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THESIS

THE BOUNDARY BETWEEN AIRSPACE AND OUTER SPACE, A FUNCTION OF TECHNOLOGY AND NATIONAL SECURITY

by

Norris J. Hanks

Lieutenant Colonel, U.S. Air Force

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

Signed N. J. Hanks

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ABSTRACT OF

THE BOUNDARY BETWEEN AIRSPACE AND OUTER SPACE,

A FUNCTION OF

TECHNOLOGY AND NATIONAL SECURITY

The boundary between airspace and outer space has been on every list of problems associated with space for many years. Almost all discussions of the problem in the legal literature attempt to link the boundary with precedents and analogies from maritime and air law. These attempts inevitably fail because the speeds and modes of travel, the threats that must be considered, and the means of defense are in a different realm. The attempts, by lawyers, to discuss the technical aspects of the problem have led to a considerable amount of science fiction in the legal literature.

When the many problems that space presented in the early 1960's are arranged in order of decreasing legal content and increasing technical and security impact, it is immediately apparent that most of the progress toward solutions has been confined to the legal problems. At the technical-security end of the list there have been many individual and group opinions, but the major space nations have remained relatively silent to preclude any confrontation that would end the precarious "cooperation" in space.

The boundary issue is not only inseparable from technology and security but it is also interrelated with several other problems, and is quite capable of destroying much of the progress already made in space law if a poor altitude is selected, or declared unilaterally.

The constraints of air law and conventional traffic control have been tightening continuously since World War I. Space law, on the other hand, has been based upon freedom and cooperative controls. This initial spirit of cooperation, if it was that, is gradually disappearing as space weapons systems are being developed that infringe upon the principles if not the letter of the law. With space traffic moving down and air traffic moving up, technology will soon merge the two areas. The two divergent sets of ethics must clash unless a boundary has been established that maintains a realistic and acceptable separation.

A discussion of the problem from a scientific viewpoint leads to a set of criteria for a workable boundary. Using these criteria, an altitude band is found above which there will be no conventional traffic (based on existing definitions of aircraft) and below which there will be no useful orbital traffic (based on temperature and thrust required problems). This altitude band (near 55 miles) should be determined accurately by the scientific community. With this natural separation, the associated problems of innocent passage, traffic control, and reconnaissance could be resolved.

Even with this boundary, the facts of life (space weapons, countries not cooperating, etc.) must not be ignored. A number of collateral considerations are discussed.

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INTRODUCTION

> Ironically enough, the lawyer finds the main crackpots and nuisances among engineers and sociologists who assume the role of amateur lawyers and give vent to rather silly if harmless rhapsodies in a field wholly unfamiliar to them.
>
> Andrew G. Haley, 1963[1]

This statement, found early in the course of research for this paper, was kept in mind while reading a considerable amount of science fiction in the legal literature. As Mr. Haley went on to say, both scientists and lawyers are needed in the fields of air and space law.[2] The present author approached the boundary problem as a possible helper from the scientific and practical sides of the house. Although the progress in and status of air and space law were found impressive, there is still room for this sort of help.

An early paper, in 1953, by Welf Heinrich, Prince of Hanover, formulated the boundary problem in conjunction with related problems of innocent passage, the nationality and sovereignty of aircraft, spacecraft, and space stations

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[1] Andrew G. Haley, Space Law and Government (New York Meredith, 1963), p. 96.

[2] Ibid., p. 97.

and the liability for damage.[3] Andrew Haley expanded this list considerably in 1958 to add the problems of radio frequency allocation and post-mission shut-down, elimination of space debris, identification of space objects, and agreements on observation from space.[4] In 1961 Eilene Galloway added the freedom of space for exploration and use, traffic control to avoid interference between spacecraft or between spacecraft and aircraft, contamination of or from space, exploration of celestial bodies, and the question of meterological activities in space.[5] There have been, of course, other authors and other lists of problems. Also, since 1961, when the United Nations first seriously addressed the subject of space law, new problems have appeared. The following list, representing the situation in 1961, will be used for preliminary discussion in this paper. Other problems will be introduced as the discussion is developed.

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[3]Welf Heinrich, Prince of Hanover, "Air Law and Space" (1953), U.S. Congress, Senate, Committee on Aeronautical and Space Sciences, Legal Problems of Space Exploration, a Symposium (Washington: U.S. Govt. Print. Off., 1961), p. 271.

[4]Andrew G. Haley, "Space Age Presents Immediate Legal Problems," Colloquium on the Law of Outer Space, First, 1958 (Vienna: Springer-Verlag, 1959), p. 5.

[5]Eilene Galloway, "Introduction," Senate Committee on Aeronautical and Space Sciences, p. xiii.

1. Freedom of space for exploration and use.
2. Exploration of celestial bodies.
3. Nationality and sovereignty of space vehicles.
4. Liability.
5. Meterological activities.
6. Radio frequency allocation.
7. Identification of launched objects.
8. Post-mission shut-down.
9. Space debris.
10. Traffic control.
11. Innocent passage.
12. Space reconnaissance.
13. Air-Space boundary.

As will be seen shortly, the first five items have been settled through U.N. resolutions and the space treaty; six and seven have been mentioned in resolutions, but are not entirely cleared; and eight and nine are continuing and growing problems, but are not too serious yet. The last four (traffic control, innocent passage, reconnaissance, and the air-space boundary) are current problems, with the air-space boundary the key to further progress.

At first thought the boundary between airspace and outer space would seem to be a simple matter, certainly no more complicated than the boundaries of territorial waters and <u>lateral</u> national airspace, which coincide. However further examination causes second thoughts. Territorial water claims range from three to twelve miles (a factor of four) and Air Defense Identification Zones extend air control for hundreds of miles.[6] From these thoughts, current disputes about innocent passage at sea and in the air are a natural next step,[7] and so it goes.

Actually, a study of the subject of the boundary best reveals its complicated nature through the fact that related information is found under almost any subject heading having to do with space and its problems. Every reference in the bibliography attached to this paper includes information bearing upon the boundary, and yet few are expressly devoted to it. Also, after pouring through literally hundreds of references and thousands of ideas, the author came to still different conclusions than did any of the preceding authors.

An early conclusion was that the four current problems (traffic control, innocent passage, reconnaissance, and the boundary) are all interrelated and inseparable, constantly meeting in the convolutions of two broader topics, technology and national security. Many authors credit the cooperation

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[6]John T. Murchison, The Contiguous Air Space Zone in International Law (Ottawa: Dept. of National Defence, 1955), p. 5.

[7]Myres S. McDougal, et al., Law and Public Order in Space (New Haven: Yale University Press, 1963), p. 715.

in space during the International Geophysical Year as the breakthrough in freedom of outer space.[8] It could as well have been an opportunity for the potential space nations to begin the development of space technology and the investigation of possible civil and military uses of space while reserving commitment on the future use and the legal status of space. Continuation of this tacit agreement would require some progress toward codification of space law, a careful separation of low altitude conflicts from this area of cooperation, and the avoidance of confrontations of any kind in space. Successful continuation would allow the slow accumulation of technical knowledge, the careful consolidation of agreed-upon legal positions, and the quiet development of those promising military systems that would not be threatening enough to prompt a challenge. In particular, the purely legal and peaceful exploration questions would be accepted for discussion while the deeper technical and more serious security problems would be postponed as long as possible. The events of the last ten years fit this pattern, as will be seen.

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[8] Richard L. Fruchterman, Jr., "Introduction to Space Law," JAG Journal, July-August 1965, p. 12.

THE BOUNDARY BETWEEN AIRSPACE AND OUTER SPACE, A FUNCTION OF TECHNOLOGY AND NATIONAL SECURITY

CHAPTER I

THE CURRENT STATUS OF AEROSPACE LAW

In recent years the regulation and claims of sovereignty over airspace and outer space have been moving in opposite directions with increasing constraints below and expanding freedom above. These opposite tendencies are separated only by the current state of aerospace technology and may clash with a vengeance when a boundary is finally established, whether through agreement or sudden unilateral decision.

The analogy of territorial waters versus the high seas (no shining example of boundary agreement in itself) will not be applicable, because the modes of travel, the need to operate through the boundary (and to land), the degree of effectiveness of control against likely threats, and almost all technical aspects are entirely different. A better source of reference may lie in aerospace law itself, in its origins, development, and current status, and in its consensus on sovereignty.

The Source

Most of the progress in space law has occurred through the General Assembly of the United Nations which, while not a legislative body or a convention assembly, does establish a consensus of world opinion on general principles.[1] Both the United States and the Soviet Union have indicated acceptance as law of at least those resolutions having to do with space activities which have been passed unanimously.[2] Most of the critical agreements, moreover, have been drafted subsequently as treaties and have been ratified by the states. It should be noted, however, that Communist China has not been a party to and does not recognize any of these resolutions or treaties.

There are two schools of thought for continued progress: the frontal assault, hoping to achieve agreement before problems become acute; and the accumulation of modest precedents, to avoid confrontations and bad early decisions.[3] The past tendency toward the second route will probably continue into the future.

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[1]"Symposium on the Law of Outer Space," The United States Air Force JAG Law Review, September 1965, p. 4, 9.

[2]Ibid.

[3]Philip W. Quigg, "Open Skies and Open Space," Foreign Affairs, October 1958, p. 97.

Codification Status

The heart of international air traffic regulation is the Chicago Convention of 1944, and the International Civil Aviation Organization (ICAO) which it created (now a Specialized Agency under the United Nations). Although Russia has never ratified the Convention, her pilots honor its provisions during flight outside Russia. The latest Russian air law was established in the Air Code of the U.S.S.R. in 1962.[4] Discussion of these documents will be postponed until later except for one significant observation valid for both: they do not mention and are not concerned with space.

The regulation of space began in the General Assembly of the United Nations in 1958 with the formation of a Committee on the Peaceful Uses of Outer Space [G.A. 1348 (XIII), 13 December 1958]. Subsequent resolutions and treaties have provided codification of consensus on many issues. Those related to the boundary problem (and their relevent provisions, paraphrased) include:

Resolution 1721 (XVI), 20 December 1961: international law, including the Charter of the United Nations, applies to outer space and celestial bodies; outer space and celestial

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[4]"The Air Code of the U.S.S.R.," Journal of Air Law and Commerce, Winter 1965, p. 30-41.

bodies are free; launched objects are to be registered with the U.N.; and the Committee on the Peaceful Uses of Outer Space (CPUOS) is invited to study and report on legal problems which may arise.

Resolution 1802 (XVII), 14 December 1962: the CPUOS is requested to "continue urgently" its work on liability, assistance to astronauts, and other legal problems; international launch facilities are encouraged; and allocation of radio frequency bands is required.

Test Ban Treaty, 5 August 1963: nuclear tests in the atmosphere or space or under water are banned [by those ratifying].

Resolution 1884 (XVIII), 17 October 1963: states are to refrain from placing weapons of mass destruction in orbit or in outer space or on celestial bodies [but no mention of development of same].

Resolution 1962 (XVIII), 13 December 1963: outer space and celestial bodies are free; international law and the U.N. Charter apply; States are responsible for all national activities including non-government; States will "consult" before conducting harmful tests or activities; launch States retain ownership of and jurisdiction over space objects if they are registered; states are liable for damage; astronauts landing will be returned from other states.

Resolution 1963 (XVIII), 13 December 1963: praises international cooperation and encourages continued efforts by CPUOS.

Resolution 2130 (XX), 21 December 1965: praises international cooperation and encourages continued efforts by the CPUOS.

Resolution 2222 (XXI), 19 December 1966 and Annex Space Treaty, same date: the resolution mentions, for the first time, to the CPUOS, "the study of questions relative to the definition of outer space." The treaty pulls together all previous agreements-through-resolution and includes: outer space and celestial bodies are free; States "undertake not to place" weapons of mass destruction in orbit or in outer space or on celestial bodies; astronauts landing will be returned from other countries; States are responsible for all government and non-government activities; States are liable for damage; States retain ownership and jurisdiction of objects while they are in space and after their return if they are registered; States will "consult" before conducting harmful tests or activities; and information flow to the U.N., as well as to the scientific community, should be increased.

Resolution 2223 (XXI), 19 December 1966: praises the work of the CPUOS but does not mention the definition of outer space.

These resolutions and treaties settle (in general terms) the first seven problems listed in the introduction. Resolutions 1721 (XVI) and 1962 (XVIII), and the Space Treaty, all state that outer space and celestial bodies are free for exploration and use by all states (problems 1 and 2). Resolution 1962 (XVIII) and the Space Treaty assign ownership of, and jurisdiction over, launched objects to the state of registry (problem 3). Resolution 1962 (XVIII) and the Space Treaty also assign liability for damage, to the launching nation (problem 4). The subject of meterological activities (problem 5) is broached in Resolution 1721 (XVI) as a field for productive cooperation, with continuing references to the subject in Resolutions 1802 (XVII), 1963 (XVIII), 2130 (XX) and 2223 (XXI). None of these resolutions contain regulatory provisions regarding meterological activities. The allocation of radio frequencies (problem 6) is considered "of utmost importance" in Resolution 1802 (XVII), and is mentioned in subsequent resolutions as an area of cooperation. The identification of launched objects (problem 7) is provided for, in Resolution 1721 (XVI), through the registry of all launched objects by the launching states with the Secretary General of the United Nations, and is included in later resolutions as a prerequisite for ownership and jurisdiction (Resolution 1962 and others). Notably lacking, however, are any resolutions dealing with the remaining six problems (shut-down, debris, traffic control, innocent passage, reconnaissance, and the boundary). Also, with the passage of time, the space activities of the states, and the discussions and resolutions in the United Nations, additional problems have appeared. Some of these new problems contain facets or combinations of the original set; others are entirely new. The definition of the words "peaceful use" (used throughout the resolution series) for example, has become a problem, particularly when associated with another problem not on the original list in 1961, "the military role in space." These and other current problems will be introduced and discussed (along with problems from the original set) as the subject of the boundary is developed in this paper.

The problems of shut-down, debris, control, reconnaissance, peaceful use, and military role are not directly related to either the high seas or the air above them (where all weapons, all reconnaissance, etc., are legal). These six will be discussed as background is established. Innocent passage and boundaries of sovereignty, however, have roots in sea and air law.

Innocent Passage Today

On the sea, innocent passage is generally permitted through territorial waters; however many countries are becoming more sensitive about it, and more inclusive in their claims of control.

In the air, innocent passage has not been permitted for many years without prior permission and then only under national control.[5]

Neither the air nor the sea analogies lead to optimism regarding the establishment of aerospace passage.

Sovereignty and its Limits

In 1953, Welf Heinrich said, "There are no provisions in positive law concerning the altitude to which the complete and exclusive state sovereignty over airspace should extend."[6] Immediately after Sputnik in 1957 Andrew Haley initiated a study of the subject of sovereignty over airspace and its limits which eventually enlisted the aid of the U.S. Senate and ultimately yielded "literally 100's of statutes and 1,000's of regulations."[7] His findings can be summarized as follows: "'airspace' and 'atmosphere' are the only terms employed . . . and they are treated as

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[5] Colloquium on the Law of Outer Space, Sixth, 1963 (South Hackensack, N.J.: Rothman, 1964), p. 3.

[6] Welf Heinrich, p. 292.

[7] Haley, Space Law and Government, p. 79.

synonymous . . . Nowhere in any of the statutes or treaties . . . is the term 'airspace' defined . . . No statute has been found which expressly purports to extend sovereignty above airspace."[8] Based upon a much more modest search, completed in early 1968 and documented by the bibliography attached to this report, it still can be stated that the upper limit of sovereign airspace is not yet defined.

