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Space Policy 19 (2003) 15–22
Space Policy
www.elsevier.com/locate/spacepol

A new role for a new millennium? The changing nature of space activities ☆

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Abstract

Space activity has lost the momentum it had in the past. During the Cold War the use of space was constrained by specific political and military conditions which gave it a strong but narrow identity. The aerospace industry, in particular, was in a position to develop protected and exclusive ties with the public sector. These times have passed and diminishing competition between the two main space powers has had consequences for the planning of major space undertakings. Space activity is in the process of being thoroughly transformed as it is forced to become more connected to general economic and industrial activity, especially in the field of information. An opportunity for a sector that has been struggling could also prove to be risky as space activity is losing some of its previously strong identity. Space currently seems to lack the high level of public support from governments it once enjoyed, while not finding an alternative in the industry itself to this declining investment. This situation should lead both the space community and the political authorities to consider new general space applications that will be more in line with the preoccupations of our modern societies and thus contribute to solving the principal global issues of tomorrow.

Almost half a century after the start of the Space Age, there are plenty of reasons for us to be considering the role played by space activities in today's society. Outer space seethes with a multiplicity of applications but, as seen by the person in the street, its use seems to oscillate between routine activity—carried out with such ease and command that it no longer provokes surprise—and exceptional enterprises, involving, for example, complex scientific missions whose meaning and aims are often hard to discern and which confine the public to the role of indifferent observer.

Thus over the past few years space efforts seem to have fallen into a relative anonymity, expressive of a profound change in the markers which have constituted the identity of space activity. Initially space always demonstrated a state-led character, witness to the immediate political and military goals it was assigned from the end of the 1950s in the USA and USSR. Subsequently, and for the same reasons, space has always manifested a powerful symbolism. Because the development and exploitation of space programmes called for national capabilities beyond the norm, while their aims sometimes demonstrated a certain nobility—a certain lyricism indeed—they established a specific identity vis-à-vis other human activities. Public space activity swiftly became structured around three major domains: military activity, scientific activity and human spaceflight. But the progressive reduction of interest in big civil programmes among governments, especially in the two premier spacefaring nations, combined with the rise of commercial interest in certain applications, in particular telecommunications, has gradually modified the environment of the space sector. These transformations, already germinating in the USA in the 1970s, deepened throughout the 1990s, to the point where space activity has become a more intimate component of society's activities as a whole.

Such an evolution does not come without a price. It is expressed in a gradual erosion of that powerful identity which characterized the sector in its totality. Of course, the public budgets of the major space organizations can still guarantee the pursuit of high-level space activity and the promotion of discovery missions and of funding for research. But thanks to strategy and new technologies, the major space agencies and the industries which support them may be in a position to concentrate their efforts in the production of social goods using space, rather than in the space effort proper. In this context the

☆ This is a translation of an article initially published in *Géo-economie*, Quarterly Review, No. 20, hiver 2001–2002, pp. 27–47, 75 Boulevard Haussmann, Paris, France, by the Institut Européen de Géoeconomie, www.geoeconomie.org.

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0265-9646/03/$ - see front matter © 2002 Elsevier Science Ltd. All rights reserved.
doi:10.1016/S0265-9646(02)00062-0

rationalization of public expenditures, the europeanization of European countries' space policies and industrial reorganizations are not without effect on current considerations. How far do these transformations affect the whole sector and, within this new landscape, what are the principal possibilities for its development?

1. A highly specific activity at first

1.1. Military space: the space–nuclear link

Until now the major organizational axes of space investment have never been called into question. For a start, military activity, while not the most spectacular element of the space effort, has nevertheless constituted one of the most enduring, if not one of the most important, since the beginning. This was particularly the case in the USA, where the birth of space activity bears a direct relation to the rise of the nuclear arsenals. It was because the USA and the USSR were able, in less than 10 years between 1945 and 1955, to arm themselves with ballistic arsenals fitted with nuclear warheads that their governments realized the importance of being able to exploit space.

