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Aeronautics and Aerospace. Globalization and Technical Junctions

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Two major features characterize the historical, sociological, and anthropological studies on aeronautics and space technologies. On the one hand, they tend to analyse aeronautics and aerospace separately as if the two fields were distinct, whereas they have much in common with many techniques moving from one to the other. On the other hand, the prevailing self-referential approach (see Lemonnier, 2004) tends to analyse all social, political, and cultural phenomena as resulting solely from technological innovation. This approach may be useful in that it reveals some details of how these technical systems operate, but it fails to see the whole picture. In this article, we aim to avoid these two pitfalls by highlighting both the interconnections between aeronautics and spatial technologies and the way they connect to the economic, political, cultural, and scientific programmes that have been instrumental to their development. This connection is neither natural nor obvious, but rather the result of a socio-historical construct whereby technologies are conceived of as systems. The very distinction between airspace and outer space derives from a cognitive and social construct which at times has contributed to blurring the differences between the fields of aeronautics and space technology. Theodore von Kármán proposed to locate the eponymous physical border of the Earth's atmosphere at 100 km (about 62 miles) above the Earth's mean sea level. Although this 'Kármán line' was accepted by aeronautics authorities in the 1950s, particularly by the International Aeronautics Federation, it has neither been universally adopted — the United States determined it to be at 50 miles — nor considered undeniable (Jonathan C. McDowell (2018) for instance placed it at a distance of 80 km), and the issue still causes taxonomical quarrels.

Propulsion is the other connection and technical issue linking the two domains that comes to mind. Mastering the right conditions and tools for moving vehicles and machines of varying size and weight whether in the air or outer space has always proved to be a technical challenge, ever since the invention of aircraft and the beginning of space travel. The knowledge and techniques of the early 'Aerospatiale' came from the military; this was the case, for instance, for applied mathematics, ballistics, mechanics, and projection as well as research and development on engines, aircraft, and rocket design. The different types of technologies involved in various propulsion systems naturally prompted decades of specific research (on turbo engines, turbo jets,

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liquid-propellant rocket engines, etc.); while the physical mastery of flight conditions was also based on twin technologies whether it be in order to transport human beings in aircraft cabins or in spaceships, or to carry cargo in a plane or in the warheads of missile launchers. This was particularly true at the height of the Cold War, when intercontinental ballistic missiles from which the 'Space Race' conventional launchers were derived delivered thermonuclear warheads.

This chapter considers the links that were established in this way as well the most significant differences between these technological fields. These connections are determined by economic, political, and cultural factors and vary according to place and time. In order to make the reconsideration of this long history of air and space transport more manageable, we have chosen to focus on five specific areas central to both aeronautics and space technology, which will allow us to study their connections: (1) the development of an ever-changing industrial sector, (2) early militarization, (3) the prevalence of political decisions in the applications of technical systems, (4)

specific technological trajectories, and (5) a notable tendency to create spectacular projects, a feature of an age marked by hubris and what some have called the 'technological sublime' (Nye, 1994). An investigation of the intersection of aeronautics and aerospace does not really fit into mainstream historiography. The landmarks of a chronological history of clearly defined technological sectors are naturally not included in the following analysis. Similarly, rather than referring to the pantheon of the leading figures of the hero histories of aeronautics and space, which often lend themselves to hagiographic or patriotic narratives (Chadeau, 1987), we have chosen to focus on those processes that eventually led some areas of activities to develop into stable technical systems, industrial organizations, and public and private administrative organizations. These are connected due to their joint expertise and procedural norms, and due to their similar if not identical values as we will examine below.

Defence Spending

Along with the notion of 'militarization', a common trope of geopolitical literature is the idea of the dependence of aeronautics on state structures turned 'space powers'. From the experimental, pioneering stage before 1914 to the concentration of the sector into a few major firms at international level today, aeronautics represents a very specific economic activity. Politics has been prominent within it, and from a very early stage. After the First World War, British aviation clearly was more advanced than other countries. The leaders of the Royal Air Force took advantage of their colonial conquests to establish 'a relatively cheap means of imperial control in sparsely populated new "mandates" in the Middle East' (Edgerton, 2013: 33); scientists and engineers as well as postal communications moved around a global empire. Even Western countries with smaller colonial territories relied on the aeroplane. The 1930s Italian fascist regime, for example, saw aviation as part of the 'constitution of material

networks that enabled colonial control through transport and speed' (Caprotti, 2011: 398).