According to John C. Cooper, in "Backgrounds of Public Air Law" (an excellent reference on the subject), the earliest exercise of control over airspace was through the Paris Police Ordinances of 1784 and 1819 prohibiting the use of Montgolfier balloons.[9] The method of enforcement is not described (perhaps by hot pursuit). The various conventions in recent years include the Paris Convention of 1919, the Habana Convention of 1928, and the Chicago Convention of 1944 (voiding the previous two).[10] All three provide for state sovereignty over territorial airspace but none define the upper limit.[11] All three imply regulation

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[8] Ibid., p. 79, 80.

[9] John C. Cooper, "Backgrounds of Public Air Law," Yearbook of Air and Space Law, 1965 (Montreal: McGill University Press, 1967), p. 9.

[10] International Civil Aviation Conference, Chicago, 1944 (Washington: U.S. Govt. Print. Off., 1945), p. 81.

[11] Ibid., p. 59.

of traffic to the height of "aircraft flight," with their definitions of "aircraft" including the necessity to "derive support in the atmosphere from the reactions of the air."[12] It is interesting to note (and could be relevant) that the U.S. definition of "aircraft" in 1926 (Air Commerce Act), reiterated in 1938 (Civil Aeronautics Act) and 1944 (Draft proposal for the Chicago Convention) and 1958 (Federal Aviation Act),[13] the Russian definition in 1962 (The Air Code of the U.S.S.R.),[14] and the German definition in 1964 (Air Navigation Act),[15] all could include spacecraft and thus space. Mr. Cooper defined the current limits of sovereignty based upon the aviation conventions: "National Airspace: The territory of a sovereign state is three dimensional, including within such territory the airspace above its national lands and its internal and territorial waters."[16] This is fine, but dodges the height problem.

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[12] Ibid., p. 253.

[13] "Symposium on the Law of Outer Space," p. 16.

[14] "The Air Code of the U.S.S.R.," p. 30.

[15] Cooper, p. 36.

[16] Ibid., p. 3.

Many authors include in the concept of sovereignty both the intention to act as sovereign and some actual display of sovereignty.[17] This rings in scientific progress and inequality among states.[18] A case in point is the U-2 in its overflights of Russia. No protest concerning the flights was made until one was brought down on 1 May 1960.[19] An example of extension of control (if not sovereignty) is the Air Defense Identification Zone (ADIZ). These zones have been established up to 300 miles off their coasts by the United States and Canada (and France for a time off Algeria)[20] to provide early warning and identification of, and partial control over, air traffic. The U.S. zone applies only to aircraft inbound to land, but the Canadian CADIZ applies to all aircraft.[21] The zones are based on the technological fact that in the air age, time and not

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[17] D. Goedhuis, "Reflections on the Evolution of Space Law," <u>Netherlands International Law Review</u>, no. 2, 1966, p. 122.

[18] John C. Cooper, "High Altitude Flight and National Sovereignty" (1951), Senate Committee on Aeronautical and Space Sciences, p. 7.

[19] Ralph E. Lapp, <u>Man and Space: the Next Decade</u> (New York: Harper, 1961), p. 118.

[20] McDougal, et al., p. 307.

[21] Murchison, p. 9.

distance is the critical factor in national security. They have been in effect since 1950 and their validity is no longer challenged.[22] Thinking of the space age, and orbital approach speeds, a "SPADIZ" would have to be rather large.

It is the belief of the author that sovereignty, the game of stated position on its limits, and the violations of laws related to it are all based upon national security. Good examples are provided by the positions of the United States and Russia through the emerging years of the Space Age.

The initial U.S. position on space was cautious and on a case-by-case basis.[23] There was no objection to Sputnik in 1957. In 1958, with United States satellites on the scene, the then Senator Johnson said, "Today outer space is free . . . No nation holds a concession there. It must remain that way."[24] A little later (with celestial bodies in mind) the position went back to a case-by-case approach, but with an understanding that past United States activities in space would be regarded as a basis for claims if claims

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[22] "Symposium on the Law of Outer Space," p. 18.

[23] Mortimer D. Schwartz, ed., Proceedings of the Conference on Space Law at the University of Oklahoma, June 1963 (South Hackensack, N.J.: Rothman, 1964), p. 23.

[24] Galloway, p. xv.

became necessary.[25] Then came the series of agreements through the United Nations, and the United States position relaxed to promote and accept freedom of space from all appropriation. The current United States position is summarized in a statement by President Johnson, made on 29 August 1965: "No national sovereignty rules in outer space."[26] The lower limit of this freedom is still open and not mentioned.

The Soviet position prior to 1959 is reviewed in "Legal Problems of Outer Space," by Samuel Kucherov. Continuing Soviet statements suggesting unlimited sovereignty hardened with the U.S. announcement of future satellites, and included official protests concerning U.S. meterological balloon flights at 80-90,000 feet in 1955.[27] This Soviet position changed sharply toward freedom of space prior to Sputnik in 1957, when U.S. legal sources were quoted regarding free space and when a new Soviet position was adopted that countries pass under an "inertial" satellite rather than the satellite passing over subjacent

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[25]Schwartz, p. 23.

[26]U.S. Library of Congress, Legislative Reference Service, International Cooperation and Organization for Outer Space; Staff Report (Washington: U.S. Govt. Print. Off., 1965), p. 4.

[27]Bin Cheng, "High Altitude Flights," Senate Committee on Aeronautical and Space Sciences, p. 141-155.

countries.[28] Looking to the future, however, Russian statements included the opinion that although national sovereignty does not extend to outer space, space is not a vacuum and international law does apply.[29] They also re-asserted their sovereignty over national airspace, stating their right to "effective control" to the "maximum ascent ceiling of present-day aircraft."[30] This foresight later was applied to the U-2. By 1960, however, the communist boundary had moved upward, "higher than aviation is developed;"[31] and a switch to the "function and mission" approach had begun, with boundaries "tied to purposes and activities."[32] Further there was discussion of the "abuse" of space, and of "appropriate defense and counter measures." The U.S.

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[28] Samuel Kucherov, "Legal Problems of Outer Space," Colloquium on the Law of Outer Space, Second, 1959 (Vienna: Springer-Verlag, 1960), p. 66.

[29] Ibid.

[30] Robert D. Crane, "Soviet Attitude toward International Space Law," American Journal of International Law, July 1962, p. 689.

[31] Vladimir Kopal, "Two Problems of Outer Space Control: the Delineation of Outer Space and the Legal Ground for Outer Space Flights," Colloquium on the Law of Outer Space, Third, 1960 (Stockholm: n.p., 1961), p. 108.

[32] Ibid.

Discoveror Program brought the first Soviet charges of spying from space.[33] By 1963, with both Russia and the United States planning moon programs, Russia was "reserving its freedom of action with respect to claims in outer space" (and so was the United States).[34] Then (again like the United States) with progress on space agreements in the United Nations, Russia began to play down sovereignty in space and go to a case-by-case approach, emphasizing scientific and technical progress in space.[35]

The current views of Russia and the United States coincide on the freedom of space and its use for only peaceful purposes. The views differ on the meaning of "peaceful." The difference can be summed up beautifully with excerpts from The Politics of Space Cooperation, by Don E. Kash: "The test of legitimacy for the Soviets has been whether the activity is military or nonmilitary . . . For the U.S. it is a question whether the activity is peaceful or aggressive . . . Both of these distinctions are rent with difficulties."[36]

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[33] Kucherov, p. 70.

[34] Schwartz, p. 23.

[35] E. Kuzmin, "Sovereignty and National Security," International Affairs (Moscow), December 1966, p. 18.

[36] Don E. Kash, The Politics of Space Cooperation (Lafayette, Ind.: Purdue University Studies, 1967), p. 96.

The current views of both states on the upper limit of airspace sovereignty agree perfectly: the limit is not only not defined but is kept out of discussion as much as possible.[37] Officially, the Air Code of the U.S.S.R. (1962) declares that the boundary of Russian airspace is "as determined by U.S.S.R. law and international agreements entered into by the U.S.S.R."[38] The United States is sitting tight with the 1944 Chicago Convention and a national definition of aircraft which could include spacecraft. However both agree that a division between space and air, between cooperation and security does exist--the latest U.N. agreement on the rescue and return of astronauts does not allow violation of territorial sovereignty during a rescue effort.[39]

Summary of Relevant Constraints

Before going on to a discussion of current problems it would be advisable to summarize some of the more pertinent constraints in the aerospace law.

National Airspace, extending laterally to the limits of territorial waters, is under the exclusive jurisdiction

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[37]Goedhuis, p. 126.

[38]"The Air Code of the U.S.S.R.," p. 30.

[39]Kathleen Teltsch, "U.N. Panel Agrees on Rescue Pact for Astronauts," The New York Times, 17 December 1967, p. 1:1.

of each state. There is no innocent passage. The upper limit is not defined. All states, and the U.S. and U.S.S.R. in particular, are carefully preserving the right to extend national airspace upward as required.

Air Defense Identification Zones have established an accepted precedent of air control extension for national security.

Airspace over the high seas is free for all reasonable use, including military weapons and reconnaissance, but can be brought under partial control through an ADIZ. The ideas of time and threat, rather than geographical limits, have been introduced.

All air traffic is subject to some control: by national and international agencies, under national statues and international agreements, and, in particular, under the International Civil Aviation Organization. None of these established procedures provide for an extension of control into space.

All objects launched into space are to be registered with the United Nations.

Outer space and celestial bodies are entirely free for peaceful exploration and use; however there is disagreement over the definition of "peaceful" ranging from "non-military" by Russia to "non-aggressive" by the United States. All nation signatories of the Space Treaty agree that no weapons of mass destruction will be placed in orbit or in outer space; however there is no ban on the development of such systems.

Each nation retains sovereignty over and responsibility for any vehicle launched by either governmental or non-governmental agencies.

All tests possibly harmful must be accepted by other nations through "consultation." Any nation can object to proposed or current tests.

Nuclear tests are banned in space, in the atmosphere, and under water.

Various nations, and Communist China in particular, do not recognize many of these constraints.

These freedoms and constraints have allowed the nations of the world to expand the development of air travel into the exploration of space without a catastrophic confrontation. Along the way, however, new problems have been generated and ignored that, at some time in the near future, will have to be faced.

CHAPTER II

THE SITUATION TODAY

Several new problems have joined the list since 1961. The definition of "peaceful use" and the military role in space, already mentioned, are intimately tied to a third, violations of space agreements. Both the Soviet Union and the United States have developed space weapons systems; both nations have claimed un-identified launches by the opposite party; etc. Because of real or suspected violations, the stated right of self defense has been extended into space. Technology and national security have taken precedence over law. The situation today is actually more explosive than it was in 1961.

In this chapter, these and other ideas will be discussed, leading to a first look at current views on the boundary.

Traffic and Trash

Conventional air traffic control has grown with time to meet the increasing demands of expanding air traffic and tightening security standards. Space launch and re-entry traffic, on the other hand, has been accommodated by simply clearing the area. Looking ahead to increased space traffic, more nations involved, and flatter launch and re-entry profiles, this is not the final answer.

Traffic in space is not only not controlled but is also increasing in density at about 50 per cent per year because what goes up often stays up for years.[1] Interferences between earth and satellite broadcasts were occurring before 1963.[2] The allocation of frequency bands has been undertaken but some of the space junk, with solar batteries and persistent transmitters, will continue transmitting for years. So far the pressures to require post-mission shutdown and de-orbiting of expended boosters and vehicles have been ignored. Shut down by command is fairly simple and might be expected through self interest if nothing else. De-orbiting, however, requires attitude control[3] and retro rocket systems. It is not likely that these systems will be added voluntarily before the heavens are one vast junk yard. Along with the expense, weight, and complexity of the systems, there is always the thought that someone else might trigger the system.

Traffic Control Now?

Most authors agree that an international control system is the ultimate answer. Beyond this point there is a

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[1] R. Cargill Hall, "Comments on Traffic Control of Space Vehicles," Journal of Air Law and Commerce, Autumn 1965, p. 329.

[2] Schwartz, p. 16.

[3] "Attitude" here is used in the physical sense: the orientation of a vehicle relative to some coordinate system.

division between the single-agency and dual-agency advocates. Those for two control agencies (one for space and another for air) stress the differences in modes and speeds of travel, the widening separation between air law and space law, and the past inactivity of the ICAO in space matters.[4] Actually, looking to the future, the modes and speeds of air and space travel will merge into a continuum as air and space technologies join across the current gap between the two regimes. Operations (and attempts to control traffic) through this continuum will expose the legal discontinuities which exist between air and space law. If the legal difficulties can be solved, traffic control is possible.

It would not be hard to extend the principles behind air traffic control to include approaching and departing spacecraft, or even orbiting vehicles, through a worldwide system of "space centers." Although current aircraft control relies upon voice communication, the increasing use of radar, automatic transmission and read-out of flight parameters, and computer prediction and routing makes integrated control of air and space the next logical step. Given the equipment, an average Federal Aviation Administration Flight Center crew in the United States could assume integrated

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[4]Julian G. Verplaetse, "Relationship between Air Law and the Law of Outer Space," Colloquium on the Law of Outer Space, Seventh, 1964 (Norman: University of Oklahoma Research Institute, 1965), p. 64.

aerospace traffic control tomorrow. The requests to "hold altitude" in an elliptical orbit would cease after a few days. A return to the laconic voice patterns of current airway chatter might take a little longer, with "bogies" approaching each other with 36,000 miles per hour rates of closure.

Most authors, including this one, favor a single agency.[5] Here the division of opinion is between an expansion of the ICAO and a new organization.[6] This split would never have developed if the ICAO had been allowed to enter the space business in the early days of legal development. With progress under way (and under control) in the United Nations proper, neither the United States nor the Soviet Union wanted the ICAO (of which the Soviet Union is not a member) to enter the picture and increase the possibility of a confrontation.[7] It is now time for the ICAO to step out smartly but carefully into the space age: smartly to

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[5]John C. Cooper, "Aerospace Law--Subject Matter and Terminology," Journal of Air Law and Commerce, Spring 1964, p. 89-94; Haley, Space Law and Government; "Symposium on the Law of Outer Space," p. 12.

[6]Symposium on the Law of Outer Space," p. 12; Haley, Space Law and Government, p. 137.

[7]Rene H. Mankiewicz, "International Civil Aviation Organization, Fifteenth Session of the Assembly, 1965," Journal of Air Law and Commerce, Autumn 1965, p. 347.

catch up and prepare for the future, and carefully to avoid national security problems by concentrating on cooperation and the functional approach and leaving the touchy questions to the U.N. proper. One of those hard to avoid will be the innocent passage problem.

Innocent Passage Again

The legal right of innocent passage through national airspace simply does not exist.[8] Getting down to fine points there might be a temporary loophole for non-lifting spacecraft because the law usually cited (Articles 3 and 8 of the Chicago Convention) to prohibit overflight applies to "aircraft" (defined in the convention as lifting vehicles etc.). This loophole is not only temporary and narrow but the Soviet and U.S. national definitions of aircraft already could include even the current non-lifting "trash cans." Another potential loophole is cited by the adherents of maritime analogy who rely upon Articles 3 and 4 of the Geneva Convention on the Law of the Sea.[9] These articles provide for free transit through intervening territory to the sea for landlocked countries.[10] So far not even air travel has followed suit.