The relationship between 'space' and 'nuclear' did not rest solely on the line of descent which exists between the technologies necessary for the development of ballistic missiles and those which lead to space launchers. It also arose from the need (swiftly felt and officially acknowledged from 1955 in the wake of reports published from 1946 onwards) to possess a permanent and impregnable means of detecting and, ultimately, targeting enemy missiles. Whereas aerial methods rapidly reached their limits in this field,[1] acquiring space-based methods of reconnaissance, early warning and targeting became a priority, given the development of offensive weapons. The doctrine of mutually assured destruction (MAD) would give these methods the air of a life assurance policy for the countries concerned and would contribute to making space a true, mutually recognized sanctuary.[2]

It was in this military field that the criterion of 'utility' was most clearly applied. Thanks to the unique nature of the applications it permits, space experienced an effort in this area which, over the course of the years, has never been downgraded. For this has not been the case with military space applications as a whole, which have been party to numerous projects from the 1950s until today but have not enjoyed the same support. For example, manned military programmes have not been supported, despite intense lobbying throughout the 1950s and 1960s. In the same way, making space a 'fourth battle field', as a well known general had heartily desired, was not considered favourably at all by the government: why militarize space when the use of intercontinental missiles offered every guarantee of efficacy? Without any true utility, such projects obtained no real support. A balance sheet of military space activity drawn up in 2000 thus confirmed the continuity of the effort undertaken since the 1950s, to the point where military space activity today defines a club effectively composed of the countries which have information gathering satellites, in particular in the remote sensing field.

However, new thinking on the military role of space is taking place today, just at the time when the major powers are questioning the policing role of nuclear armaments in the face of 'new threats'. Thanks to the burgeoning possible forms a threat might take, space programmes might take a quite different place among an expanded set of security tools and see their role exceed the narrow applications with which they have been identified up to now.

1.2. Civil programmes: the manned flight–space science duality

As the second historical wing of the development of space activity, it was the major civil space programmes, which initially reflected the competition for political and social pre-eminence between the two blocs at the end of the 1950s. The most spectacular aspect of this competition took the form of 'man in space', and became the familiar space race. The Apollo programme, undertaken by the USA as a direct response to the flight of Yuri Gagarin on 12 April 1961, directly mobilized 180,000 people with a budget of $94 billion (in 1990 dollars) and achieved the first Moon landing in 1969,[3] reaching a peak in 1965 when it represented 0.8% of US GNP. But competition also extended to space science, especially to planetary exploration with unmanned probes, a less well known area of space activity, but one where competitive pressures were expressed just as intensely (on this point see [1]).

This characteristic, again the legacy of strong government interest, was expressed by an almost binary civil activity, with all the consequences that entails.

If we consider the American case, which is responsible for over 70% of global public space expenditure, the picture is particularly illuminating. In 2000 the NASA budget ($13.8 billion) was built around two principal pillars: the manned programme (with the two major pillars of the ISS and the Space Shuttle) and the science programme in its broadest sense, including the major

[1] Gary Powers' U-2 spy plane was to be shot down by Soviet air defence in 1960. In August 1960 the first satellite photographs were transmitted to the US authorities.

[2] Their secret use was hidden behind the euphemism 'national technical means' in disarmament treaties.

[3] There were six successful Moon missions in total.

scientific Earth observation programmes, but otherwise largely composed of a recently relaunched Mars exploration programme. This duality is expressed not only in budgetary terms but also in the internal balance of NASA, where these major programmes must receive privileged representation, especially when it comes to the managing teams, which have to guarantee the correct representation of the research centres concerned. And then the space industry itself is broadly structured around the demands of NASA, especially in the field of manned flight, with an industry presence in each of the federal states for each of the agency's main programmes being a requirement.

These rules have broadly influenced first US, and subsequently global, space expenditure, only because of the link created among spacefaring countries or groups of countries by the space station programme. For example, for Europe, which is one of the station partners, the ISS remains a long-term structural element, both in terms of its activity and its budget.[4] However, two profound identity crises 20 years apart have destabilized these general equilibria since the heights attained by space activity in the 1960s.