In warfare, aviation was an indispensable part of the military strategy of defence and attack. In some countries, the extent of the aeronautics sector was even demarcated by governmental decisions. That was the case in the 1930s in the USSR, where the army implemented 'the Douhet doctrine of strategic offense, which emphasized the role of heavy bombers in modern warfare' (Bailes 1976: 79). Nevertheless, this techno-political orientation was first and foremost intended to assert the 'legitimacy' of Stalin's power, rather than serve an actual military strategy.

The war effort completely transformed aviation and its manufacture. Vast orders were placed to produce planes, and manufacturers wanted to be able to fulfil them. The history of the aeronautics industry is the story of an increasing prominence of major competitive groups, initially at the national, and then at the international level. In this respect, the company that was to become Lockheed Martin is a good example of the establishment of a 'military-industrial complex' from the 1950s onwards, a complex which required a great adaptability to market downturns and steady political support (Hartung, 2010). For Boeing, its 'dual civil-military' business was a factor of stability. This duality has enabled these different sectors to adapt constantly (Depeyre, 2013: 62). In France, Dassault's focus on military aeronautics activities was based on a strategy of 'diversification' particularly in 'the command of military weaponry systems' (Carlier, 2013: 30, 32).

Because engines are used for military purposes, their design and development as well as their use and maintenance are classified as 'top secret'. The mystery in which they are shrouded has contributed to turning some planes whose technological set up is only partially known into quasi myths. Aerial or spatial reconnaissance programmes, e.g. the CORONA programme of satellites deployed under the CIA authorities between 1959 and 1972 (Day, 1998), were not disclosed until decades after they were conducted. The technology used in the field of aerial reconnaissance was re-used in space. The military strategy at work during the Cold War was based on cross-geopolitical power surveillance and contributed to the connection of air and space technologies and to the globaliation of surveillance systems.

Countries' preparation for a generalized conflict over the course of thirty years, from the 1950s to the 1980s standardised and at times merged the air and space sectors. As early as 1959, American forces carried out an unsuccessful missile strike attempt against the satellite Explorer 6 from a B47 bomber (Bille, Lishock, 2004: 169). In 1977, the American army plans to use F15 fighter planes to destroy Soviet satellites (Gottfried, Lebow, 1985: 151). By contrast, the Strategic Defence Initiative proposed by the Reagan administration was geared towards driving the Soviet Union into an arms space race rather than merging air and space technologies.

Industrial Sectors and Golden Opportunities

Recent literature on the early aeronautics industry has uncovered the significant part played by small-sized organizations and how public funding was not necessarily always the key to success. From the late nineteenth to early twentieth century, the 'first stable aeroplanes' were actually manufactured by small and medium size companies (Olivier, 2017). In the United States, the Wright brothers worked on a small scale and initially worked on both design and manufacture. Public funding (which could, at times, be significant, e.g. in the case of Samuel Pierpont Langley) did not necessarily grant success — far from it. The main reason was that early aeronautics was not organised according to the principles of contemporary industrial capitalism, but rather had developed within a sports culture based on exploits and feats. It only developed into an actual industrial and commercial sector requiring specific technological developments during the interwar period (Bilstein, 1969: 411), although this development was uneven (Heitmann, 1988: 327).

The concentration of production into an extremely small number of companies

such as Boeing or Airbus able to oversee the large-scale manufacture of reliable civil and military aircraft was supported by the implementation of a network of factories located on different continents (Zuliani, Jalabert, 2005). And yet, this network was not systematically internationalized. Europe illustrates the limits of partner states' pro-active policies towards industrial integration. Attempts to set up a European economy of military aviation (which materialized in the Eurofighter project) were hindered by 'existing national options' (Hoeffler, Mérand, 2015: 76).

Beyond asserting a nation's power and being a symbol of imperial and military domination, aviation and aeronautics have become a political instrument of economic conquest since 1945. Because the sector is highly concentrated, governments are commonly directly involved in capital-intensive technological transfers or trade alliances. In the 1970s, the French President Georges Pompidou lobbied diplomatically to support the partnership between SNECMA (a French aircraft engine manufacturer which was later renamed Safran Aircraft Engines) and General Electric, which was formed to build the CFM-56 engine and to create the French-American CFM International joint venture. Beyond business interests, aeronautics is strategically important in international relations and protects the independence of those countries that manage to be self-reliant in the field. International agreements are therefore overseen, and even controlled, by governments who consider them necessary to the preservation of their power, and also to safeguard national industries against the risk of disintegration.

