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# NEW CHALLENGES IN INTERNATIONAL ORBITAL DEBRIS POLICY

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## ABSTRACT

Over the last several years, many parties have given increased attention to the threat to space activities posed by the growth of orbital debris. However, progress in mitigating the growth of orbital debris has been slowed by technical, economic, and political uncertainties. This paper discusses the challenge of establishing effective U.S. and international policy for orbital debris within the framework of the increased use of space for economic ends. It also examines the role that the U.S. Congress might play in the U.S. approach to controlling the growth of orbital debris.

## INTRODUCTION

Recent news announcements about private firms that seek to establish low Earth orbit (LEO) satellite systems for a variety of telecommunications services have generally focused on regulatory and financial issues. However, the number of satellites proposed for some of these systems (up to 840 satellites in the case of the Teledesic system) raises concerns about their potential contributions to orbital debris in regions of LEO that are already under stress from existing debris.

Designing launch procedures and satellite operations to reduce the generation of orbital debris generally exact an economic or operational penalty. Although debris reduction strategies vary greatly in cost, some of the most effective ones, such as removing spacecraft from orbit at the end of their useful life can be very costly.[1] Hence, nations have been reluctant to impose requirements that might limit their range of economic or operational options. The U.S. government has been especially hesitant to impose standards on its private sector that would reduce the competitiveness of U.S. satellite systems compared to non-U.S. systems. Nevertheless, orbital debris experts agree on the need to reduce or eliminate the production of orbital debris in order to preserve the ability to operate spacecraft safely, especially in low Earth orbits. The economic and other costs of losing spacecraft could be very high in some orbits. For example, some medium low Earth orbits (800 - 1000 km and 1500 - 1700km) may soon subject to a chain reaction phenomenon, in which debris collisions cause sufficient debris to sustain additional colllisions.[2] In these orbits, debris will remain for thousands of years. Even a total cessation of space activities will not eliminate this effect because once begun, it is self-sustaining and debris does not "wash out," as it does at lower altitudes. Continued production of orbital debris by the United States and other countries threatens U.S. national security, the pursuit of science from space, human safety in space operations, and the economic viability of commercial satellites.

While specialists have long recognized the threat posed by the growth of orbital debris, in the United States, at least, the concern over orbital debris has not yet reached a level of political awareness

requiring urgent action by government. The relatively low policy priority given to orbital debris issues to date by both the Executive and Legislative branches of the U.S. government reflects this perception. However, the importance of maintaining the viability of near-Earth space operation - both piloted and robotics - will eventually lead to increased attention from policymakers, especially should a significant impact occur on the space shuttle, the planned space station, or the Hubble Space Telescope. these are all relatively large space structures with large cross sections and therefore more likely to suffer debris impacts than smaller ones in the same orbits. They also receive greater notice by the media and the public than others because they involve human spaceflight. Indeed, even without such a dramatic occurrence, there are encouraging signs that such a dynamic is slowly developing. Policymakers are becoming more aware of the harmful economic effects of orbital debris. The announced plans for the deployment of large, multi-satellite constellations by communications providers has begun to focus additional attention on the debris question.

Orbital debris has long been recognized as a global problem that ultimately will require remediation at the international level. What then are the prospects for an international agreement to control the growth of orbital debris? Over the near term, the prospects do not look good. Lack of political or economic pressure, combined with continued technical uncertainties over the extent of the debris threat, have not led to rapid action on any type of international orbital debris agreement. Nevertheless, as orbital debris experts learn more about the threat it poses, and inform a wider public, support for international action grows. In order to explore what may be possible, the following sections examine the technical, economic, and political contexts in which orbital debris policy will be made.

## THE TECHNICAL CONTEXT

The technical aspects of the orbital debris issue may be divided into two main categories: (a) the knowledge of the nature and extent of the debris environment and its rate of growth, and (b) the technologies required to minimize the creation of new debris and those needed to shield against existing debris. Movement towards and international agreement is hampered by the fact that significant gaps remain in our understanding of the nature and extent of the orbital debris threat on the one hand, and incomplete understanding of the economic and operational consequences of proposed technological fixes on the other.