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[8] John C. Cooper, "Passage of Spacecraft through the Atmosphere," Colloquium on the Law of Outer Space, Sixth, 1963, p. 3.

[9] Max Sorensen, "Law of the Sea," International Conciliation, no. 520, November 1958, p. 199.

[10] Goedhuis, p. 125.

Some authors argue that innocent passage for space vehicles is already established through custom.[11] However, the communist view ranges from no innocent passage[12] to only after an understanding with the state concerned.[13] The United States has avoided the problem through over-water launches, ocean landings, and a lack of official statements on the subject.

Current launch trajectories cover distances of 600 miles below 100 miles altitude; and the re-entry profiles (even for current low-lift shapes) exceed 2,500 miles. Distances of 7,500 miles below 50 miles are expected in the Apollo re-entry.[14] As true lifting bodies and, eventually, boost glide and aerospace planes enter the picture, these distances will approach the full flight trajectory at altitudes below current orbital perigees. The number of potentially spacelocked countries will only increase with time and technology.

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[11] Ibid., p. 136.

[12] Jacek Machowski, "Certain Aspects of the Right of Innocent Passage of Space Vehicles," Colloquium on the Law of Outer Space, Fourth, 1961 (Norman: University of Oklahoma Research Institute, 1963), p. 60.

[13] Goedhuis, p. 141.

[14] "Symposium on the Law of Outer Space," p. 24.

With these ideas in mind most authors have agreed on the need for innocent passage only to disagree on the method of solution. Some see a qualified acceptance contingent upon guarantee of peaceful use.[15] Others look again to sea law but find no direct analogy.[16] Air law differs from sea law due to the time-threat relation; space law must acknowledge a further giant step. Still others combine a qualified acceptance of maritime analogies with the requirements of space operations to suggest altitude zones, contiguous zones, and the like, which would allow low orbit or other continued flight and only catch the ascents and descents in the sovereignty web. This idea is interesting and will be pursued later; for the present it suggests a low boundary of national control.

The current status of innocent passage remains as it was described by John C. Cooper in 1963:

> Acceptance of the principle of free use of outer space does not carry with it free use of national airspace any more than the principle of freedom of flight over the high seas has carried with it the freedom of continued passage into national airspace--that is not at all.[17]

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[15]U.S. Naval War College, International Law Studies 1962: the International Law of Outer Space, by Carl Q. Christol (Washington: U.S. Govt. Print. Off., 1966), v. LV, p. 254.

[16]McDougal, et al., p. 715.

[17]Cooper, "Passage of Spacecraft through the Atmosphere," p. 3.

Innocent passage like traffic control awaits a decision on the boundary altitude. All three hinge on national security.

A History of Violations

The history of tightening control over airspace is a history of response--to interpretations, infringements, and violations of the law. Enforcement of customs, immigration, health regulations, etc., has influenced the trend but the two main impeti have been bombardment and reconnaissance.

The bombardment problem could have been avoided in its infancy if the nations had adhered to and extended one of the provisions of the First Hague Peace Conference of 1899: ". . . to prohibit, for a term of five years, the discharge of projectiles and explosives from balloons or by other new methods of a similar nature."[18] Of course they didn't, and World War I securely locked away the concept of freedom of the air.

During World War II two new forms of bombardment arrived on the scene, the V-1 Buzz Bomb and the V-2 Ballistic Missile. The Chicago Convention of 1944 later addressed the V-1 problem in Article 8, requiring special authorization

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[18]"Declaration Relative to the Prohibition of the Throwing of Projectiles from Balloons," Carnegie Endowment for International Peace, The Proceedings of the Hague Peace Conferences: the Conference of 1899 (New York: Oxford University Press, 1920), p. 264.

for the over-flight of pilot-less vehicles. The Air Code of the U.S.S.R., of 1962, states further that such a vehicle must be controlled by the nation overflown.[19] The ballistic missile was a different bird and not covered by any past custom or convention. In a very wise move (intentional lack of action being considered a move) it has been excluded entirely from regulation by, in effect, considering it a long range projectile--neither a space vehicle nor an air vehicle. In this role it does not violate the Space Treaty even though most of its trajectory can be in space. Two recent technological advances have, however, raised the issue in a way that may require regulative action: maneuvering re-entry warheads, and fractional orbit bombardment systems. As long as there is no maneuvering in space (thrusting), maneuvering during re-entry (aerodynamic) tends to meet the usual criteria of atmospheric war, and does not violate any specific law. The orbiting vehicle, exemplified by the Soviet Fractional Orbit Bombardment System (FOBS), should be a violation of the Space Treaty if one is ever launched with payload.

The announcement of the Russian FOBS by Mr. McNamara opened a Pandora's box of opinions and theories on what was

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[19] "The Air Code of the U.S.S.R.," Chapter III, section 76, p. 35.

actually an old question. The idea of a FOBS was discussed and rejected in the United States as early as 1958 when President Eisenhower's Space Advisory Committee deemed it "clumsy and ineffective."[20] In 1961 Ralph E. Lapp hedged: "Their military worth is debatable, although a few would question the terror potential of such weapons."[21] The FOBS was predicted in 1962 as a threat,[22] but rejected in 1963 as "not . . . as effective . . . as already existing types of ballistic missiles."[23] The question should have become academic in 1963 with U.N. Resolution 1884 (XVIII) banning orbital weapons. However neither this resolution nor the Space Treaty of 1966 banned the development of such weapons. As a result the Russians could cite the treaty while developing and testing the weapon: "The treaty bans the orbiting around the earth and launching into space of vehicles carrying nuclear and other types of mass destruction weapons."[24]

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[20] Maxwell Cohen, ed., Law and Politics in Space (Montreal: McGill University Press, 1964), p. 65.

[21] Lapp, p. 109, 120.

[22] John C. Cooper, "Self-Defense in Outer Space . . . and the United Nations," Air Force and Space Digest, February 1962, p. 51.

[23] Cohen, p. 66.

[24] A. Piradov and V. Rybakov, "First Space Treaty," International Affairs (Moscow), March 1967, p. 21.

It would have been interesting to hear the Russian justification of the FOBS as a developed system. Instead, Mr. McNamara, in a move brilliant for propaganda impact but puzzling from technical and legal viewpoints, announced the Russian FOBS first and <u>declared it legal for use</u>: "/the Soviets/ have agreed not to place warheads in full orbit; that is why this is a fractional orbit, not a full orbit, and therefore not a violation of that agreement."[25] This statement was the official United States response but definitely not a consensus of American opinion. As the <u>Air Force Times</u> put it, "Some dispute with this view has been expressed by members of Congress and in the civilian press."[26] It will be interesting to learn (someday) what the reason was behind the United States acceptance of this obvious violation. It could have been that the threat it presented was not considered sufficiently important for a challenge that could end "cooperation" in space. Another reason could have been that the FOBS created a "ceiling" under which the United States can develop better weapons (such as the Multiple Independent Re-entry Vehicle) with a Russian challenge impossible due to their own prior move. Many

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[25]"Intelligence Reports Russia Testing Orbital Atomic Bomb," <u>Newport</u> (Rhode Island) <u>Daily News</u>, 4 November 1967, p. 1.

[26]"Soviet Bomb Seen as New Type Threat," <u>Air Force Times</u>, 15 November 1967, p. 3.

authors believe that Mr. McNamara either made an error in his evaluation or had other knowledge of the FOBS mission.

An interesting propaganda scenario he may not have considered is described by T. M. Conrad in an article, "Bombs in Orbit."[27] In this scenario the Russians launch five objects into orbit and state that they are research vehicles. The citizens of the world, and particularly those of the United States, become restive as the formation repeatedly passes overhead. The choices of the United States include: (1) Inspect (by disassembly); (2) Destroy (by nuclear-tipped interceptor); or (3) Ignore. The inspection might prove the objects to be actual research vehicles; the nuclear blast would break the space treaty; and a lack of action would produce increasing unrest in the United States and snickers from abroad. In each case the United States loses the game.

On the possible-other-mission side, a recent opinion registered is that the FOBS is not a bombardment system at all but a reconnaissance system, to be used for coverage of United States ABM tests at Kwajalein now, and as a quick-return strike assessment system later.[28] The quick reaction

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[27]Thomas M. Conrad, "Bombs in Orbit," Commonweal, 8 December 1967, p. 333.

[28]Philip J. Klass, "Soviet Payloads Overfly Nike-X Test Site," Aviation Week, 11 December 1967, p. 81.

time, short flight time, and new flight path of the system do allow placement of a FOBS over the Kwajalein test site to observe the arrival of a target vehicle from Vandenburg and the firing of a Nike X ABM. A Soviet trawler off the California coast could call the shot, and one off Kwajalein could control the FOBS.

With no current defense against the propaganda mission except nuclear-tipped intercept missiles it might be advisable to develop a rendezvous system with inspection and conventional warhead capability. On the other hand the reconnaissance mission is an active issue in the United States-Russian dichotomy on the peaceful uses of space and might explain the whole thing.

As mentioned above, the bombardment problem could have been solved forever by its prohibition in 1899. Similarly, or conversely, the reconnaissance problem could have been resolved by its acceptance in 1874, when the Declaration of Brussels stated that a person was not a spy merely because he passed over enemy lines in a balloon.[29] World War I started with a little of both flavors, but technology rapidly provided tastes of bombardment and reconnaissance

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29"Conference at Brussels on the Rules of Military Warfare," Gt. Brit., Foreign Office, British and Foreign State Papers, 1873-1874 (London: Ridgeway, 1881), v. LXV, Article XXII, p. 1084-1085.

too exotic to ignore. Bombardment was too productive to pass up, and reconnaissance was too effective to allow unopposed. Skipping over the intervening years, the Chicago Convention attempted to nail the lid on peacetime reconnaissance from aircraft with its Article 36: "Each contracting state may prohibit or regulate the use of photographic apparatus on aircraft over its territory." Russia, not a contracting state, is not protected; however, Zhukov has cited the article.[30]

In 1956, Wilfred Jenks foresaw the reconnaissance role of satellites and predicted, correctly: "No abstract principle is likely to be of much service for the purpose of resolving such questions."[31] With a closed society and dependence upon secrecy in their strategy, the Russians have been solidly against all forms of reconnaissance. When they raised an objection concerning the overflights of Russia by United States meterological balloons in 1956, the flights were stopped without United States comment.[32] Several U.S. aircraft have been shot down alongside Russian airspace,

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[30] G. P. Zhukov, "Freedom of Space and Its Limits," Colloquium on the Law of Outer Space, Sixth, 1963, p. 5.

[31] Wilfred C. Jenks, "International Law and Activities in Space" (1956), Senate Committee on Aeronautical and Space Sciences, p. 40.

[32] Quigg, p. 105.

with the United States objecting in each case. But back overhead again, the United States did not object when the U-2 was bagged near 70,000 feet in May 1960. The United States has clearly recognized Russian jurisdiction vertically to U-2 altitudes.[33] Zhukov made two statements in 1960:

> From the viewpoint of the security of a state it makes absolutely no difference from what altitude espionage over its territory is conducted.[34]

> In the past, considerations of state security have been of decisive importance in determining the airspace regime. Today the same considerations must underlie the regime of outer space.[35]

These statements came after the demonstrated capability to down a U-2. In 1962 the Russian view on reconnaissance from space was carefully and officially expressed in two drafts presented at the United Nations:

> (h) the use of satellites for the collection of intelligence . . . is incompatible with the objectives of the conquest of outer space.
>
> Declaration of Legal Principles[36]

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[33]McDougal, et al., p. 275.

[34]G. P. Zhukov, "Space Espionage and the Law," International Affairs (Moscow), September 1960, p. 56.

[35]"Symposium on the Law of Outer Space," p. 27.

[36]Everyman's United Nations, 7th ed. (New York: United Nations, Dept. of Public Information, 1964), p. 443.

> (7) . . . space vehicles aboard which devices have been discovered for the collection of information . . . shall not be returned.[37]

Soviet drafts and statements in 1963 were almost identical,[38] and have not changed since. None of these ideas has appeared in the final resolution for which they were submitted.

For the United States, President Eisenhower, in 1955, proposed not only complete freedom of aerial photography but also "blueprints of military establishments" throughout the United States and Russia--the "open skies" approach.[39] There was some discussion of these ideas, but no action on them. After Sputnik, in 1957, the United States proposed a joint early warning system. The talks never got past the agenda formulation stage.[40] Yet over Cuba in 1962 (after things had cooled down) there was no objection to continued U-2 flights when the U.S. declared them necessary for self

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[37]United Nations, General Assembly, Union of Soviet Socialist Republics: Draft International Agreement on the Rescue of Astronauts and Space Ships Making Emergency Landings, A/AC. 105/L.3 (New York: 10 September 1962).

[38]United Nations, General Assembly, Union of Soviet Socialist Republics: Draft Declaration of Basic Principles Governing the Activities of States in Use of Outer Space, A/AC. 105/C.2/L.6 (New York: 16 April 1963); Zhukov, "Freedom of Space and Its Limits."

[39]Walter Levison, "Air Inspection," Evan Luard, ed., First Steps to Disarmament (New York: Basic Books, 1965), p. 103.

[40]Ibid., p. 106.

defense. By 1963 the United States had adopted the current official position that satellite reconnaissance is "non-aggressive" and thus "peaceful."[41]

Turning to the views of legal authorities, in 1953 Welf Heinrich said, "observation cannot be a convincing reason for extending sovereignty . . . beyond the atmosphere."[42] In 1961, Lapp noted the Russian pattern of first objecting to the U-2 flights as violating Soviet sovereignty, then claiming that space was free for their satellites, and then objecting to SAMOS as violating their sovereignty.[43] The difference, of course, was reconnaissance. In 1962, Christol compared reconnaissance to spying in peacetime (not defined by treaty) and said the Russians were trying to modify international law.[44] Leonard Meeker, in 1963, stated very clearly: "International law imposes no restrictions on observation from outside the limits of national jurisdiction. Observation from outer space, like observation from the high seas, is consistent with international law."[45] And finally, after some of the recent progress in

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[41]Schwartz, p. 143.

[42]Welf Heinrich, p. 319.

[43]Lapp, p. 117.

[44]U.S. Naval War College, p. 282.

[45]Cohen, p. 82.

space law, Joseph R. Soraghan wrote in 1967: "Neither the Space Treaty nor either of these [UN] resolutions [1721 (XVI) and 1962 (XVIII)] however, deals explicitly with reconnaissance activities carried out in space."[46] He went on to summarize the current United States and Russian views regarding reconnaissance and its legality (paraphrased):

Russia: military and therefore non-peaceful; espionage and therefore illegal.

United States: self defense and an open society against a closed society; non-aggressive and therefore peaceful; outside boundaries of sovereignty and therefore legal; like the high seas.

Both Positions: tenable, based upon the interpretation of peaceful, but the U.S. position is stronger.[47]

With due apology for submitting a legal opinion, this author believes that the Russians could end reconnaissance at any time by declaring a boundary altitude at some arbitrary height and prohibiting reconnaissance below it. This, like a United States challenge on the FOBS, would end "co-operation" in space. Actually the Russians have been relatively quiet on the subject since 1963, perhaps because reconnaissance could always be carried on in secret, and perhaps

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[46] Joseph R. Soraghan, "Reconnaissance Satellites," McGill Law Journal, March 1967, p. 458.