Astronautics, by contrast, started around the 1950s, following the early experiments with ballistic missiles. In the United States as in the USSR, the sector was organised under the structure of the state authorities, who were highly invested in it due to nuclear escalation and the Space Race. The armies' and NASA's purchasing and sub-contracting policies greatly influenced the setup of a 'private' industry, for which aeronautics was fertile ground and which helped introduce the notion of an 'aerospace sector' and supported its implementation (Bromberg, 1999). In Europe,

national agencies have also been instrumental in organizing the industrial sector of astronautics. The European Space Agency, which was established in 1975 after several failed cooperative efforts, sought to develop the Ariane programme by combining an ambitious launch policy for the European space community with a relatively strong French control over the future of the companies tasked with building and operating the launcher (Krige, Russo, Sebesta, 2000: 455–90).

These technical systems rely on a number of critical infrastructures and dedicated organizations. On the ground, airports are entirely dedicated to ensuring the continuity of air transport operations, and their sites include runways, terminals, control towers, maintenance facilities, and garages, as well as customs and security systems (more stringent post-11 September 2001), air passenger traffic control, and cargo management. They also have the necessary connections from this self-contained world to the surrounding environment, e.g. other transport systems, and are integrated into the landscape, the local or regional economy, and into the geopolitics of countries. By contrast, access to military airports and the spaceports of governmental agencies or armies is not within everyone's reach. This is not surprising, as these comprise strategic facilities, destruction technologies, or launch sites for missiles and rockets. These sites are nevertheless embedded into specific sites which in turn they transform, like Kennedy space centre in Florida or the Guyanese spaceport in French Guiana. The latter's location in Kourou is emblematic of the relationship between launch facilities and imperialism (French Guiana became a French colony in the sixteenth century): the launch site extends, in a highly technical form, the French colonial project of controlling a distant territory that is administered according to the principles of the metropole (Redfield, 2000, 2002). In addition to these infrastructures, which open up airspace and outer space, an entire regulatory environment has developed gradually, regulating and constraining movements. The air and space regulations implemented by governmental or non-governmental bodies to ensure viable traffic on airways and space orbits. Therefore, these aerospace industries and all their necessary additional practicalities are interdependent, changing the face of the world in the course of the twentieth century. They have now become vital parts of industrial and post-industrial societies. Intercontinental travel has become common for some parts of the population, just like the flows of information and the interconnected 'global village' that had been imagined in the 1950s have materialized in part via satellite telecommunications and 'cultures in orbit' (Parks, 2005).

Aerospace Strategies

As mentioned previously, aeronautics technology has a strong military component. The global conflicts of the twentieth century advanced the development of aircraft and embedded weapons. As early as the 1910s, 'military commissions' in France supported the country's small and medium sized companies in the sector, while the army had four suppliers — Blériot, Farman, Voisin, REP — which were expected to produce around forty aeroplanes each. In 1911 the number had gone up to five —

Blériot, Farman, Nieuport, Deperdussin and Breguet — each with 57 orders (Olivier, 2017: 216). Although public military orders consistently underpin the system of aeronautics capitalism, relations between the army and aeronautics were far from smooth in the early twentieth century. In Prussia, during the First World War, the 'nationalization of industry was never even a remote possibility because [...] the army firmly believed in competition among private enterprises' (Morrow, 1977: 51). Similarly, in the United States, the army was strongly averse to aeronautics innovations. At the beginning of the twentieth century, Major General George Owen Squier tried to convince military staff that the recent innovations in aeronautics were worth considering; above all, he wished to adopt the model set up by the British Advisory Committee for Aeronautics (BACA) (Gross, 1990: 287), which had been carrying out top-level research in aeronautics in Britain since 1909. After the National Advisory Committee for Aeronautics (NACA) finally emerged in the United States in 1915, Squier continued to try to convince the army to create 'a giant American aircraft production program' (Gross, 1990: 292), but 'was alarmed by the army's highly fragmented aeronautical engineering efforts' (Gross, 1990: 296). It is therefore clear that creating military structures dedicated to aeronautics research was not an obvious path, even during the First World War. And yet, the First World War dramatically changed the range of long-term possibilities opened by aeronautics to military action. In wartime Britain, 'British aviation was relatively backward compared with that of France' (Fearon, 1985: 23). The 'crucial change was that, by 1918, flight was an intrinsic part of national defence, as large aircraft could fly to Berlin and return, the possibility of carrying fare-paying

passengers over long distances was now more than a visionary gleam — it was a reality' (Fearon, 1985: 24).

