturing lead times and launch rates, so critical in SpaceX's approach, has escaped the Europeans. Not only does Ariane 6 not have a recoverable stage, but its design and manufacturing times place it well out of the market.

The same applies to the satellite constellations. With the exception of OneWeb, which fortunately was purchased by the French operator Eutelsat, Europe is absent from

the race for low-Earth orbits, which are critical in the information war. The European Commission launched a call for tenders for the construction of a sovereign satellite infrastructure in 2022, IRIS2, but this will not see the light of day until 2027. With the current restrictions on dual applications and approval rules, these deadlines are likely to be exceeded. All these inefficiencies are reflected in private investment, which in Europe cannot find the leverage provided by American public funding. The imbalance with the United States in terms of fundraising was 1 to 10 in 2022, and in terms of access to finance 1 to 20, particularly for Series B or C fundraising and bank loans. Rising interest rates will further widen this gap. All in all, while the race to low-Earth orbit is attracting new companies to Europe[3], the European space community is struggling to consolidate its assets. In this strategic sector, the seed money for companies is still largely American.

WHICH REFORM?

If the American doctrine, now shared by China, is to dominate space, what is Europe's? Until now, Europe has developed a civilian industry to support the military needs of its Member States, focusing on scientific applications and the geostationary market. This strategy is no longer adapted to the information war. For example, free access to *Copernicus* Earth observation data primarily serves the GAFAMs, who are also taking advantage of the colonisation of low-Earth orbit to lock in the markets for civilian applications.

As the decline of the launcher industry shows, the fordisation of the space industry has rapidly led to the decline of that in Europe. Hence the latter has to build an industrial strategy that cannot be confined to new windows and new entrants. It cannot expect a new Musk, the pioneering and unifying entrepreneur who is anything but a European legend. As for the digital giants, they are American and Chinese. Hence the sector's institutions must be reformed, to encourage the vertical integration of the incumbent players, competition between them in new markets (including the launch market), *iterative* innovation in their processes, and access to public funding, particularly military funding, on a continental scale.

A reform of this kind involves the European Union's political leaders at the highest level. It is unprecedented in its complexity, as it combines industrial aspects with questions of defence and sovereignty on a European scale. Space is becoming increasingly militarised. The war in Ukraine, which not only strengthens NATO, but also makes its members more aware of regional sovereignty issues, makes the adoption of this agenda all the more necessary. In our view, it is inevitable if Europe is to overcome its decline and build a civil and military sovereignty based on a space presence that is more than a tribute to the past.

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[3] We met around forty of them during the survey referred to above.

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