Indeed, commentators have often cited the lack of sufficient technical knowledge of the debris problem and its remediation as a reason for delaying development of an international agreement. For example, Maclure and Bartley recently argued that

> while the problem of orbital debris is recognized as serious, it is believed that the level of scientific and technical understanding of debris generation and minimization is not at the point where formalized international policies and practices can accurately be formulated.

and

> Given the dearth of knowledge, incomplete technological development, untested preventive mission operations, and technical and political sensitivities, it appears that the current course of informal international consultation and information exchange will continue for at least the near term.[3]

The range of technical uncertainty surrounding the orbital debris issue now appears to be narrowing. Scientists have made many new observations and

refined their models of debris distribution, especially for debris larger than 1 cm in diameter. They are still very uncertain about the distribution of smaller debris. Spacecraft and launch designers are continuing research on technologies related to shielding and the mitigation of debris growth. In the United States, the National Research Council (NRC) of the National Academies of Science and Engineering has been conducting a technical assessment of the orbital debris environment and of control techniques.[4] The NRC's report, now under review, should provide a welcome synthesis of what is known about the nature and extent of the orbital debris problem and potential technical solutions. As such, it should prove to be a useful resource for policymakers.

At the operational level, several Federal agencies, notably the Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA), have undertaken the development of a "handbook" of design and operational guidelines to be followed in launches undertaken for the U.S. government.[5] However, these proposed guidelines are still in draft form, and will not be promulgated until comments have been received from industry. the Clinton Administration is attempting to include industry's concerns and viewpoints in its formulation of technical standards and policy. At the same time, NASA officials have encouraged informal discussions and information-sharing among the world's space agencies.

In the past, absence of consensus on the technical aspects of the orbital debris issue has made the U.S. Congress and the Executive Branch reluctant to impose regulatory or other measures on government and private sector users of space. However, recent observational data on orbital debris growth are likely to raise the level of concern in both Congress and the Administration. Specifically, debris counts obtained with the Haystack radar indicates that while the debris densities in certain orbital altitudes have grown at a slower rate than predicted by debris models, the growth at the orbital altitudes that will be occupied by the proposed "Little LEO" communications satellite constellations is significantly greater than was anticipated.[6] Such a perceived commercial spacecraft could well give additional impetus to efforts to reach a consensus on orbital debris mitigation measures.

## THE ECONOMIC CONTEXT

As noted in an earlier paper,[7] nations have been reluctant to commit to orbital debris mitigation measures in the presence of technical uncertainty on the extent of the debris problem because such measures generally would exact an economic or operational penalty on government or private sector participants. Yet, the threat faced by any individual operator is quite small. This perspective, unfortunately, does not adequately address the true social costs of unrestrained debris growth. In this regard, the debris problem is similar to other pollution problems involving several parties with diverse economic and political interests. As Macauley has pointed out,

> ...the probability-weighted expected value of spacecraft loss may not presently be large enough to focus attention on debris. For example, estimates of the probability of a geostationary communications satellite being ruined by debris average about 1 fin 1000 during the expected life of the spacecraft. Multiplying this probability by the cost to replace a typical satellite give $5000,000 as one measure of the expected loss. This amount is so small that most satellite owners do not worry about the impact of debris...however, while the low expected loss values may accurately

represent private losses, they may underestimate social losses because of externalities attributable to the technology of debris proliferation (collisions can beget so-called 'cascading' amounts of debris) and other factors.[8]

Although the social losses attributable to unrestrained debris growth might prove to be unrestrained debris growth might prove to be very significant over the long run, e.g., eventually loss of the use of some orbital altitudes, the economic costs of regulating launch vehicle and spacecraft design and operation to minimize debris growth are also real, and must be faced in the near term. Informed policymaking requires a better understanding of the costs of alternative debris reduction and mitigation strategies. To that end, the House Committee on Science, Space, and Technology included report language in its fiscal year 1994 NASA authorization bill (H.R. 2200) that directed the Office of Science and Technology Policy (OSTP) to involve the satellite and launch vehicle industries in its development of a plan for controlling orbital debris.[9] In adding this provision, the Committee recognized the considerable expertise about launch vehicle and satellite design that resides within the private sector, and the need to involve an important sector of the launch community hat would be affected by design changes.

Nonetheless, U.S. industry is likely to propose design or operational requirements that disadvantage it relative to overseas competitors. Even those companies that have announced plans for voluntary debris reduction measures (for example, de-orbiting low Earth orbit satellites before all maneuvering fuel has been exhausted)[10] will be vulnerable to competitive pressures that ultimately may lead them to back away from their proposed voluntary actions, especially if U.S. policymakers vacillate over the appropriate policy to follow.