Therefore, war served as a demonstration to Western governments that aeronautics could both contribute to convincingly building a strong geopolitical power while harnessing the emerging market of long-distance transport. The post-1945 period saw the continuation of this competitive logic marked as it was by countries trying to develop nuclear weapons as the ultimate deterrent. That is why the United States, the USSR, and France developed what Claude Carlier and Sylvain Champonnois have called 'the nuclear triad', i.e., 'strategic bombers, ground-based ballistic missiles, [and] nuclear-powered ballistic missile submarines (SSBN)' (Carlier, Champonnois, 2014: 361). Aviation was now part of a scheme which ruled geostrategic relations during the cold war. Over the course of six decades, aeronautics had thus moved from an exploratory sector to a vital instrument of political prestige and power. As outlined above, this gradual inclusion of aeronautics in public military programmes was complemented by the development of a dedicated industrial sector which was dependent on public procurement and defence spending.

Trajectories of Technological Invention

Aeronautics has undergone significant technical changes over the course of more than a century. These changes concern both specific parts of aircrafts (e.g. retractable

landing gear and wings) and propulsion itself which has always acted as driving force of technological development. Historians in the field of techniques have highlighted that the aeronautical sector is uniquely defined by the way innovations emerge and integrate into existing processes. What follows focusses on some iconic examples resulting from two types of modelling.

Walter G. Vincenti proposed a general theory of aeronautical engineering including its learning processes and knowledge, and the way they relate to production (Vincenti, 1990). Notably, he explained the invention of the retractable landing gear as the result of a 'variation-selection' process. For that purpose, he examined the work of John K. Northrop, 'one of the most creative and influential airplane designers in the quarter-century following the mid-1920s' (Vincenti, 1994: 2). Northrop's Alpha aircraft had 'fixed landing gear' (Vincenti, 1994: 6). The idea of a retractable landing gear was mentioned in a report to the 'technical advisory of United Aircraft' (Vincenti, 1994: 7). But trials carried out at the California Institute of Technology convinced Northrop 'to adopt the pants-type gear in place of a retractable design' (Vincenti, 1994: 7–8). The subsequent versions of Northrop's aircraft (particularly XFT-1) led to a multitude of tests and experiments. Vincenti emphasises that Northrop did realize that a retractable landing gear was more operational, but that his choice of a 'fixed gear looks to be a temporary deviation from an engineering mainstream' (Vincenti, 1994: 14). The retractable gear did not result from an initial technical difficulty but was part of a 'variation-selection model' characterised by two successive 'phases', one 'hidden', the other 'overt' (Vincenti, 1990: 22). Consequently, engineers created 'a variety of variants'; of the overt variants, among others, the fixed landing gear and the retractable gear were retained as feasible (Vincenti, 1990: 23). After using the fixed gear, the daily control of difficulties actually made it possible to implement the retractable gear which had remained on the list of the engineers' solutions (Vincenti, 1990: 24).

The other technological model, which was proposed by F. G. Geels, relies on an analysis of co-evolutions and 'multi-level dynamics in transitions'. The iconic illustration of this model is the shift from propeller to turbojet between the 1930s and the 1970s (Geels, 2006). The way innovations develop can be traced at three levels: niche innovations that 'act as "incubation room" for radical novelties', the 'meso-level' innovations which are 'formed by socio-technical regimes', and those on the 'macro-level [...] formed by the socio-technical landscape' which are linked 'to aspects of the exogenous environment' (Geels, 2006: 1004). The breakthrough therefore moves from a constrained niche innovation to a class of learning processes for engineers before becoming a 'new technology' (Geels, 2006: 1004). Geels noted that in the inter-war period, passengers 'complained about noise, vibration, turbulence and airsickness', which led airline companies to demand 'larger aircraft that could fly higher to reduce turbulence and airsickness. They also wanted greater speed

and longer range' (Geels, 2006: 1007). However, in this regard, propellers imposed limitations, as they could not reach high speed levels. Both engineers and scientists worked on 'the turboprop, using the rotational power of a gas turbine to spin a shaft that powered a propeller', but aeronautics specialists did not believe in this particular