[47] Ibid., p. 463.

because their Cosmos has proved reconnaissance worthwhile to them. As President Johnson said in May 1967 regarding United States reconnaissance satellites: "They let me know how many missiles the enemy has."[48] He could have added, "and where, of what type, how well hardened, and in what status of readiness." By exposing the activity and status of each side to the other, space reconnaissance, a military activity in space, is helping to keep the peace.

The Military Role in Space

Even without weapon development and reconnaissance it would be difficult to isolate space exploration from military participation. Besides the natural use of military hardware and military trained crews to hasten the development and use of space systems for peaceful purposes there is bound to be a spin-off from peaceful advances in technology toward military applications. The formation of NASA in the United States was an attempt to separate, for label, acceptance, and international cooperation, civil from military space activities. The result has been a qualified success in the eyes of the world but has been plagued by controversy, duplication of effort and cost, and a continuous natural tendency of the two programs to merge. Most of

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[48] J. S. Butz, Jr., "Under the Spaceborne Eye: No Place to Hide," Air Force and Space Digest, May 1967, p. 93.

the NASA astronauts, and many of the department heads and engineers, are openly military officers. The launch crews, recovery ships, and many other support activities, are military. The very first American satellite was launched on a military missile by a military launch crew.[49] These are not clandestine operators but necessary and obvious participants. To the United States, the word peaceful means non-aggressive, not necessarily non-military.

The Russian approach has been almost identical (using military hardware, crews, etc.) except, of course, theirs has been entirely peaceful--like the FOBS. As Andrew Haley said in Space Law and Government, "Soviet writers, on their part, tend to use the word 'peaceful' as a blanket term to describe the activities of the Soviet State."[50]

Conclusions on the relationship between civil and military uses of space will be reserved to the last chapter of this paper; the main and continuing problem, however, was pointedly described by Taubenfeld in 1963: "Satellites equipped to perform 'peaceful' observations necessary for mapping, meterological and similar surveys will provide

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[49] Simon Ramo, ed., Peacetime Uses of Outer Space (New York: McGraw-Hill, 1961), p. 202.

[50] Haley, Space Law and Government, p. 155.

information inevitably useful for military purposes . . ."[51]

Inspection and Registry

An early interest in the "peaceful use" problem was demonstrated in United Nations Resolution 1148 (XII), November 1957, which called for a study of an inspection system to ensure peaceful uses of outer space. That idea got nowhere.[52] Public registry (with the U.N. Secretary General) of all space launches has been called for in resolutions but not entirely implemented. Both Russia and the United States have claimed un-registered launches by the other party.[53] Strangely enough, Article XII of the Space Treaty provides for visits (and thus inspection) between stations and vehicles on celestial bodies. The message is clear: security gets more demanding close to home. Someday the problem will come to a head when one country destroys an unidentified space vehicle belonging to another.

The Ultimate Right to Bag

This being basically a legal problem, the author will quote from the authorities:

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[51] Schwartz, p. 20

[52] Ivan A. Vlasic, "The Growth of Space Law, 1956-65," Mankiewicz, ed., Yearbook of Air and Space Law, 1965, p. 401.

[53] Schwartz, p. 261.

First, can the problem be ignored?

> . . . the point that must be stressed here is that the military implications of the penetration of outer space can be ignored only out of naivete, blindness, or political convenience.
>
> Taubenfeld[54]

Second, is the problem a legal one? After discussion of Articles 2(4) and 51 of the U.N. Charter,

> The real problem is not legal. The question is rather one of scientific progress, military strategy, and national policy. If a state determines that the conditions are present justifying action, and if effective means are available, action can be taken on land, at sea, in the air--or in outer space.
>
> Cooper[55]

Third, a scenario: a space vehicle with unknown cargo and purpose is approaching with . . .

> a. . . . imminent penetration of the sovereign airspace, and in the absence of notice of emergency . . . warrant/s/ defensive action . . .
>
> b. . . . proximity . . . that should it hold an aggressive purpose or intent, there would be insufficient time to counter the attack, would warrant a requirement for disclosure of purpose and destination . . . denial of information . . . could result in defensive action . . .
>
> DeSaussure and Reed[56]

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[54] *Ibid.*, p. 21.

[55] Cooper, "Self-Defense in Outer Space . . . and the United Nations," p. 56.

[56] "Symposium on the Law of Outer Space," p. 44.

Fourth, until things settle out,

> States will continue to assert, within the limits of their effective power, a unilateral competence to police or destroy space objects regarded as impermissibly affecting the security of their land masses.
>
> McDougal and Lipson[57]

Fifth, and again,

> . . . wide consensus in both East and West . . . claim a unilateral competence to take measures of self protection anywhere . . .
>
> McDougal[58]

Sixth, looking back at ADIZ's and ahead to the future, and innocent passage,

> There is no doubt that similar rights would obtain for missile identification. Any such regulation would have priority over air law . . . some such network as ADIZ-CADIZ would have to be worked out.
>
> Verplaetse[59]

And last, getting serious with an international police force,

> As long as the individual states retain their nuclear and space weapons, an effective sanctioning force must also possess such weapons.
>
> McDougal[60]

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[57]Myres S. McDougal and Leon Lipson, "Perspectives for a Law of Outer Space," American Journal of International Law, July 1958, p. 426.

[58]McDougal, et al., Law and Public Order in Space, p. 316.

[59]Julian G. Verplaetse, "Conflicts of Air and Outer Space Law," Colloquium on the Law of Outer Space, Third, 1960, p. 147.

[60]McDougal, et al., Law and Public Order in Space, p. 507.

Summarizing all of these statements (plus others not included) it is the consensus of opinion that a state has the right to defend itself (if it can) against a threat from space. Thinking of the present attitude of certain nations that have not joined in all of the cooperative agreements, plus the open advantage taken of the agreements by other nations, it behooves all nations to look to their weapons.

Views on the Boundary

With the status of air and space sovereignties, the absence of innocent passage, the problems of traffic control and trash, the long history of violations, the necessary military role in space exploration, the divergent views on reconnaissance, the partial lack of inspection and registry, the total lack of cooperation from some countries, and the ultimate right of self defense in mind, it is now possible to present a first look at the current views on the boundary against this backdrop of realism.

As one would expect, with so many years of discussion and so many facets to the problem, there are about as many differing opinions as there are persons stating them, and several have switched more than once through the years. However, again, there are patterns and groups. The first and major split is between yes and no, for or against a boundary.

Views Opposing a Boundary

Taking the "no's" first, there are four variants: not needed; not feasible; too early; and "use the function-mission approach instead." Again a series of quotes is in order:

Not needed:

> . . . consensus of reasonableness . . . has reduced, and possibly eliminated, the need (at least for the present) for fixed or relatively fixed boundaries . . . [or] . . . buffer zone . . .
>
> Christol[61]

Not feasible:

> Any alternative solution, which would extend the comprehensive exclusive competence of states upward to variously defined high altitudes is . . . patently unrealistic.
>
> McDougal[62]

> No projection of vertical boundaries upward to any distance can serve adequately to protect the reasonable interests of underlying communities.
>
> McDougal[63]

> It is extremely unlikely that agreement could be easily reached on a precise limitation of

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[61] "Symposium on the Law of Outer Space," p. 22.

[62] McDougal, et al., Law and Public Order in Space, p. 320.

[63] Ibid., p. 322.

> the upward extent of the underlying State's unilateral right of exclusion . . .
>
> John A. Johnson[64]

Too early:

> For all these reasons [complications, possible impass, retardation of other progress] it would appear wise to refrain from attempting any demarcation of outer space from airspace . . .
>
> Jenks[65]

This is also the United States position. In 1962 a government official, with reference to GA 1721 (XVI) which declared outer space free for exploration and from appropriation, stated:

> The General Assembly did not seek, quite rightly in the judgment of the U.S., to go beyond these two principles and to define where airspace leaves off and outer space begins . . . the drawing of a precise line must await further experience and a consensus among nations.
>
> Gardner[66]

This is still the United States position.

Use the function and mission approach:

> I am hopeful that space law writers may agree that these resolutions [1721 & 1962] . . . should abate past pressures for determining just where sovereignty ends and outer space

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[64]Schwartz, p. 142.

[65]Wilfred C. Jenks, Space Law (New York: Praeger, 1965), p. 176.

[66]Richard N. Gardner, "Extending Law into Outer Space," American Journal of International Law, July 1962, p. 798.

> begins. It appears that the Resolution 1962 recognizes that it is the space activity undertaken that will determine the subjacent States' tolerance thereof and not how far above it that such activity is undertaken.
>
> Menter[67]

> Such a line, if and when drawn, will not be the product of purely scientific considerations, but rather will be largely the product of political-legal factors . . . It is submitted that non-peaceful uses of space devices at any altitude . . . will be considered illegal.
>
> Christol[68]

This is the Russian position. Robert D. Crane, in Soviet Attitude Toward International Space Law, sums it up: ". . . political and ideological evaluation of the nature and function of the specific activity rather than on the activity's vertical location."[69]

Although the two major countries of the world agree with each other that no boundary should be defined today, there are many other countries and individual authors who disagree. Most opinions favoring a boundary hinge on the fact that if one is not established through agreement, one will be established unilaterally through sudden need or

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[67]"Symposium on the Law of Outer Space," p. 10.

[68]U.S. Naval War College, p. 166.

[69]Crane, p. 686.

national design.[70] Most such opinions also recognize the fact that sovereignty requires a boundary:

> It is certain that the national boundaries on earth have very little relevance to the problems of space. But it is also certain that we have to take our world as it is, complete with its hundreds of boundary lines and its jealously national sovereignties, as the starting point for an attack on these problems.
>
> Bloomfield[71]

Several nations, including Sweden, Spain, Chile, and the Netherlands (in 1958), and Canada and France (in 1962) have officially called for a boundary.[72] The limits suggested have included "the atmosphere," flight supported by reactions of the air, all regions accessible to man, "useable space," 60,000 miles, and infinity. These few examples of suggested limits are merely a clue to the miriad ideas put forth by the exponents of a boundary.

Views in Support of a Boundary

The basic split on the "yes" side is between an arbitrary height and one based on physical characteristics. The arbitrary height group then divides to favor either a single boundary or several (contiguous zones and the like).

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[70] Goedhuis, p. 136.

[71] Lincoln P. Bloomfield, The Peaceful Uses of Space (New York: Public Affairs Committee, 1962), p. 18.

[72] McDougal, et al., Law and Public Order in Space, p. 323.

The physical characteristics group really shatters, into a dozen or more: atmospheric characteristics; gravitational characteristics; vehicle characteristics; method of lift or flight; speed-altitude combinations; skin temperature limits; capability to control; etc. Actual boundaries suggested range from 10 miles to infinity, and include some very novel scientific concepts: "The natural laws of earth end where the earth's gravitation loses its effect and hence the dividing line between air and outer space is this precise point (about 60 miles high) where the earth's attraction ceases."[73]

Actually, during the research and writing of this paper, the author has been favorably impressed with both the knowledge of aerospace behind the recent drafts of aerospace law and the far-reaching provisions and implications contained in the agreements regarding space. So far, however, the merging of air and space technology, which will happen regardless of law, has been not only ignored but contradicted by diverging trends in the separate laws for the two areas. Before proceeding with the discussion of a boundary it is, therefore, advisable to present a primer on this blend of technology which merges air and space and yet suggests a natural separation altitude which could satisfy all parties.

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[73] Fruchterman, p. 11.

CHAPTER III

AEROSPACE TECHNOLOGY, AND TRENDS

Aerospace law must anticipate technology. In this age of exploding technology there are few scientists who claim more than superficial knowledge in more than one limited area. The lawyer has no more business in the technical evaluation and prediction field than the scientist does in the legal profession, yet a combination is required for joint progress. The only realistic answer is conversation between the two professional groups. The ideas which follow may be ridiculously simple to many readers, but each is in response to one or more technical errors noted in the legal literature on aerospace.

The Atmosphere

Any defined beginning of space based upon the physical properties of the atmosphere would be arbitrary--there are no discontinuities in temperature, pressure, density, number of molecules, or in any other characteristic parameter. Even the first "line," the tropopause, is not fixed in height or constant in temperature. Even at orbital altitudes there is sufficient atmosphere to cause drag and produce eventual re-entry. An un-pressurized pilot is useless without oxygen above 20,000 feet and dies (<u>with</u> oxygen) due to blood boiling above 60,000 feet; yet the U.S. Air Force altitude requirement for astronaut wings is 50 nautical miles. As will be seen later, this requirement is based upon flight phenomena only indirectly related to the physical properties of the air.

Gravity

Gravity, the force of mass attraction between bodies, does not suddenly end anywhere. As the laws of nature have it, this force decreases with distance between the bodies (the inverse square law):

$$F = \frac{G\, m_1\, m_2}{r^2} \text{, where} \qquad (1)$$

G = Universal Gravitational Constant

m_1 = mass of one body

m_2 = mass of another body

r = distance between bodies, radius

A plot of force versus radius is a smooth curve, only approaching zero as the radius becomes infinite.

A satellite exerts the same force on a planet as the planet does on the satellite. However the effects on each are far different due to differences in mass, and resultant acceleration (a).

$$F = ma \text{ ,} \qquad (2)$$

or $$a = \frac{F}{m} \text{ , the acceleration.} \qquad (3)$$

The huge mass of the planet results in very little acceleration of it toward the satellite (both held motionless and released). The net result is called the "1½ body problem," where the motion of the planet due to the satellite is ignored. When a third body, like the moon, enters the act the small space probe is attracted toward both in the "2½ body problem." The two large bodies ignore the presence of the vehicle but it feels the attraction of both. There are points where the attraction is equal from both, but not in the locations or the directions often assumed. The locus of these points of equal force can be calculated, and forms an oblong sheath around the smaller body (m_2):

$$F = \frac{G\, m_1\, m}{r_1^2} = \frac{G\, m_2\, m}{r_2^2}\,, \qquad (4)$$

Where m is the probe, m_1 the large body, r_1 the distance from the large body to the probe, m_2 the smaller of the two bodies, etc. Then

$$\frac{r_2}{r_1} = \sqrt{\frac{m_2}{m_1}}$$

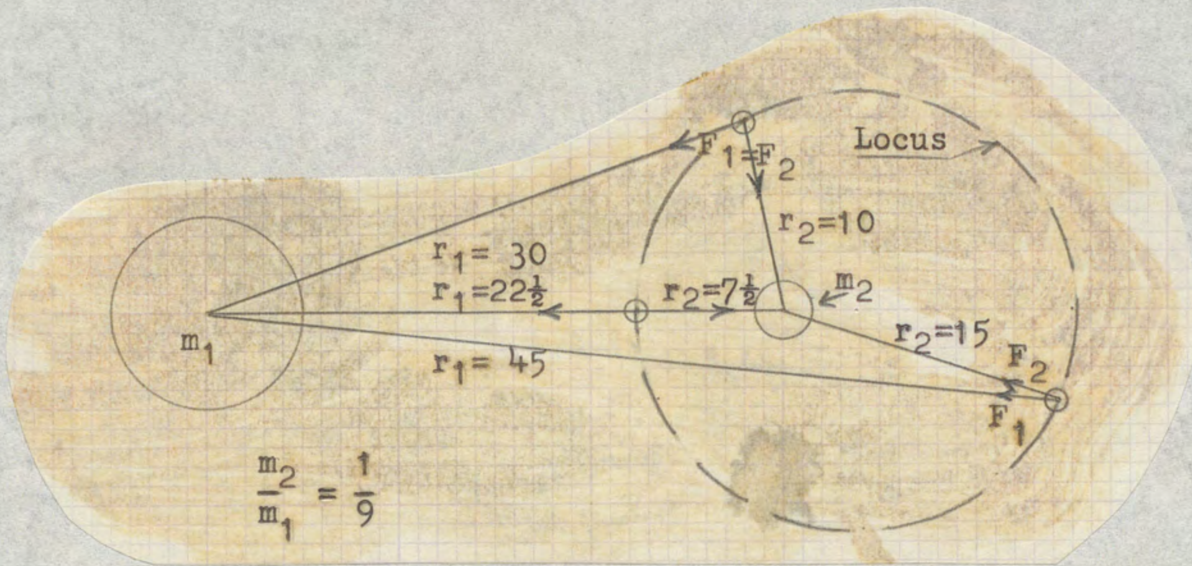

Fig. 1.--Locus of Equal Forces

Even this sheath is the locus of only equal force, not equilibrium. The only point of equilibrium is on the line between the two bodies; and even this does not include forces related to motion. Adding motion takes the problem into the realm of classical mechanics (where there are points of equilibrium). Other planets (and the sun) also enter even this simplified picture to force the conclusion: gravitational values or equilibrium points are not of any use in the boundary problem.