2. A progressive slowdown of the initial impetus

2.1. The first 'identity crisis'

Civil space activity never really recovered from the end of the Apollo programme. Paradoxically, from the 1970s onwards, the political and technological success of the programme had very negative consequences for the space budget in the USA and for the post-Apollo programmes then envisaged by NASA. Devoid of interest in the eyes of the government of the time, NASA's plans for planetary conquest were remaindered as a 'rump' programme—the Space Shuttle—which had great difficulty establishing itself and which, once developed, did not manage to create other projects in its wake. The programme is still controversial today because of its cost and is betting its future on full use of the ISS.

This latter programme, subject to numerous vicissitudes, is for its part the regular target of political and budgetary assaults. On the one hand, its orientation towards investigation of the inner planetary environment makes it a precursor programme for manned flights to the red planet, something which is, for reasons given above, not really on the agenda. On the other hand, scientific undertakings to explore the cosmos do not enjoy much public visibility and have difficulty playing the role of budget driver. Consequently, the dual structure of civil space activity (manned flight, scientific activity), inherited from a highly specific political situation, is today finding its limits.

2.2. The second 'identity crisis'

From the military point of view, the end of the Cold War represented a second period of questioning with the advent of profound strategic and military changes. The Gulf war demonstrated the absolute necessity of adapting military space to the new strategic conditions, particularly in the case of observation, early warning and telecommunications. For these three large applications areas are united in having been precisely adapted to dealing with confrontation between two blocs, which left them somewhat ineffective in the first 'post-cold war' conflict between the USA and Iraq. The new operational requirements (ability to detect short-range missiles, availability of wide-field observation and digital cartography, and of individual, secure transmission to mobile equipment) led the USA to overturn programmes that were underway and, further, entirely to rethink the very structure of the military space programme and its relationship with its technological environment.

This consideration favoured the concept of transverse architecture, integrating military and civil technologies as needed. It corresponds to a much wider trend within society which has made the civil sector a driver of high technology and which has erased the differences between civil and military technologies for whole areas of activity. It therefore marks a break with the precise operational identification, which has characterized military space programmes up to now. Complementarity and flexibility are the shibboleths of military space today, shibboleths supposed to respond to the challenges posed by enemies who are less easily identifiable and more mobile than hitherto. The attacks of 11 September 2001 in the USA have demonstrated the validity of the premises on which such concepts are based.

The consequences of the new state of mind which presides over the military use of space are significant. They affect not only space programmes, but also the whole space architecture, military and civil. The past few years have seen the passage from highly specific space applications responding to relatively unchanging strategic imperatives (MAD) to the notion of hardware which is above all adapted to the needs of the user of the space service. Nevertheless the military world remained the manager of all those applications which affected it. The current situation is leading towards the making of a further leap, whereby hardware adapted to the military user evolves into hardware hired or 'borrowed' from the civil world for certain applications. The US military authorities have also taken this step in a number of

[4] In November 2001, the cost of the station (development and operation) was estimated at $100 billion over 10 years from 2006, the expected date of its full entry into operability.

cases, in particular in the field of telecommunications following the conflicts in the Balkans. Clearly, this erosion of the specific nature of military programmes via the broadening of the extent of their mission, which has passed from military defence *stricto sensu* to the wider notion of security, is also contributing to the questioning of the powerful space identity discussed above.

3. An unresolved difficulty: top-down over bottom-up changes

From the economic and industrial point of view, the changes that have been imposed on the space sector have essentially been carried out from the top down. The loss of specificity among space activities proceeds in fact from governments' re-evaluation of their needs and a desire to rationalize public costs, rather than from any real explosion in commercial activity. Up to now all the plans laid for enlarging the truly commercial use of space have been exposed as without foundation. This is certainly true for manned flight (which remains the most costly activity), in which all hope of being able to manufacture medicines or special alloys, say, has long since been abandoned. But it is also the case for a collection of activities that have a priori been considered more 'applicable', such as Earth observations and, to a lesser degree, telecommunications and satellite navigation.

3.1. Downstream value-added technologies

Of course, the latter two activities comprise an important commercial opening and they represent the sole two examples of space applications from which the private sector can expect significant growth. The space telecommunications sector has now achieved relative self-sufficiency in certain applications, with an average of 53% of its turnover produced by the private sector. Space telecommunications are by far the most developed space market, with an annual global turnover of around $10 billion in 2000 for satellite construction and the renting of transponders alone. In the same way, with a market that had established itself with a turnover of around $4 billion in 2000, the navigation, precise positioning and—above all—time synchronization permitted by satellite navigation systems may give rise to the development of real industrial activity in this field. Europe is not misguided in choosing to launch itself into the satellite navigation adventure with its Galileo programme, which could be operational by the end of the decade.