innovation. Turbojets then 'emerged independently from the work of Franck Whittle in Britain, Hans von Ohain and Herbert Wagner in Germany', who were 'relative outsiders to the aviation regime' (Geels, 2006: 1008). In that case, the scope of the technological domain was restricted due to the aeronautical community's lack of involvement. The war 'created a window of opportunity for the jet engine pioneers' (Geels, 2006: 1008); then a potential market for the gradual appropriation of the technological breakthrough opened up. Turbojets became part of the aeronautics technical apparatus after the Second World War, when they were adopted by civil aviation (Geels, 2006: 1010). 'Expanding markets created space for further stretching of existing aircraft designs, leading to the Super Constellation (1950) and DC-7 (1953)' (Geels, 2006: 1011). The turbojet was one step that led aeronautics innovation to develop gradually and spread commercially to the world.

The constraints of outer space travel triggered aerospace research. Technological research and dangerous experiments sending flights to the brink of outer space have now become part of the legend and of popular culture imagery with films such as *The Right Stuff* (1983). The US Air Force's X-15, a rocket-powered aircraft, revealed the great skills of pilots as well as the dangers they ran during the flights (Evans, 2013). Concepts for futuristic spaceplanes form part of the history of utopias about 'colonising' space, but realism prevailed for a long time — until the careful introduction of space shuttles happened and circum-terrestrial space flights became routine in the post-Apollo period. The design and manufacture of this extraordinary and supposedly reusable vehicle turned out to be extremely complex. The 1986 Challenger accident marked a tragic turning point in the growth of the sector. Spaceplane projects were not dropped entirely, but restricted to suborbital 'tourism' under the Karman line, as was the case, for example, for SpaceShipOne which won the 2004 XPRIZE — a distant echo of the Orteig Prize won by Charles Lindbergh in 1927.

These two instances of technological transformation clearly highlight the specific nature of aeronautics, i.e. the abundance of engineering proposals that is a necessary in the preparation for the following selecting stage, with the upscaling of innovation depending on the capacity of engineers (in the case of turbojets, military engineers) to work on the breakthrough and prepare its roll-out (Figure 1).

Hubris and Extravagance

Finally, aeronautics and space technologies, just like so many other technologies, are characterized by excess. Here, hubris does not consist of mobilizing huge scientific, technical, financial, and military resources or 'big science' alone. Air and space experiments also concern the physical risks taken by pilots and passengers. Mikael Hård and Andrew Jamison describe the Wright brothers' early experiments at the very beginning of the twentieth century: 'With the help of wind tunnels, and expert advice from scientists in Washington about aerodynamic principles, the Wright brothers were the ones who won the race to achieve manned flight. It was one of the oldest forms of hubris' (Hård, Jamison, 2005: 97).

Fig. 1. STS-70 Rollout NASA on The Commons.

Aeronautics and space hubris led to extreme experiments in which human bodies were confronted with unfamiliar and potentially dangerous physical conditions. From aviation pioneers to the first astronauts putting their lives at risk in space capsules that were being tested, experimental practices in air flight and space have always had a similar share in excess.

Examples of gigantism in aircraft design are plentiful, from the Hughes H-4 Hercules to Airbus A380, and of course Stratolaunch, the world's biggest airplane designed by Scaled Composites. Flying these giants required extremely powerful engines that swallowed much fuel. There again, the design of this type of aircraft took advantage of the techniques mobilized by the army during the Cold War. The engineers' creativity was boundless. The technological competition between the two superpowers pushed the experimentation with nuclear energy, e.g. in the Aircraft Nuclear Propulsion Project and its incredibly long flights (James, 2000) or the 'nuclear ramjets for unmanned bombers or cruise missiles' in the Pluto project (Hacker, 1995: 85). These technologies were certainly promising, but their implementation could be risky. Despite its positive results, the Pentagon put an end to the programme in 1964 (Hacker, 1995: 89), just like Eisenhower had stopped the ANP in 1956 (James, 2000: 173). For these programmes, engineers were invited to push their imagination to the very limits of the possible in engineering. The Lockheed division of Advanced Development Projects, also nicknamed 'Skunk Works', was known for its bold projects of legendary aircrafts, notably the U-2 tested on the famous Area 51, or, more recently, the F-22 Raptor. Whether it be designing stealth aircrafts, RPAVs

(remotely piloted aerial vehicles), or ICBMs (Inter-Continental Ballistic Missiles), or working on projects of military satellites, engineers have summoned all their inventiveness and the spirit of competition to create the most lethal weapons.