An object escaping from a planet travels along a parabolic path (if barely escaping) or a hyperbolic path (for higher velocities). The focus of the parabola or hyperbola is at the center of the planet.

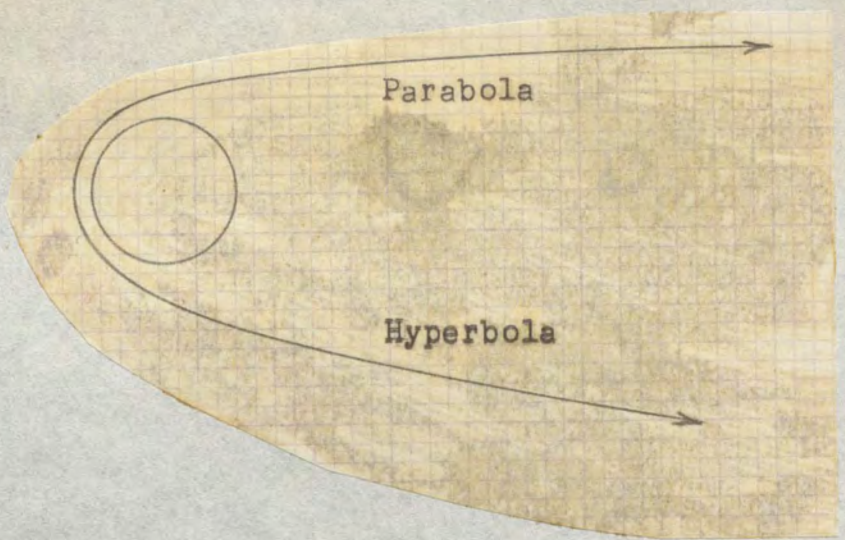

Fig. 2.--Escape Trajectories

Every object traveling but not escaping and on a "free trajectory" (no thrust, lift, or drag, but only gravitational force) is on an ellipse with one of the two foci at the center of the planet (the other an "empty focus").

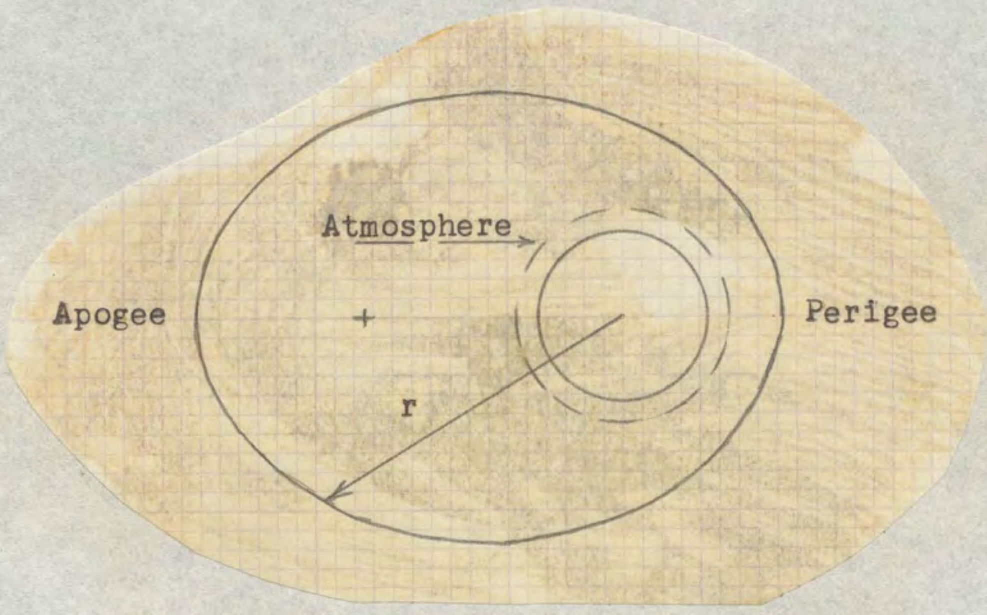

Fig. 3.--The Elliptical Orbit

Every ellipse has a perigee (minimum) and apogee (maximum) radius from the focus at the center of the planet. An "orbiting" vehicle has a perigee high enough so that atmospheric drag does not cause slowing and re-entry on that pass. Neglecting drag, every non-escaping free body travels on an ellipse. A ballistic missile (ICBM) merely has a perigee inside the earth (if it could pass through); an artillery shell is a smaller version of the ballistic missile (the parabolas of range tables assume a flat earth); and a pea shooter would produce a very low apogee, a perigee close to the center of the earth (but on the other side), and a skinny ellipse.

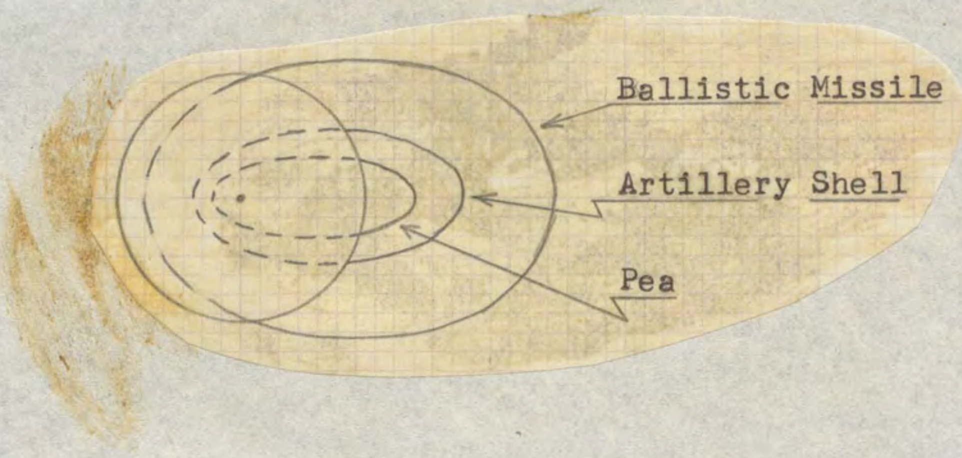

Fig. 4.--Elliptical Trajectories

All of them (neglecting drag and terra firma) are calculable and repeating ellipses. Before going into the characteristics of elliptical orbits, the circular orbit (a special case of an ellipse) will be discussed.

The force of gravity (F_g) attracting a body (m_b) toward earth (m_e) is, from equation (1) above:

$$F_g = \frac{G\ m_e\ m_b}{r_b^2} \text{ , where} \qquad (6)$$

r_b = radius from the center of the earth to the body.

Centrifugal force (F_c), acting outward and perpendicular to a curved path, is

$$F_c = \frac{m_b\ v_b^2}{r_c} \text{ , where} \qquad (7)$$

v_b = velocity of the body, m_b

r_c = radius of curvature of the path

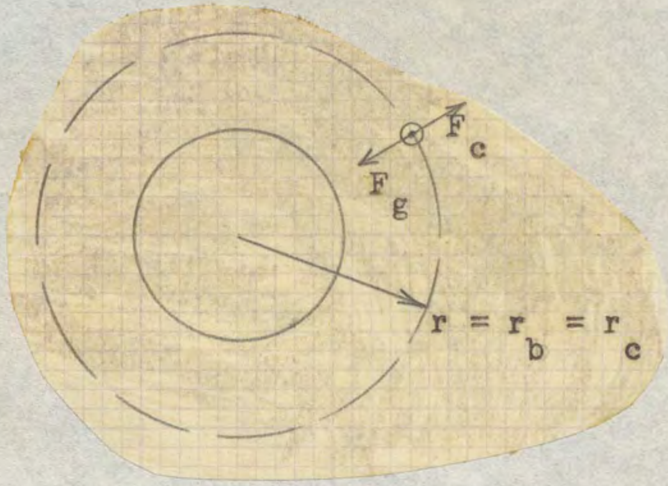

Fig. 5.--Circular Orbit

In a circular orbit the curved path is the orbital circle; the force in is gravitational; the force out is centrifugal; the radius of orbit is the radius of curvature; and the two forces are in equilibrium:

$$F_g = \frac{G\ m_e\ m_b}{r_b^2} = F_c = \frac{m_b\ v_b^2}{r_c}$$

Canceling equal radii, re-arranging, etc., the velocity for circular orbit (where centrifugal force just balances gravitational attraction) turns out to be:

$$v_b = v_c = \sqrt{\frac{Gm_e}{r}} \qquad (8)$$

Both G and m_e are constant (note m_{body} is not even in the equation) and circular orbital velocity varies inversely with the square root of the radius--the farther out the <u>slower</u> the velocity. For anyone wishing to explore this idea, the product (Gm_e), called μ, for earth is

$\mu = 1.41 \times 10^{16}$ feet^3/ second^2 for radii in feet and velocities in feet/second. The radius at Earth's surface is

$R_o = 2.09 \times 10^7$ feet, to which one adds altitude in feet to the desired radius.

The small change in radius (and velocity) due to a few feet (or miles) of altitude is apparent. The circular velocity at zero altitude for earth is 25,950 feet/second.

Now the period (or time of one orbit) is merely the distance around divided by the circular velocity:

$$P = \frac{2\pi r}{v_c}, \text{ or} \tag{9}$$

combining equation (9) with (8),

$$P = \frac{2\pi r^{3/2}}{\sqrt{\mu}} \tag{10}$$

Again all parameters are constants except the radius. As r increases the period increases. The period at 100 miles is about 90 minutes, at 22,000 miles about 24 hours--yielding the synchronous condition for some orbits.

The synchronous orbit is a very special case which is much abused in the literature (satellites "hovering over the United States" etc.). <u>All</u> orbits occur in "great circle" planes, planes which cut through the <u>center</u> of the earth and in which the shape of the earth cuts a <u>circle of equatorial size</u>.

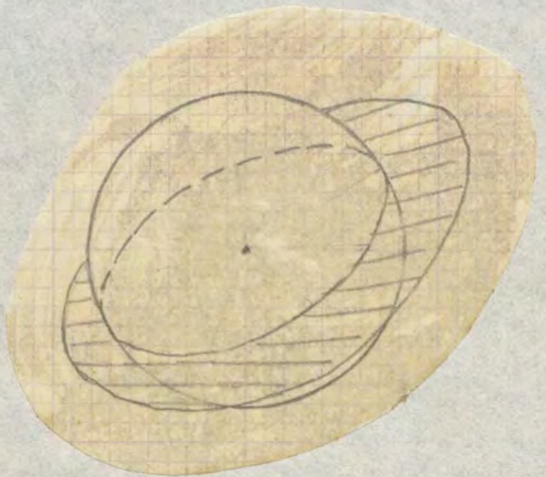

Fig. 6.--Great Circle Plane

There are no orbits along latitude lines or on any other small circle track; and there are no "hovering satellites" except over the equator. The hovering or synchronous satellite is one in an equatorial orbit (i.e., in the plane of the equator), moving eastward (the direction of earth rotation) and at 22,000 miles (to yield a 24 hour period, and, incidentally, very little threat to the earth). A point on the equator turns eastward and remains under the satellite. An orbit along a latitude line (to hover somewhere off the equator) would require horrible amounts of fuel in continuous thrust, as will be seen later. Near the synchronous orbit conditions, small inclinations of the orbital plane off the equatorial plane yield north and south excursions (to the latitude of the inclination angle) each way; and small amounts of ellipticity from the circular orbit cause movement fore and aft from the point below on the equator. A combination yields the figure eight patterns, presently seen in the ground tracks of most synchronous satellites, which average out to a circular orbit over the equator at 22,000 miles.

All orbits are "inertial" (that is influenced only by gravity) and are not interested in or influenced by earth rotation. The plane of an orbit remains aligned with the "fixed stars" at a constant angle with the plane of the ecliptic (the earth-sun plane); and the object goes around repeatedly, always having the exact same parameters (r, v, and flight path angle relative to the radius from earth) at the same point in the orbit. The ground track on a non-rotating earth would be a great circle, cocked at the angle of orbital inclination relative to the equator, and precessing once in 365 days (as the earth circles the sun). The object reaches North and South latitudes exactly equal to its inclination angle. An object launched at a given latitude <u>must</u> pass through at least all North and South latitudes less than its launch latitude.

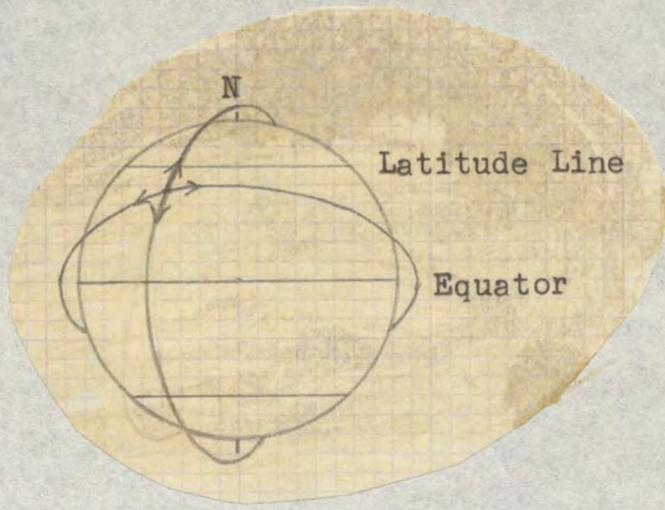

Fig. 7.--Included Latitudes

If it is launched other than straight east or west it will include higher latitudes also, because its insertion point will be some point on an orbit that does extend to higher latitudes.

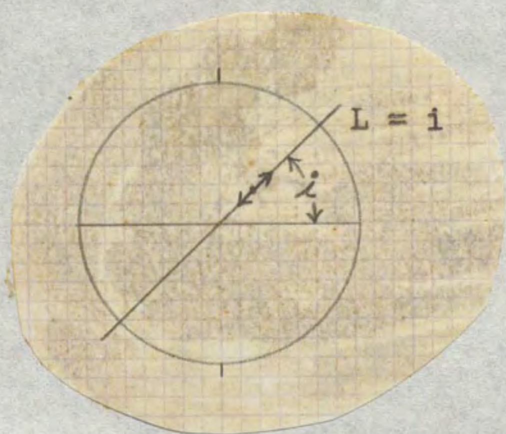

Fig. 8.--Launch Latitude & Direction

The United States can launch a satellite that does not pass over Russia, because its latitude is less than Russia's. Russian shots cannot avoid the United States, because the U.S. is at a lower latitude than Russia. This might explain continued Russian interest in freedom of space and avoidance of innocent passage questions. If things got locked up, Russia would need a launch site between the United States and the equator.[1]

The final ground tracks are the result of the earth turning under the satellite (or ICBM). As the object proceeds along its inertial orbit the eastward-turning earth brings ever-more-westward points under it. If the period is 90 minutes, the earth will have turned 22.5 degrees (plus precession) during one orbit and a given spot on earth will "see" the orbit moving successively westward with each pass. Combining all of these activities, one gets the "sinusoidal" ground track histories.