Nevertheless these two fields leading the extension of commercial space activities are no less dependent on the downstream services associated with them and are not able to generate sufficient revenues on their own. We should recall, for example, that space telecommunications represent only about 2% of general telecommunications traffic and that their utilization rate varies considerably according to the services concerned. Thus, while television constitutes the main market for telecommunications satellites, making up around 75% of their activity, the dynamism of the fixed communications market, by contrast, is all coming from terrestrial links, basically thanks to significant investments in new technologies (cable, fibre optic), to the direct detriment of satellite links, now confined to the distribution of information at the local level. Finally, the hopes generated by the development of mobile telecommunications services has for now been dashed, thanks to a still immature market and to a resurgence of competition from the classical systems. Those who bet on the commercial success of the 66 satellites of the Iridium system, the first satellite communication system serving mobile telephones, lost their money and owe the salvage of the system to its recovery by the Pentagon. Globalstar, the other system in the wings, which claims greater interoperability with terrestrial GSM systems, is nevertheless also experiencing similar difficulties. Industrial strategies are clearly staking their chips increasingly on the exploitation of space telecommunications, i.e. on the most remunerative part of the activity. This move, common to the space industry as a whole, was started several years ago by some of the largest US space businesses, such as Hughes (which divested itself of the satellite construction side of its business—to be taken over by Boeing—and kept only those areas involving the use of space technologies), and Lockheed Martin, which is increasingly investing in the operational side of the business.

Satellite navigation is proving to be a formidable technology generator whose commercial applications involve the users of downstream systems rather than the orbital segment itself. Some projections estimate that direct applications of the system, i.e. end-use of the navigation function, would represent less than 6% of the total market, whereas intermediary uses within complex systems would account for the remainder. Also expected is strong parallel growth in personal applications, which, based on extrapolations from tendencies observed over the past 4 years, should experience 50% annual growth. The increase in intermediary uses in addition to direct end use should take on an importance which is, however, poorly defined, since it is essentially dependent on customers, services and applications that must themselves first understand, if not create, the utility the former can have for them.

But it is satellite imagery above all which best illustrates this real commercial dependence, with a relatively narrow, stable market that has defied all attempts to develop it. With a turnover of around $200 million in 2000, the sale of space imagery has not really

proved capable of creating new applications or new markets since the first efforts made by the French firm Spot Image at the beginning of the 1980s. And despite highly optimistic forecasts, the arrival of new entrants to the market following the US decision of 1994 to permit the commercial exploitation of high-resolution (1 m) images has also been expressed neither in an explosion of the market nor in any fundamental alteration of its structures.[5] Given the relative indifference of the public to these developments and a public-sector user community which remains modest, the types of use of space imagery are fairly stable and demonstrate the complementarity of the satellite with aerial photography, whose annual turnover is over 15 times higher.[6] The conservatism of the market has therefore scarcely been affected by the provision of increasingly precise images.[7] Here too a distinction needs to be made between direct applications and exploitation downstream of these applications. There is a world of difference, both transatlantically and, increasingly, in Europe, between space imagery activity proper, characterized by the provision of images or data (the 'data market' in US terminology) and the production of information from these data ('value-added information market'), which brings into play a complementary industry, dealing with the processing, treatment, storage and communication of data. This new category of activity thus gives the lion's share to IT companies, which may become a key player in the sector and contribute to a profound transformation of it commercially speaking. At any rate it is this area of the activity which is now the object of the biggest financial efforts, whether public in origin, notably in the USA, or based in industry. It is significant to note that the very young company Space Imaging is already reorientating part of its business. It is doing so first in the field of data collection, with rising investment in the field of aerial photography but also in information production, for which it is gambling on the fusion of data and on technologies to aid decision making. It is targeting a range of clients who need 'information' in real time. While doubtless promising from a commercial point of view, this type of activity is at an early stage and has the drawback of requiring heavy investments at the start.