From the time when V2 plans were brought back to America to the colossal Saturn-5, the Defence and NASA space programme engineers achieved the construction of an extraordinarily complex technical system. Soviet engineers were just as proactive and developed the N-1 launcher Herkules, which, although it was abandoned in 1974 after a number of failures, manifested unprecedented technological research work. Research in design grew to be extremely sophisticated. Countless spectacular and futuristic projects were designed by engineers. For example, projects relating to space stations triggered the imagination of developers of passenger travel via spacecraft from the very beginnings of the space age, and an 'astroculture' emerged (Neufeld, 2018: 137). The early visions were always extremely bold and contributed to making 'spaceflight' tangible; at the time, this was as much a matter of 'conquering' space as a matter of travel. In the 1970s, after the achievement of the lunar landing of Apollo in 1969 which captured imaginations worldwide, there was much speculation about the next steps. Settlement projects varied from visions of escapes aboard vast space settlements, akin to the O'Neill 'cylinders' in *The High Frontier* (1976), to settlement on Mars, which is still a source of inspiration for thousands of space enthusiasts in the United States. The fantasy of humans who, when extracted from their natural environment, finally enjoy a fulfilled life in the cosmos is an ancient dream that is now pursued by those known as the 'New Space' entrepreneurs; from Jeff Bezos to Elon Musk, 'visioneers' combine the hubris of high-tech engineering with utopian visions, to dream up and engineer the bright new worlds of a forthcoming future. (McCray, 2013). In the meantime, prior to the advent of these 'new frontiers', both entrepreneurs and space agencies have been trying to keep up the pace and develop oversized super heavy-lift launch vehicles like the Space Launch System implemented by the NASA or the Super Heavy/Starship launcher designed by SpaceX to transport the first 'settlers' to Mars.

The five main sectors characterizing aeronautics (industrial involvement, the politicization of technology, close links with the military sector, the specificities of technical evolutions, and hubris) apply to space as well. Moreover, these five distinctive features closely intersect: the military-industrial complex is a major provider of large-scale projects, as demonstrated in the case of ANP and the Pluto project. Similarly, some innovations would not have emerged without the involvement of military engineers or without the creation of a civilian market that is strongly regulated and backed up by governments. This interrelation reached its highest levels in the space sector immediately after the Second World War.

This long history is full of glorious stories, failed ambitions, worldwide celebrations, ruined projects, models, and rusted metal sheets. The growing environmental concerns of the younger generations in the twenty-first century puts the future of these technologies into question. Although aircraft engines

are more fuel efficient than they used to be, and although the experiments on solar planes help move away from the use of fossil fuels to propel planes, the climatic impact of air transport is

clearly a subject of concern for those organizations in charge of expanding it, especially as air traffic keeps growing worldwide, foreshadowing congested airways and hub airports. The filling of circumterrestrial space with satellites also raises problems of management and pollution. Before the 2000s, this was a matter of indifference (space was 'open'), but now the increasing volume of space debris is a source of worry for the space community (Saint-Martin, 2016) — the prospect of collisional cascading (the Kessler syndrome) is no longer a sci-fi scenario, and the governance of orbital systems firmly needs to be adjusted. Apart from this, the militarization of space has become a strategic issue for world leaders.

In spite, or rather because of these obstacles, imagination and anticipation have reappeared in the last few years. The futuristic fantasies of space exploration, which had faded from the 1990s onwards, are back in the news, although the outcome of this 'new Space Race' is both uncertain and fragile. For the most enthusiastic proponents of this renewed space race, it will make it possible to escape from spaceship Earth in the hope that mankind will be able to survive in the farthest reaches of the solar system in Gerard O'Neill-like orbital settlements. In such scenario, strategic and technological hubris continues to fuel investments in aeronautics and space. Therefore, the globalization of these two sectors relies on geopolitical configurations of confrontation (similar to what underpinned the Cold War or colonization), but also on the industrial strategies of major corporate groups (since both space and aeronautics require significant resources), as well as on clearly stated state strategies (since air and earth surveillance are a prerequisite of territorial sovereignty), and on specific technological trajectories. The global pattern which emerges at the junction of these different determinants shows space and aeronautics to be more than ever the two sides of the same technological coin.

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