The elliptical orbit follows the same laws and patterns but introduces further variations. As an inertial orbit its total energy (kinetic plus potential) is constant (energy is conserved):

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[1]It could, in fact, be the key to the continued Soviet "cooperation" in space. This potential block against Soviet space activities was not mentioned in any of the legal or scientific literature found during the course of research for this paper.

$$K.E. + P.E. = C \tag{11}$$

$$\frac{m\,v^2}{2} + m\,g\,h = C_1$$

$$\frac{v^2}{2} + g\,h = C_2$$

For convenience a form of potential energy notation (based upon gravitational potential) is used which yields negative values increasing to zero at infinity (so still positive upward).

$$\frac{v^2}{2} - \frac{\mu}{r} = C_3 \tag{12}$$

This notation makes total energy, C_3, to just escape (zero velocity at infinity) exactly and continuously equal to zero. Thus all escape trajectories have positive total energies, all orbits negative total energies, and the velocity to escape from any given radius is:

$$v_{escape} = \sqrt{\frac{2\mu}{r}} \text{, from (12) with } C_3 = 0$$

Equation (12), with the value of C_3 constant and established by values of v and r anywhere along the orbit (a sighting), gives the value of v for any r, etc.

$$v^2 = 2\left(C_3 + \frac{\mu}{r}\right) \tag{13}$$

As r increases toward apogee, v decreases to a minimum at apogee. The opposite is true for perigee, the point of minimum radius and maximum velocity. Kinetic and potential energy interchange with a constant total. Exactly at apogee and perigee the relations are very simple:

$$v_a \times r_a = v_p \times r_p \tag{14}$$

Going to the circle for a moment, r is constant in equations (12), (13), and (14), and velocity is constant as expected. As an orbit becomes more elliptical its speeds and altitudes vary more and more through the orbit, and so does its timing over the ground.

The angle swept by the radius from the center of the planet to the orbiting object includes equal areas in equal times (Kepler's Second Law).

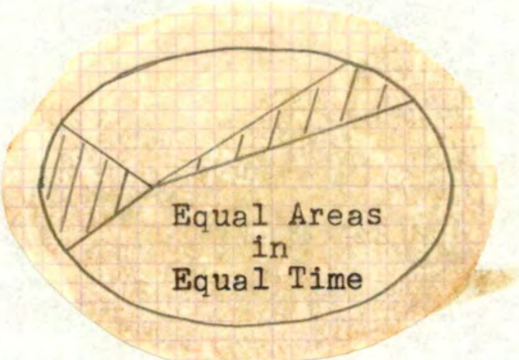

Fig. 9.--Orbital Timing

This fits with the faster swing at perigee (shorter radius) and explains the changes in angular rates (and erratic ground patterns) common with elliptical orbits. Thinking about the time required to pass over a given country, this time will decrease as altitude is decreased and will be least when a perigee is overhead. If circular velocity at

100 miles is about 25,000 feet/second, a perigee velocity at that altitude would be faster. The <u>maximum</u> possible time over a country can be calculated using the circular (slower) velocity, making the calculation easy and conservative. If a country lies 1,000 miles along the orbital ground track, the maximum time a vehicle at 100 miles altitude will be over the country turns out to be 3.5 minutes.[2] Thinking of ADIZ's and their original intent to provide one hour warning, a 35-minute SPADIZ would extend about 10,000 miles back along the orbital track. In today's world situation that is just about to the launch pad that is being worried about.

So far, all of this has been ancient history. The early satellites were launched into inertial orbits, to stay there as space trash or (more recently) to be returned in a one-shot re-entry. Still in the past but moving ahead in time, space operations have included altitude and phase changes.

Altitude and Phase Changes

The most simple altitude change occurs when a "short burn" (impulsive velocity change) is made at perigee or apogee and parallel to the original flight path. In each

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[2] $$\frac{1{,}000 \text{ mi.} \times 5{,}280 \text{ ft./mi}}{25{,}000 \text{ ft./sec.} \times 60 \text{ sec./min.}} = 3.5 \text{ minutes}$$

case the new velocity vector is parallel to the old and through the same point. The new orbit will pass through this same point, with the new velocity, and the opposite end of the orbit will move in or out.

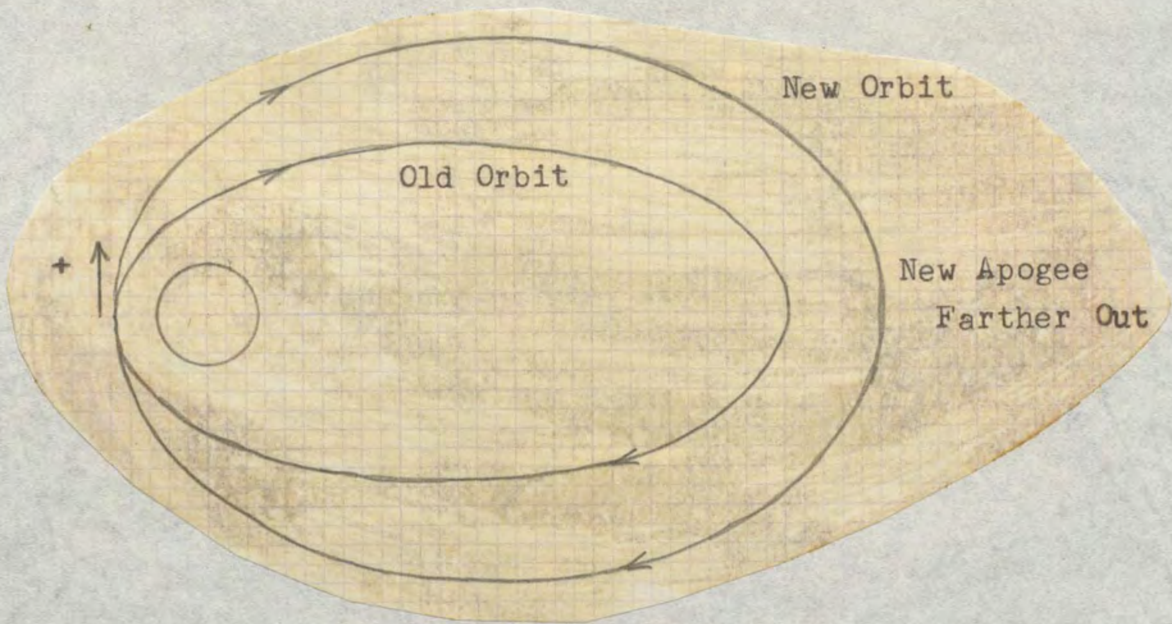

Fig. 10.--Altitude Changes

A positive kick at perigee raises apogee; a negative kick lowers apogee; a negative kick to leave circular velocity at perigee would yield a circular orbit at perigee height; etc. Similarly a positive burn at apogee moves perigee out; a negative one moves it in--as in initiating re-entry.

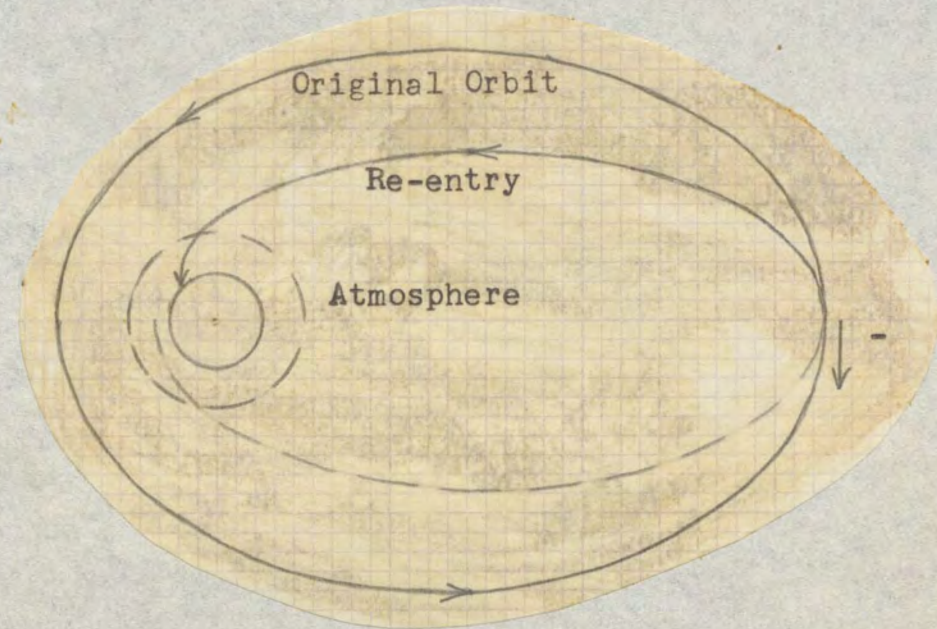

Fig. 11.--Re-entry

A decaying elliptical orbit becomes more circular because each pass through the atmosphere (at perigee) slows the vehicle and reduces the next apogee height. In theory it becomes circular and slowly spirals in going faster each revolution because circular velocity is faster close in. A new theory is required as the spiral gets steep.

During all periods of "coast" the orbits are predictable, etc., but each new "burn" starts a new orbit, making tracking by outsiders difficult.

The problems of advancing or retarding position in a given orbit (for conjunction with other vehicles, etc.) are usually handled through temporary altitude changes. Wishing to advance in orbit one could fire a retro (negative) at perigee, ride through a lower apogee (closer in and a shorter period) back to the same perigee altitude and then fire positive, back to the original velocity and the original orbit. The time at perigee would thus be advanced (sooner). The same effect could be obtained by firing negative at apogee, bringing the perigee in, etc. (if the perigee cleared the atmosphere). To retard position the opposite order of firings is used; plus first, to make a larger longer orbit, and minus second, to regain the original orbit but behind in time. Thinking of ground controllers, traffic control, and the adjustment of positions, space vehicles will not merely speed up and slow down (while holding altitude) upon request. Thrusting in-plane at other points in the orbit increases or decreases energy and time similarly but also cocks the orbit to a new orientation in the same plane. Altitude changes are relatively "cheap" in fuel expended and can be expected, for use upon request in control and for use in evasion when desired.

Plane Changes

Changes of orbital plane are a far different matter.

Considering the velocities of orbit (25,000 feet/second or so) a small velocity increment to the side produces very little effect.

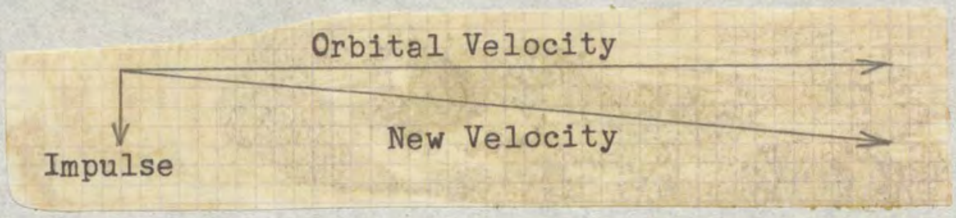

Fig. 12.--Plane Changes

As a rough figure, it takes about 17% of local circular velocity to change the plane 10 degrees at the opportune place in the orbit and 24% at the worst time. These increment sizes represent tremendous amounts of fuel. For those desiring a hovering satellite over the United States (or worse, over Russia) it would require a continuous plane change, to hold along a local latitude line, and an altitude to yield the synchronous condition. The winner of the contest would be the company with the fuel contract.

Lifting Bodies and Boost Glide

Numerous references are made in the literature to lift (reaction force) ending at 53 miles. It <u>is</u> a significant altitude but both lift and drag are available and present well past that height. The Mercury capsule utilized drag to re-enter. The Gemini program used an offset center of gravity, and a resulting cant of its heat shield and the force vector, to "fly" (up, down or sideways depending upon roll angle). The Apollo will use more of this idea to first roll "inverted" and fly into the atmosphere (for capture) and then roll to various angles to modulate its re-entry path and touchdown point within a "footprint" capability.[3] A lifting body provides considerably more lift and footprint and ends its flight in a horizontal landing on a runway. Extendable wing surfaces will further increase lift and maneuver capability, and slow the landing speeds. Jumping to the middle of future development, such a vehicle will allow launches to a long range glide (the Dynasoar of the early 1960's was such a vehicle). With a series of short burns enroute, a series of ascents and descents yields the "boost-glide" vehicle. This concept also allows plane changes by turning with lift while at lower speeds, altitudes, and angular momenta in the atmosphere. At a still

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[3]The "footprint" is the area on the ground anywhere within which the approaching vehicle can land by using its maneuvering capability to fly to the chosen spot. As the maneuvering capability increases (through more lift provided, etc.), the size of the footprint increases. As less lift is used, the footprint shrinks to the non-lifting impact point.

later stage of development one sees a continuous climb under power to cruise at high altitudes or to go on into orbit, and controlled descents to a horizontal landing on any chosen runway. This is the aerospace plane. The projected Dynasoar, a single-boost, once-around vehicle, could have opted for either Seattle or Miami while over Australia. A United States contractor is currently proposing a post-re-entry cruise vehicle, a lifting body with auxiliary propulsion for aerodynamic cruise.[4]

These future vehicles must be considered in any plans (and laws) regarding security, traffic control, or a boundary which they can cross at will and will cross at least twice.

Continuous Thrust

Continuous thrust is usually associated with deep space (ion propulsion, etc.) but there are other applications (low thrust, long burn) which are, or will be, related to the boundary problem and security. The use of thrust for altitude and plane changes has been discussed in terms of short burns. To date all actual space programs have used short burns for two reasons: they allow simple calculations and trajectories; and they are easier to implement (simply

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[4]"Convair to Study Space Vehicle with Atmospheric Cruise Capability," Missile/Space Daily, 1 December 1967.

hold attitude while burning, etc.). Low-thrust long-burn orbit modifications will be used in the future for better efficiency, and to present more difficult targets to any tracking and intercept system.

Continuous thrust at increasing levels will allow lowering of minimum orbital altitudes as mission requirements dictate and technology allows. Theoretically (but not practically) one could maintain a continuous circular "orbit" at zero altitude. A more practical and expected use is in the aerospace plane operation where thrust-as-required will be used to climb to and cruise at desired altitudes.

Launch and Re-entry

All early launches were made to the East to take advantage of earth rotation and the eastward velocity of the earth's surface (and the launch pad). This help ranges from 1,500 feet/second at the equator to zero at the poles. Conversely, westward launches require up to 1,500 feet/second extra velocity from the booster (3,000 feet/second more than the Eastward launch), and those into polar orbits a westward component to kill the pad velocity and head straight, etc.

Actual launches to date have used two or more relatively short burn times among long periods of coast. The two theoretical extremes, each using two burns, are:

1. Launch straight up, to coast to orbital altitude, and then fire horizontally to orbital speed.

2. Launch horizontally, to a perigee speed at zero altitude that will produce a rise to the desired orbital altitude at apogee, and then fire at the launch ellipse apogee to obtain the desired orbit (and not sink back down to the surface perigee).