3.2. The inevitable support of the public sector

Thus, despite the amount of talk on the commercial potential of space, all efforts at modernizing and establishing private space activity have been public, thereby creating space activity from the top down. As mentioned above, the establishment of commercial remote sensing activity was only made possible through the support of governments, notably and most recently the US government. Such establishment has been supported in two ways:

- First, in the very creation of the companies concerned, which are the result of activities formerly carried out by military actors. These companies have been able to profit fully (by direct employment of staff from the defence community) from the skills and expertise developed with public funds, giving themselves the possibility of using technologies already developed and understood by the military for much lower cost. In this context, while the notion of Commercial Off-The-Shelf (COTS) goods is often used to describe the phenomenon of the military using commercial technology, we may need to invent a notion of Military-Off-The-Shelf (MOTS) goods to take account of the opposite movement, which first began in the USA in the 1990s.
- Second, and doubtless most importantly, at the world level, this space activity is basically held together by public, in origin essentially military, demand, which finds in these new 'commercial' activities the means of externalizing functions which are useful to it. The advantage for the public sector lies in having access to activities, which may find openings in the civil sector and may be used for ends other than exclusively military ones. The establishment of sources of information is facilitated not only for the development of commerce but also for diplomatic or political ends outside of strictly military usage. In parallel, the public sector retains its quasi-monopolistic position and controls both prices and the size of the market through its budgetary decisions. This is the case in the USA, where companies have complained repeatedly about unkept promises of finance by the government, which had announced annual support to the tune of $100 million to be shared between the three principal firms. The US authorities have preferred the technique of focused assistance—more individualized but smaller amounts.[8] But this dependence goes beyond one single US case to involve the majority of the other providers of imagery who, like Spot Image, have seen

[5] The US companies Space Imaging, Orbimage and Earthwatch have all launched such satellites. One only has to compare the $200 million average turnover of revenues from space imaging activity with the investments made by these three companies—$750 for Space Imaging's Ikonos 1 and 2 satellites; $250 for Orbimage's Orbview 3 and 4; and $185 for Earthwatch's QuickBird 1 and 2—to understand the relative nature of the concept of commercial profitability.

[6] According to a recent study by Frost & Sullivan, Commercial Aerial Imagery Data Market, Revenue Forecast, 2001.

[7] Which are now reaching 0.65 m since the orbiting of a new satellite, QuickBird 2, by the US firm Earthwatch in October 2001.

[8] Such was the case, for example, in October 2001, with the Pentagon's outright purchase of the images of Afghanistan by Space Imaging's Ikonos satellite for a total cost of $1.9 million. This contract was renewed on 5 November 2001.

their activity largely dependent on public orders (even though, in the case of the French firm, the Pentagon can legitimately be regarded as a private customer), or on the defence requirements of their own and other 'client' countries. This has been true for the Israeli company ImageSat, the other provider of high-resolution images. This company gets most of its turnover from the sale of ground-stations, which allows governments—the only clients likely to be able to pay the asking price—to control the use of a satellite within a 2000-km radius of the station. Here we can speak of a true hiring of a satellite service in the direct interests of the defence forces of countries who have no space capability of their own.

3.3. A state-based dependence which involves all sectors of space activity

While it may be the exemplar, space imagery is clearly not the only activity implicated in this dependence on the state. Even telecommunications cannot escape this rule, and that includes some of their most up-to-date applications, such as mobile telephony. Here, the commercial failure of Motorola with its Iridium system can be analysed with the benefit of hindsight. Iridium was the fruit of a reorientation of state-industry relations in the USA, whereby the government, in this case, helped finance a family of spacecraft which could be exploited by a private telecommunications operator (Iridium LLC), which would count the Pentagon among its favoured customers. This new kind of relationship reached the point where, from 1996 onwards, the Iridium system was an integral part of the military communications architecture plans of the US Department of Defense. This close relationship between firm and government led to the establishment of a highly specialized system in a very narrow segment of the market (direct mobile telephony), at a time when the majority of competing projects were betting either on interconnections with terrestrial networks, or on the provision of a broader range of services (especially multimedia services).