Commercial satellite operators are more likely to take appropriate steps to reduce their contributions to orbital debris if they have clear and consistent U.S. and international policy. Thus, the pace at which the orbital debris problem is resolved is likely to depend both on the development of relatively low cost remedies and an international agreement on the uniform imposition of those remedies.

## THE POLITICAL CONTEXT

In the United States, as in most other countries, the orbital debris problem has largely been limited to the domain of the specialist. Experts at NASA and the DOD laboratories have done a great deal of research on the characteristics of debris, the extent and growth rate of orbital debris, and potential shielding and debris mitigation strategies. Lawyers and economists have also analyzed orbital debris issues from their perspectives. However, politicians and policy makers have not perceived orbital debris growth to be a high priority issue relative to the many other issues requiring their attention. Thus, the history of the political response to the orbital debris problem has been one of study and the issuance of non-binding policy statements rather than the development of specific and binding debris control strategies. Development of approaches to controlling orbital debris by and large has been left to the operational agencies (for example, NASA and the DOD in the United States). To date, federal government officials have been reluctant to pursue any binding international agreement on debris.

In fact, the amount of attention devoted to orbital debris at the political level had been quite limited. It can be argued that 1988 marked the first year in which the orbital debris issue received much prominence politically. In that year, the House Committee on Science, Space, and Technology held a hearing on the subject and explored a number of

technical and policy issues . Earlier in the year, the Reagan Administration had issued a space policy directive that included a statement on orbital debris:

> All space sectors will seek to minimize the creation of space debris. Design and operations of space tests, experiments and systems will strive to minimize or reduce accumulation of space debris consistent with mission requirements and cost effectiveness.[11]

The Administration established an interagency working group and asked it to provide recommendations on the implementation of the orbital debris policy. That task force delivered its report in 1989.[12] At about the same time, the European Space Agency (ESA) undertook its own examination of the orbital debris situation.[13] On the Congressional side, analyses of the orbital debris problem were requested of the Office of Technology Assessment[14] and the General Accounting Office.[15] Section 118 of the fiscal year 1991 NASA Authorization Act (P.L> 101-611) focused additional attention on the debris issues and went beyond the 1988 space policy directive by calling for a zero-growth strategy for the control of orbital debris and for an international agreement to implement such a strategy:

> Section 188 (b) SENSE OF CONGRESS - It is the sense of Congress that the goal of the United States policy should be that --
>
> (1) the space related activities of the United States should be conducted in a manner that does not increase the amount of orbital space debris; and
>
> (2) the United States should engage other spacefaring nations to develop an agreement on the conduct of space activities that ensures that the amount of orbital space debris is not increased.[16]

Because Section 188 reflected the "sense of Congress" rather than a legislative directive, it did not bind the Administration to act. If did, however, reflect Congressional interest in a strong debris control policy.

Although encouraged by the research and collaboration undertaken by the operation al agencies in the years following the enactment of P.L. 101-611, the House Science, Space and Technology Committee believes that the United States needs to devote more attention to implementing orbital debris control strategies, and that more progress needs to be made towards the development of an international agreement on control of orbital debris. To that end, the fiscal year 1994 NASA authorization bill (H.R. 2200) directed the Administration, with input form industry, to develop a plan for the control of orbital debris, and to establish a timetable for the initiation of discussions on an international agreement:

> The Office of Science and Technology Policy, in coordination with the National Aeronautics and Space Administration, the Department of Defense, the Department of State, and other agencies as appropriate, shall submit a plan to Congress within one year after the date of enactment of this Act for the control of orbital debris. the plan shall include proposed launch vehicle and spacecraft design standards and operational procedures to minimize the creation of new debris. The plan shall propose a schedule for the incorporation of the standards into all United States civil, military, and commercial space activities. Finally, the plan shall include a schedule for the development of an international agreement on the control of orbital debris.[17]

After a slow start, the Administration

appears to be trying to satisfy the intent of the legislative provision. An interagency report on orbital debris is expected later this year. Given the apparent seriousness with which the Administration is addressing the Congressional concerns, it is likely that Congress will wait to review the Administration's proposed plan of action before undertaking additional oversight activities related to the debris issue. However, continued Congressional forbearance cannot be presumed in the event that a debris-related accident involving the shuttle or a high-profile commercial or government satellite occurs.[18] Under the circumstance, any remaining areas of uncertainty - technical or otherwise - on the orbital debris issue are not likely to be sufficient to prevent Congress from acting.