The second method is more efficient and is used--by first climbing straight up a little and then bending over and accelerating to the perigee velocity.

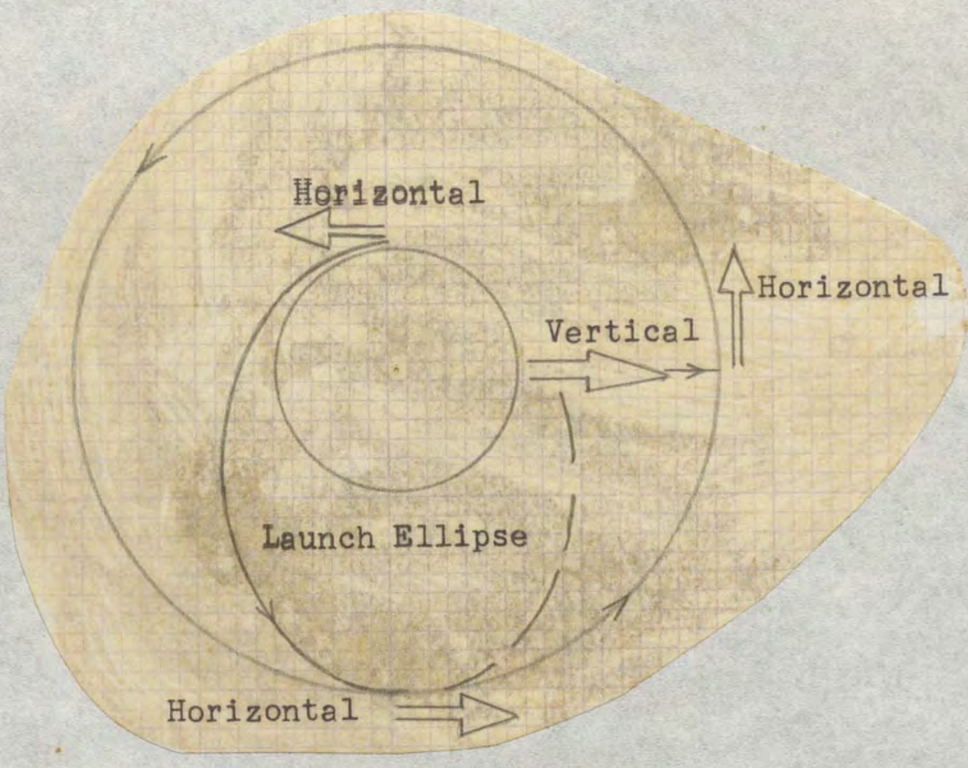

Fig. 13.--Launch Profiles

This makes for a long rise at relatively low altitude, as seen today.

Another maneuver that has been used, and will be seen more in the future, is the "dog-leg launch." As mentioned above, plane changes are expensive. Also as mentioned above, orbits are displaced to the West about 22 degrees on each pass. To rendezvous with an object not passing over the launch pad one must get into its plane and then join it. Launch followed by plane change followed by advance or retard take time and fuel. A cheaper and faster method is to launch at fairly low energy over toward the orbital plane desired, turn and fire up to and then into the orbit (the actual "launch" being in the proper plane), and, hopefully, join the target in the single dog-leg launch (a three-burn operation). The calculations, time at low altitude, and azimuth freedom required are considerable but necessary.

Then besides these few-burn techniques there are all combinations up to the continuous maneuver-and-burn launch.

Re-entries are initiated by a retro burn which produces a perigee low enough in the atmosphere for drag to kill the energy (producing heat) and prevent a return into space. Pure non-lifting re-entries are completely predictable and straightforward. Lift, if available, can be used, to fly down to aid capture, to fly up to reduce re-entry angle for range extension or heat load stretch-out, or to fly to the side. The result is a landing footprint available from an initial condition in space. As technology advances, the limitations on maneuver due to heat and dynamic loads will be moved back, allowing more maneuvering enroute and a larger footprint for landing. The aerospace plane is the current goal, with thrust available throughout the pattern. Until it comes along, traffic control will remain pretty much a matter of clearing the area. Long before then, however, defense against maneuvering vehicles will have become very difficult.

Bombs From Space

The standard ICBM is not considered a space vehicle by "peaceful uses of space" standards; yet it obeys all of the space laws of nature--in an elliptical orbit with a perigee inside the earth. The future incorporation of all of the above technological ideas has already been started with the Russian FOBS and the American MIRV. These are both devices designed to confuse the relatively simple warning and intercept problem presented by a standard ICBM.

The standard ICBM travels in a great circle plane that cuts the launch pad, the center of the earth, and the future position of the target (at impact). Considering the known pads and targets it is not hard to figure the directions from which attacks will come. This allows the construction of "radar fences," anti-ballistic-missile-missiles, etc. However a sneaky enemy with a large booster can come in from the rear, firing the long way around in the same plane.

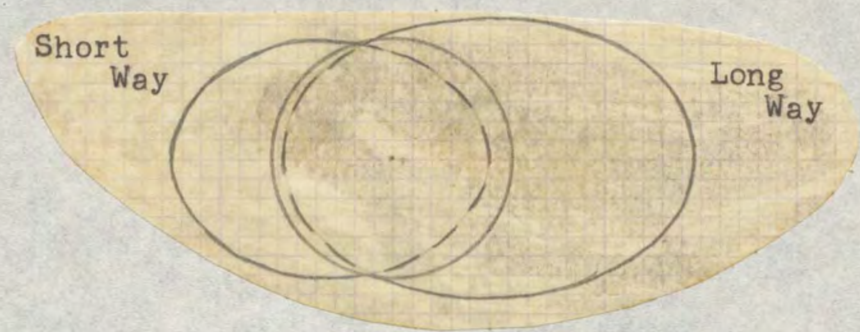

Fig. 14.--Choices of ICBM Trajectories

This was the idea that was considered and rejected by the United States years ago, for several reasons:

1. Less accurate.
2. Longer flight and warning time (if seen at launch).
3. Smaller warhead for a given booster.

This method would, however, be as legal as the normal ICBM.

The Russian Fractional-Orbit Bombardment System (FOBS) employs the rear approach (to defeat United States warning systems) but also makes the trip in orbit (to avoid the high lofted shot). Launched into a low orbit from Russia, the FOBS arrives over the United States from the South. The warhead can be called down, out of orbit, to hit a specific target. There are four major advantages in this system over the long way ellipse:

1. It remains lower and thus is seen later by radar at the target.

2. Its flight time is shorter.

3. The time from actual call-down to target impact is much shorter than any ICBM flight time.

4. If there is no intention to attack on the first pass it can be left in orbit, and <u>any</u> orbit. All orbits will eventually pass over any target at a latitude less than that of the launch pad. With this intent, various orbital plane inclination angles can be used and <u>the weapon can come from any direction</u>.

All of these put together add up to a new threat that would violate the space treaty even by Mr. McNamara's standards. If, on the other hand, the FOBS turns out to be a reconnaissance vehicle, it has the built-in capability to pass over any target and return for recovery.

Reconnaissance

Reconnaissance from national airspace above a country is illegal and subject to attack in peace or war. Reconnaissance from space is legal to the United States but illegal to the Soviet Union. Both countries are using reconnaissance satellites.

The basic sensor systems used for reconnaissance are photography, infra-red, and radar.

Photography from space is possible only in daylight and is blocked by clouds or haze. Its resolution (smallest size detail discernible) decreases with height and increases with camera focal length and film sensitivity (number of lines per millimeter). Image "smear" due to relative motion decreases with increasing film speed (faster shutter speed possible) and with film-pull or camera-swing techniques used to match the motion. Space photographic technology has been developed from aerial photography systems already far along with the resolution and smear problems. The KS-25 camera (U-2 variety), for example, is said to obtain a two foot resolution from 100,000 feet.[5] At 150 miles, a three-foot focal length camera with 70 millimeter film could cover a ten-mile wide strip and resolve objects 12 feet in diameter.[6] This is not adequate for good intelligence, which requires 5-10 foot resolutions to identify most weapons systems. This would require a four inch focal length at 50,000 feet, but 144 inches at 300 miles (with standard film).[7] The NASA projects (with better film) are

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[5]Lapp, p. 114.

[6]Ibid.

[7]Levison, p. 114.

getting three-foot resolutions from 150 miles now, and are experimenting with 240-inch and 960-inch cameras. The 960-inch camera could resolve to one foot with this same film.[8] All of this data merely points out two things: intelligence people will be pushing for lower altitudes; but all altitudes (out to 300 miles or so) will provide useful intelligence.

Infra-red is also stopped by cloud cover, and usually must be supported by photographic coverage for detail, but (registering temperature differences) it can be used in darkness and can detect underground activities, camouflaged facilities, earth textures, etc., plus missile exhausts, re-entry vehicles, and anything else of a different temperature than its background (like the wake of a submerged submarine). Using optics, it obeys much the same laws of range versus resolution, etc., as photography.

Radar is up in the frequencies beyond radio transmissions. It can penetrate clouds and is equally useable day or night, but has poor resolution (particularly as an active transmission-reflection-reception-image device). Its "maps" (photographs of the scope) present images including rivers, significant terrain features, large buildings, etc., but little detail. A prime use in intelligence, however, is

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[8] Butz, p. 94.

in the passive, listening mode (along with other electronic listening devices), noting wave lengths, pulse widths, and pulse repetition rates ("signatures") of radars. Improvements continue to be made, as in other reconnaissance methods.

The future will include combined systems plus multispectral sensors and lasers.

Multispectral photography already includes three-color systems which provide simultaneous pictures in different spectrum bands for examination together. The startling clarification of detail and temperature difference indicate material in construction, water content, excavation sites, heights of objects, types of plants, types of rock, salinity of water, etc.,[9] and, through water, show bottom contours and submarines to a depth of several hundred feet.[10] This is an entirely new field, already successful in its infancy.

Currently the hang-up in the use of all of these devices is the slow transmission rate of data to the ground. Transmission time increases as sensitity increases because more information is presented for each item covered. Lasers and other coherent radiation devices look like the future

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[9] Ibid.

[10] Ibid., p. 93.

answer to this problem, increasing transmissions speeds by factors near 100:1.[11] A lower altitude, however, would also decrease transmission time by reducing the number of lines required for a given resolution. A once-around recoverable reconnaissance vehicle solves the problem by delivering the data without loss of either time or fidelity. Laser development for traffic with earth could take a long time but a recoverable vehicle is current state of the art. "It is probable that for inspection purposes, a system combining transmission and recovery techniques will prove to be most effective.[12]

Anyone considering the boundary problem should expect space reconnaissance to get faster, more effective, lower in altitude, more important in security, and to be a larger bone of contention. Although some nations claim to want it stopped, no one has developed the capability to do more than complain.

The Capability to Bag

Russia supposedly has an anti-ballistic-missile system deployed around Moscow. The United States is developing the Sentinel system against a future threat from Red China.

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[11] Ibid., p. 95.

[12] Levison, p. 118.

The United States already has a limited anti-satellite system (on Johnson Island, based on the Thor booster), and evidently has begun development of a close-intercept system not requiring a nuclear blast for target destruction.[13] All of these systems will provide a limited capability to bag individual targets, and to make a point in the game of one-upmanship. None of them, however, will provide an impenetrable defensive system. Early warning and massive retaliation will remain the keystone of deterrence.[14] The various intercept systems will have their greatest impact in the areas of national sovereignty and the boundary, through their capability to destroy individual space vehicles deemed unacceptable by a nation's standards (as the U-2 was). Eventually a satellite inspection system will be developed (probably manned), providing the capability to inspect, board, disable, modify the orbit of, or destroy any satellite.

General Trends

There are no trends in the characteristics of the atmosphere or in the laws of aerodynamics or celestial mechanics.

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[13] George C. Wilson, "U.S. Will Develop Weapon to Down Enemy Satellites," Washington Post, 12 February 1968, p. 1.

[14] John S. Foster, "Space and Military Realities," Astronautics and Aeronautics, February 1968, p. 82.

Any advances will be through technology, employing these characteristics and laws. Altitude and phase changes in orbit will remain easier than plane changes, but all will be facilitated by advanced propulsion systems and, eventually, continuous or frequent thrust or the use of lift. Lifting bodies will completely void all of the current simple notions of inertial flight paths, bringing increased maneuverability and ending predictability. The eventual combination of lift plus continuously available thrust will produce the aerospace plane, merging air and space into aerospace. Somewhere along this path of development bombs in true space vehicles will become more accurate and far harder to defend against than the inertial ICBM's of today. Reconnaissance will be developed far beyond its current state and eventually bare all surface, and considerable sub-surface (land and sea), facilities and activities to the eyes of the enemy. Reconnaissance altitudes will decrease in lower orbits and increase with aircraft development to eventually encompass all aerospace altitudes (except for a band near 50-70 miles where temperatures will probably make it unprofitable). Somewhere in this development the discussion of the legality of reconnaissance will be resolved, through a unilateral or agreed boundary, an intercept incident, or acquiescence to open skies. The intercept incident could occur at any time.[15]

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[15] An incident similar to the U-2 case in 1960 could suddenly extend sovereignty into space.

Existing laws and customs for civil and military traffic, traffic control, and cargoes in national airspace are at complete variance with the recent agreements regarding the space above this national airspace. Operations going on now in one area would not be allowed in the other. Acquiescence has postponed confrontations as freedom for research has taken precedence on both sides. Continued infringements (such as the FOBS) of the written and tacit agreements will hasten development (and counter-development) and hasten the day when the acquisition of knowledge through free research will be outweighed by a real or suspected threat. On that day, unless a boundary is defined, freedom of space will disappear as current national airspace constraints are extended into space. An agreed boundary could preserve and extend the future freedom of space if, at the same time, nations began really abiding by the agreements.

CHAPTER IV

A NATURAL BOUNDARY IS REQUIRED

The many legal and technical facts and opinions discussed to this point can now be applied--to justify predictions about the future, to discuss suggestions made by other authors, to supply a realistic set of criteria for the boundary, and to provide technical background for the selection of a boundary altitude. It is believed that the natural boundary selected encompasses the past and looks to the future.

Civil versus Military Uses of Space

In January 1965, Dr. Edward C. Welsh, Executive Secretary of the U.S. Aeronautical and Space Council, made a statement regarding the future use of space for normal civil flight: "We will continue to expand air transportation uses of the aerospace medium. The supersonic and hypersonic transports will be followed eventually by routine flights in space."[1] Transportation is but one of the civilian uses and, like many of the others, equally applicable for civil or military use:

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[1] "Symposium on the Law of Outer Space," p. 11.

TABLE I

Civil and Military Uses of Space

Civil	Military
Transport	Transport/Bombardment
Meterology	Meterology
Navigational Aid	Nav. Aid/Guidance
Communications	Command/Propaganda
Geodetic Survey	Surveillance/Targeting
Weather Modification	Coercion
Space Stations	Command Posts
Crews	Crews
Research and Development	Research and Development

In every one of these applications there is common research and development, there have been mixed (civil and military) programs and personnel, and there will be no basic difference in the final vehicles. Many of the applications can be used simultaneously for civil and military operations, and many are already developed.[2] Transfers of technology and hardware between civil and military research and development have always occurred, in both directions, and will continue. The United States Manned Orbiting Laboratory (MOL) is using derivatives of the Gemini spacecraft and pressure suits and the environmental control system and fuel cells from Apollo; it may also combine research with the Apollo Applications Program.[3] In a more mundane but significant area, chartered airline aircraft are presently

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[2]Foster, p. 84.