This new state-industry relationship therefore largely contributed to defining the shape of the service provided by Iridium, a service in which commercial results were no longer the *sine-qua-non* for the existence of the system. Of course, the parallel rise of terrestrial systems of mobile telephony played an important role in Iridium's difficulties in making its mark commercially, but the crucial, early involvement of the US government in the funding of and outlets for the satellite system leads one to question the true commercial nature of the project from its earliest days. It should be noted, moreover, that, following the system's threatened destruction through bankruptcy, the US state finally—and not without some hesitation—bought the whole system, of which it remains the sole real user, and entrusted its maintenance to Boeing.

The launch industry remains the public-sector activity *par excellence*. Highly dependent on government markets and a generator of important levels of industrial activity, this sector does not lend itself to the search for markets which are by their nature limited and scarcely accessible to numerous private actors. Thus the European company Arianespace remains the world's principal provider of commercial space launches today with 10 launches carried out in 2000; in the same year there were 28 US launches in total, of which 21 were of government-owned spacecraft. While competition is fierce in the launch market, especially since the arrival of Russian and Ukrainian launchers in the form of joint ventures with the two US giants Lockheed-Martin and Boeing, companies are nevertheless condemned to operate in a market of limited size, as studies carried out by Arianespace have shown. The disappointed hopes for the telecommunications satellite constellations which were to multiply the number of launches, along with the development of increasingly powerful geostationary satellites, coupled with the general consolidation of commercial activities linked to 'new technologies', have largely contributed to this slow-down. Furthermore, the development of reusable launchers, the other track pursued by the space agencies for several years in order to lower the cost of access to space, has yet to bear fruit. The example of the US Space Shuttle is instructive. The cost of launching a kilo to orbit on the Space Shuttle is around $28,000, a much higher figure than on any of the apparently more expensive expendable launch vehicles currently in use.[9] The only attempt to cut the umbilical cord to the state has been made by NASA, which tried to get the X-34 small reusable launcher programme financed by industry itself, with the promise that the latter would be supported by the agency. However, the unprecedented character of the situation soon caused the industry partners to retreat as they withdrew from the agreement and obliged NASA to assume its role as prime contractor and moneylender, finally leading to the programme's suspension.[10]

[9] This figure is from a balance sheet drawn up in 1990 and cited in Rand Corporation, US Access to Space: Launch Vehicle Choices for 1990–2000, March 1990.

[10] Given the constraints of chemical propulsion, the performance gains of the engines, achieved at a high price, can only be balanced by a marginal improvement in performance, which leads one to believe that only a technological quantum leap in this field would grant launch activity a new lease of life, in terms both of placing satellites in orbit and, ultimately, of installing large-scale infrastructures in space.

4. A second difficulty: caught between the public and private domains

As we can see from the above summary, space activity seems to be caught in a double bind. On the one hand, the state seems to be increasingly inclined towards externalizing and 'delegating' such activity to industry and commerce (while remaining the principal user). On the other hand, industry, which has experienced significant concentration over the past few years, sometimes, as in the USA, predicated upon the expectation of new areas of demand from the public sector, particularly in the information field, is broadening its skills and is resolutely reorientating itself towards the exploitation of the space segment and the provision of services. We should note that for the moment this development remains an essentially American one, which sometimes provokes fears of a loss of 'core competence' in Europe. But it remains the case that, in emulation of the successive mergers and acquisitions carried out by the two US giants, the major European firms have also been tempted to broaden their skills spectrum.