## NEXT STEPS TOWARDS AN INTERNATIONAL AGREEMENT

Most observers believe that in order to control the growth of orbital debris, the spacefaring nations must eventually reach agreement on the means of limiting debris production. However, as we noted earlier, the United States and other spacefaring nations remain reluctant to initiate substantive discussions on the form of such an agreement. Indeed, to date the Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space has not added the debris issue to its agenda, and it is only within the last year that the Scientific and Technical Subcommittee had taken up the debris question. As Maclure and Bartley observe,

> The United States has taken the position that greater knowledge of debris is required before adding the issue to the Committee's agenda, or before beginning to discuss the establishment of international regulatory measures. [19]

However, the spacefaring nations ocntinue to add objects into the near Earth sjpace environment. We do not have unlimited time to continue study and analysis. For example, the planned deployment of a series of multi-satellite constellations of communications satellites over the coming decade into orbits already under threat of runaway growth in the debris population may force regulatory decisions to be made in the absence of complete information. In addition, the recently announced U.S. space transportation policy[20] calls for a substantial upgrade of existing U.S. expendable launch vehicles; decisions on appropriate orbital debris control strategies prior to the commencement of those upgrade activities could help avoid potentially significant costs later. The European Space Agency has found, for example, that it is much cheaper to build in debris-reduction in the design stage of a launch system than to do so after it is operational.[21]

Finally, the realignment and consolidation of launch vehicle and spacecraft companies world wide is proceeding at an accelerating pace and increasingly is blurring the competitive distinction between different nations' space industries. Space industry is becoming internationalized in a manner similar to that of other high technology industries. This therefore may be an opportune time to begin to establish a clear set of international orbital debris guidelines.

What then is the next step along the road to a binding international agreement on controlling the growth of orbital debris? Williamson in an earlier paper proposed a five-step process.[22] Given the developments of the last several years, it can be argued that the time is right to attempt to reach consensus among the launching nations on a minimum set of mitigation strategies that can be implemented over the near term ("Step 2"). the United States has already identified a number of debris reduction steps that could provide the basis for an agreement. For example, it has arranged

to vent launch vehicle upper stages so they are unlikely to explode, and it has designed circuitry for spacecraft batteries so they are unlikely to short out and explode.[23] U.S. experts have assisted launch vehicle designers in other countries to identify remedial adjustments to their launch vehicles.[24] However, and incremental approach may be seen by some as not ambitious enough, and by others as premature.

In response to the former criticism, such an incremental approach, while of necessity limited in scope, is realistic given the level of attention devoted to debris issues at the policy level to date and would significantly advance the process of developing a comprehensive international agreement. In response to the latter criticism, the risks of inaction and delay outlined above make it clear that movement, however modest, towards an international agreement to control the growth of orbital debris is by fore the better alternative and should be encouraged. The status quo is not an acceptable alternative.

In an earlier paper, we suggested starting an informal international orbital debris organization similar in structure to the Committee on Earth Observations Satellites (CEOS).[25] Other observers have suggested similar institutional structures.[26] Such an organization could begin to formalize the technical steps needed to reduce the production of orbital debris, especially in the orbits most at risk. Such steps would have the salutary effect of speeding the reduction of contributions to the debris population. They signal that the spacefaring nations are really serious about reducing the deleterious effects of orbital debris and would make launch and spacecraft manufacturers and operators much more aware of the problem. Their active involvement could further the development of more cost-effective methods of limiting orbital debris.

After the committee of spacefaring nations reach consensus on the basic steps to be taken and presented its findings to the Scientific and Technical Subcommittee of COPOUS, it may be appropriate for the Legal Subcommittee of COPOUS to take up the mater, in order to debate and resolve the definitional, jurisdiction and control, liability, and other issues that many legal experts consider need addressing in preparation for an international agreement.

In the United States, the consideration of orbital debris limitation should be one of the factors explicitly considers when agencies propose spending public funds for new systems and when companies bring forth proposals for operating licenses. Ultimately, however, for the reasons cited earlier, Congress will want other nations to act along with the United States. It will be looking to officials of the U.S. agencies for leadership. the United States has led the early efforts to learn more about the orbital debris problem and to propose solutions. It could and should lead in developing a near term international solution.

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