Acknowledging new economic, technical and political stakes, European firms have for several years been accelerating the pace of industrial restructuring in Europe. Following the creation of national hubs, e.g. around British Aerospace and Matra Marconi Space in the UK, DASA in Germany and Aerospatiale-Matra in France, the idea of creating a major European company which would be able to compete with the US giants took hold. Its first incarnation came in 1997 with the new European Aerospace and Defence Company (EADC), which was to become the European Aeronautics Defence and Space Company (EADS) in 1999 with strong Franco-German encouragement.[11] The result was the creation of a true European aerospace group, which is ranked third in the world in terms of turnover.[12] The question remains of the future of space activity as such within this context of industrial restructuring. The widening of the perimeters of these large groups, which now combine space and aeronautical activities; the increasingly tight webs of cross-cutting interests, causing the subsequent incorporation of units formerly devoted to the construction of satellites into entities with much wider ambitions, whether in services or telecommunications; and, finally, the trend towards the opening up of capital implied by the Europeanization of the aeronautical industry may lead the industry to evaluate its space activity against other wider strategies. By detaching itself from the classic model of state-industry relations, as much through state 'delegation' as through its own restructuring and subsequent difficulty replacing the public sector, space activity seems to have fallen between two stools. From an industrial point of view, this situation has been made concrete by the reduction in public investment reflected in now frequent cancellations or elisions of programmes, along with the difficulty in finding stable political balances, for example in the establishment of a common European security and defence policy. The aerospace industry as a whole thus finds itself confronted not only with the obligation of transforming itself but also with the requirement to generate the conditions of that transformation.

5. Future perspectives

The transformation of space activity has essentially been expressed in changes in the way it is used. In this sense space activity has become an area which is increasingly hard to recognize as a single sector. In Europe there has been a reduction of public investment in space activity itself, as well as a dilution of the sector because of its complete restructuring. The effects of such a transformation are profound. In the USA similar developments have arisen for the same reasons and are affecting industry as much as the US space agency.[13] If the major US companies are chiefly betting on the development of complex information systems, for their part NASA managers have been hoping to reposition the agency in the technology innovation race, a position it deserted for the need to achieve results in its major, especially manned, programmes.[14] Competition in this field was fierce and remains so today with rival programmes at the Pentagon and the Department of Energy.

From the point of view of space activity itself, such an orientation is not neutral and leads one to fear the abandonment of purely scientific goals in favour of technology. Indeed, for several years NASA management has supported the idea that it would do better to attach priority to technological rather than basic research. The effort to accord technology a greater place between the two traditional areas of manned flight and science at NASA was a constant of the new programmes embarked upon by its previous administrator, Dan Goldin.

[11] Also incorporating the Spanish firm CASA, EADS saw itself as a response to divergent/opposing British strategies which manifested themselves around the association between British Aerospace and GEC which gave rise to BAE systems.

[12] With over $24 billion in 2000, which puts EADS after Boeing and Lockheed at $51 billion and $25 billion turnovers, respectively, for the same year.

[13] These developments are nevertheless of lesser proportions. Annual US investment still hovers around $30 billion.

[14] Hence, for example, the 'New Millennium' technology programme, with its EO-1 and Deep Space probes, aiming to show that NASA remains competitive in the IT field and the management of complex systems in space.

This two-pronged dilution of activity is a challenge that governments (hoping to preserve their role of customers of the space sector) and industry (which must find ways of maintaining its expertise) must take up. The trick will involve two things: discovering more-or-less everyday applications which can justify the pursuit and development of large space programmes, and which will integrate these programmes' role in increasingly complex groups of activities; and avoiding the erasure of their specific nature and the disappearance of particular skills over time. Demonstrating the contribution of such programmes while taking care not to make them conspicuous at the technical level will doubtless require passing from the notion of a space programme to the wider concept of global application. This is the meaning of the European Global Monitoring for Environment and Security (GMES) project, for example, whose aim is to use space-based methods of monitoring the environment, both existing and to come, in coordination with other capabilities in order to respond to the global preoccupation with protecting the environment. Beyond its precise content, a programme of this type may well be the precursor of a new way of exploiting outer space. It pairs the space and ground segments and could eventually combine public finance and private projects to bring about cooperation between civil and military methods in the same mission, here surveillance of the planet and its atmosphere.

Paradoxically, while it tends to erase the specific characteristics of the space sector, it is perhaps in this broadening of its missions that the sector will get its second wind. Here perhaps is the space community's long sought after alternative, the means of rebuilding its reputation that has so far been attempted via public education. Bringing space to society, rather than society to space—here doubtless resides the true renewal of a field of activity, which holds all the cards to satisfy numerous industrial and political ambitions. Space may even become a real power player again in the 21st century.

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[1] Bruce Murray. Journey into space: thirty years of space exploration. New York: Norton, 1989.