[3]*Ibid.*, p. 83.

carrying military passengers and ammunition to Viet Nam from the United States.[4] Turning to the military applications which might look like civil operations, the Strategic Air Command (SAC), and others, currently employ airborne command posts (KC-135 aircraft).[5] These are likely to move into space when found feasible. The legality of these, and of early warning systems, reconnaissance, and many other applications, has not been settled. The past and current answer is secrecy:

> The USAF had to deliberately disguise its Discoveror program. . . . 1959 . . . as research in re-entry techniques /in/ aid to NASA's Mercury program. In truth, as has since come out, the program was to lay the groundwork for recovering photographic film and other records from orbiting reconnaissance satellites--spy satellites to be blunt.[6]

The Russian attitude is much the same.[7] These activities (or their suspected presence) will enter the sovereignty-versus-freedom-versus traffic control problem.

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[4]"U.S. Passenger Jets Flying Ammunition," Washington Star, 1 December 1967, plus "Correction," 2 December 1967.

[5]Sydney Fields, "Looking Glass," New York Daily News, 5 December 1967.

[6]Otto O. Binder, Victory in Space (New York: Walker, 1962), p. 137.

[7]U.S. Congress, Senate, Committee on Aeronautical and Space Sciences, Scientists' Testimony on Space Goals, Hearings (Washington: U.S. Govt. Print. Off., 1963), p. 42.

Traffic Control and Innocent Passage

Traffic control will be necessary to prevent collisions between spacecraft, between spacecraft and aircraft, and between spacecraft and space debris. Some provision for innocent passage will be required, for military as well as civil vehicles. Currently, all space-related passage is allowed because the boundary has not been defined and because the two major powers have exercised restraint in practice and avoided the issue in debate. One suggestion for the future is "occasional exclusive competence," to resolve each case without prejudicing those following.[8] This would leave the possibility of blackmail and sudden objection, and could introduce a requirement for inspection by any number of individual countries prior to launch. As Mr. Taubenfeld has stated:

> Short of a complete system for filing flight plans, backed by an actual inspection of payloads before launching or, alternately, of a program of launchings solely under the direction and control of an international organization, the nerve-wracking implications of almost any human penetration of outer space will increasingly become inescapable.[9]

A set of clearance criteria has been proposed by the David Davis Memorial Institute that might be practical below a low boundary: (paraphrased)

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[8]McDougal, et al., Law and Public Order in Space, p. 321.

[9]Schwartz, p. 20.

Consent required, provided that

a. it is not withheld if prior notice is given, if the over-flown nation is satisfied with the purpose, and if the vehicle is so controlled as to obviate danger to aircraft and the surface.

b. a vehicle capable of operating as both aircraft and spacecraft will be deemed an aircraft during passage.

c. emergencies will be honored and passed.

d. except in the case of emergencies, any state may divert or destroy any spacecraft which enters its airspace without consent.[10]

Diversion might be a little difficult for the spacecraft operators to accomplish at the last minute, but the remainder seems quite realistic and practical. An international control system compatible with this draft has been suggested by R. Cargill Hall: (again paraphrased)

a. Registration and Identification Information

(1) flag state of ownership

(2) public or private craft

(3) identification markings and characteristics

(4) manned or un-manned

(5) purpose of mission

(6) electronic frequencies to be used

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[10]David Davis Memorial Institute of International Studies, "Draft Code of Rules on the Exploration and Uses of Outer Space," <u>Journal of Air Law and Commerce</u>, Spring 1964, p. 148.

b. Flight Plan

(1) launch location

(2) launch date, time, and trajectory

(3) planned orbital parameters

(4) planned lifetime

(5) planned re-entry and recovery

(6) planned disposition of boosters and payload

c. Post-launch Data: Up-date all data and keep current.[11]

Such a system (very similar to conventional aircraft flight plans and control in national airspace) would be a reasonable prerequisite for passage below a reasonably low boundary. With the current and future tracking and control capabilities of major countries, it might also serve as an international flight plan for <u>all</u> altitudes. Item a.5 would be the big question that might require pre-launch inspection.

Inspection, in the words of Andrew Haley, is an "unpalatable" and "delicate" subject, the cause of "termination of talks." However, "to put off such an undertaking for later years will make even more difficult the reaching of international agreement."[12] In the opinion of this author, inspection will never be accepted prior to <u>all</u> space launches

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[11]Hall, p. 334.

[12]Haley, <u>Space Law and Government</u>, p. 140.

but would be accepted if required for innocent passage below a reasonably low boundary. If the boundary were low enough to satisfy long range and orbiting overflight users (above it) and high enough to satisfy national security criteria without control above it, the David Davis formula for passage, the Hall flight plan, and an extension of current flight control methods could incorporate the lower regimes of space flight into the conventional matrix of air sovereignties and regulation and maintain the separation between terrestrial conflict and space cooperation.

Suggested Boundaries

The various categories of suggestions were outlined in Chapter II. Some of these ideas can now be examined against additional background.

Functional Criteria

The idea of regulating by cargo and purpose, rather than a boundary, has been proposed by Russia plus a number of well-known legal writers.[13] Unfortunately they are either relying upon the continued separation of air and space or are ignoring the present differences, regarding inspection, between the two regimes. The passage of a foreign

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[13] McDougal, Lipson, Christol, Hildred, Fruchterman, and others.

aircraft through the airspace of any nation is granted by that nation based on cargo, purpose, and inspection rights. Yet the idea that the Soviet Union would grant pre-launch inspection rights to all nations to be overflown by their space vehicles is absurd. What the Russians really mean for the space regime is a statement concerning the cargo and mission by the launching nation. The statement cannot be checked by inspection, but can be checked, to varying degrees, by the intelligence agencies of the world. This "faith" approach is the one being used in space, and should be continued. It should be separated from the actual regulation of aircraft by cargo and purpose at the boundary between national airspace and outer space.

Altitudes and Zones

Altitudes suggested by advocates of a boundary range from 10 miles to infinity, and hit almost every mile in between. Criteria range from gravitational force through the limits of coercive power, to none, just name it arbitrarily. Zones have been suggested, both vertically and horizontally, from "space cones" out to infinity (and sweeping space as the earth turns?), through lateral and vertical SPADIZ, to layers of contiguous zones in the aerospace above each country. Many of the ideas have merit within the limits and framework of the discussion where found, but fail when applied to other present and future facets of the total problem. Through the long years of discussion, however, one boundary (suggested by a scientist) has kept re-appearing. It also has gradually gained the backing of more and more people who have really gotten deep into the subject, and the realistic criteria for success.

Final Criteria

Successful and lasting solutions to time-related problems require foresight, scope and realism in the solution criteria. The following criteria for a solution to the boundary problem are based upon the research and thought that have gone into this paper. They are probably short in foresight, and are definitely limited in scope, but it is believed that they are realistic.

1. National sovereignty, air law, aircraft control regulations, and all of the well-defined freedoms and constraints of civil and military <u>aircraft</u> flight must be separated from open space, space law, lack of close regulation, "faith," and the ill-defined but generally opposing freedoms and constraints of <u>space flight</u> at a boundary where air and space technology will remain most separated as aerospace technology merges the two areas of operation.

2. Traffic control of vehicles traversing altitudes common to air and space vehicles must provide safe separation

of <u>all</u> traffic and conventional control of traffic <u>cruising</u> for any length of time at conventional altitudes.

3. Traffic control of space vehicles must provide separation between space vehicles and from space debris.

4. The transition from air control to space control (and return) must be smooth, hopefully under a common agency and, ideally, at an altitude of minimum traffic.

5. National security must be preserved to a degree near present standards.

6. Civil and military space operations require a low enough boundary to permit reasonable overflight without innocent passage problems.

7. The boundary must meet the various demands of all parties so that each nation sees a net gain in adopting it.

8. The boundary must anticipate technological advances.

A Suggested Boundary

Air law and space law have been created for two isolated regimes. Fortunately, nature has provided an altitude band in which overlap of the regimes is possible but impractical, and through which only transients will pass.

Referring back to Chapter III, the density of the atmosphere decreases as altitude increases. In order to obtain lift equal to its weight, an aircraft must fly faster (in true airspeed) as it flies higher. As it flies faster, parallel to the curved surface of the earth, centrifugal force supports an increasing amount of its weight. With current lift devices an aircraft flying higher (and faster to do it) reaches a condition at about 53 miles in which atmospheric lift has become insignificant compared to the "lift" of centrifugal force, and the aircraft is actually in a powered orbit. The critical altitude is not exact, because the characteristics of the atmosphere near 53 miles are not known exactly, better lifting devices would raise it,[14] and the total lift line joins the orbital flight line assymptotically (not in an intersection). Of course any vehicle reaching this altitude can fly higher (by zooming[15] or by using more thrust than that required for level cruise). With continued high thrust such a vehicle could raise its "orbit" to any level, gradually requiring less thrust as it approached the drag-free orbit altitudes. Such a vehicle can also develop and use lift for turning, maneuvering, extending the glide, etc., at altitudes well above 53 miles.

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[14]With more lift available, the vehicle can fly slower at a given altitude, or fly at the same velocity at a higher altitude. Centrifugal force values are thus postponed to higher altitudes as aerodynamic lift capabilities are increased.

[15]In a zoom, airspeed is traded for altitude by pulling up and climbing without sufficient thrust to maintain the airspeed. Using this technique, an aircraft can be climbed above its steady state ceiling. It will continue to lose airspeed and, eventually, will fall back to lower altitudes if it is not pushed over and flown down.

However, from about 53 miles up a vehicle is no longer supported predominantly by the reactions of the air, and the standard aircraft definition ends. This is the von Karman Primary Jurisdictional Line, suggested by Dr. Theodore von Karman (back in the 1950's) as a natural separation line between air and space travel,[16] and it does remain as a lid on conventional traffic. It is not the end of all lift, as some authors suggest, and it is probably not exact. The occupants of an aerospace plane will notice no discontinuity while passing through the altitude, and will be able to maneuver above it with gradually decreasing aerodynamic lift as altitude is increased. It is unlikely, however, that vehicles will cruise near this altitude, because of the drag and the skin temperatures developed by the high true airspeed (and Mach number)[17] in the significant amount of air still present.

Coming down from above, a non-lifting vehicle could orbit at sea level by maintaining orbital speed for that altitude. This again is not practical due to thrust requirements and temperature problems. These are as serious at 53 miles for

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[16] Haley, Space Law and Government, p. 98.

[17] True airspeed is the actual velocity of an object through the air. Mach number is the ratio of this true airspeed over the speed of sound in the ambient (surrounding) air. Skin temperatures are a function of the Mach number and the temperature of the ambient air. Thus, an object traveling at constant true airspeed at various altitudes (and ambient temperatures) will experience varying skin temperatures, all calculable through Mach number and ambient temperature.

the non-lifting vehicle lowering its orbit as they are for the lifting vehicle increasing its altitude, and get worse lower. It is extremely unlikely that any space vehicle will orbit below 50 miles, and quite unlikely that useful reconnaissance, etc., can be conducted in the band between 50 and 70 miles due to all of the problems encountered.

All of these ideas can be combined in a series of figures--take-offs on the figure of von Karman and Haley.[18]

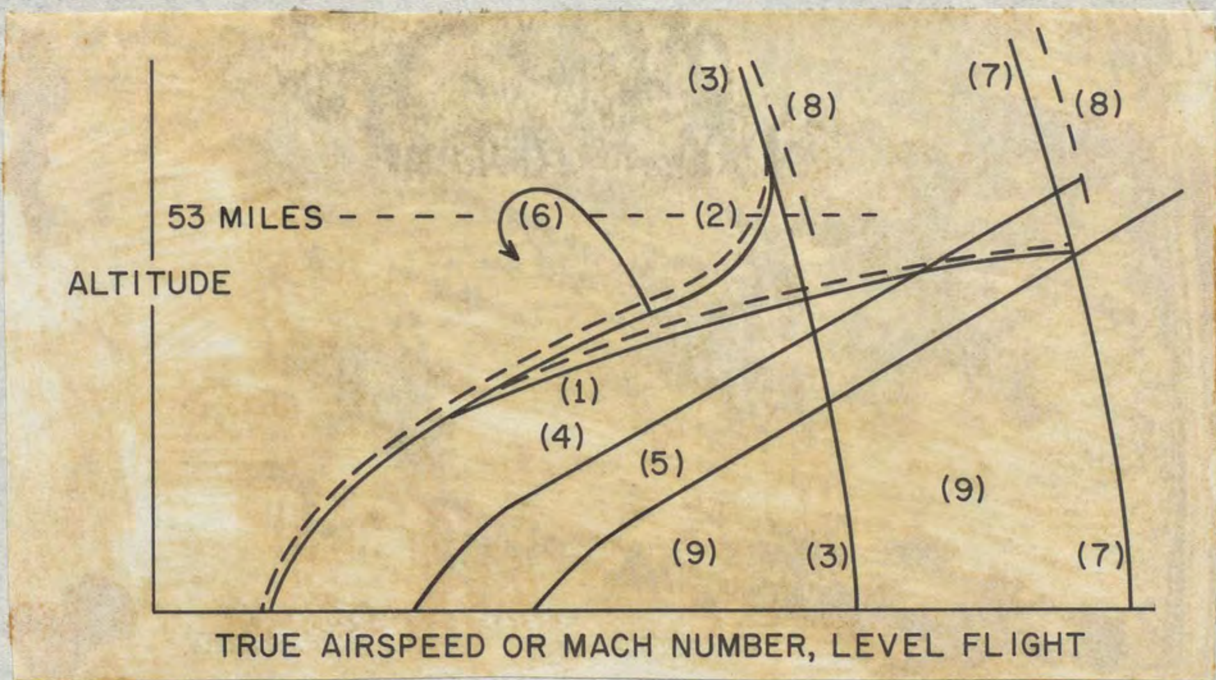

Fig. 15.--Flight Conditions
as a Function of Speed and Altitude

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[18] Andrew G. Haley, "Parameters of Space Law," Colloquium on the Law of Outer Space, Eighth, 1965 (Norman: University of Oklahoma Research Institute, 1966), p. 221.

Curve (1): the true airspeed or Mach number (at maximum lift coefficient) required for lift equal to weight in level flight without the help of centrifugal force. The line is raised (dashed line) with better lift devices.

Curve (2): the actual true airspeed or Mach number required for horizontal flight with centrifugal force increasing with horizontal velocity and reducing the lift required. Eventually the remaining lift required becomes insignificant (compared to the centrifugal force) at about 53 miles. The curve is assymptotic to curve (3) and not an intersection.

Curve (3): orbital velocity for a non-lifting vehicle, decreasing with increasing altitude.

Curve (4): stabilized skin temperature at some named value (say 2000°F), a function of Mach number and the ambient temperature, with curve (5) for a higher temperature.

Curve and area (6): a zoom of an aerodynamic vehicle to higher altitude, temporarily trading kinetic energy for potential energy. A zoom can exceed the von Karman line altitude but not in "conventional" or "stabilized" or continued flight.

Curve (7): escape velocity, decreasing with altitude.

Curves (8): lifting vehicle "flying inverted" to hold itself below its energy altitude, or getting captured.

Area (9): the area below line (4) or (5) where a vehicle would be too hot for practical operations. The orbit line (3) crosses this line to too hot a little below the von Karman line. Well above this, however, the heat, shock wave, ion sheath, etc., would eliminate infra-red and other activities.

The resulting areas of operation are shown in the following figure.

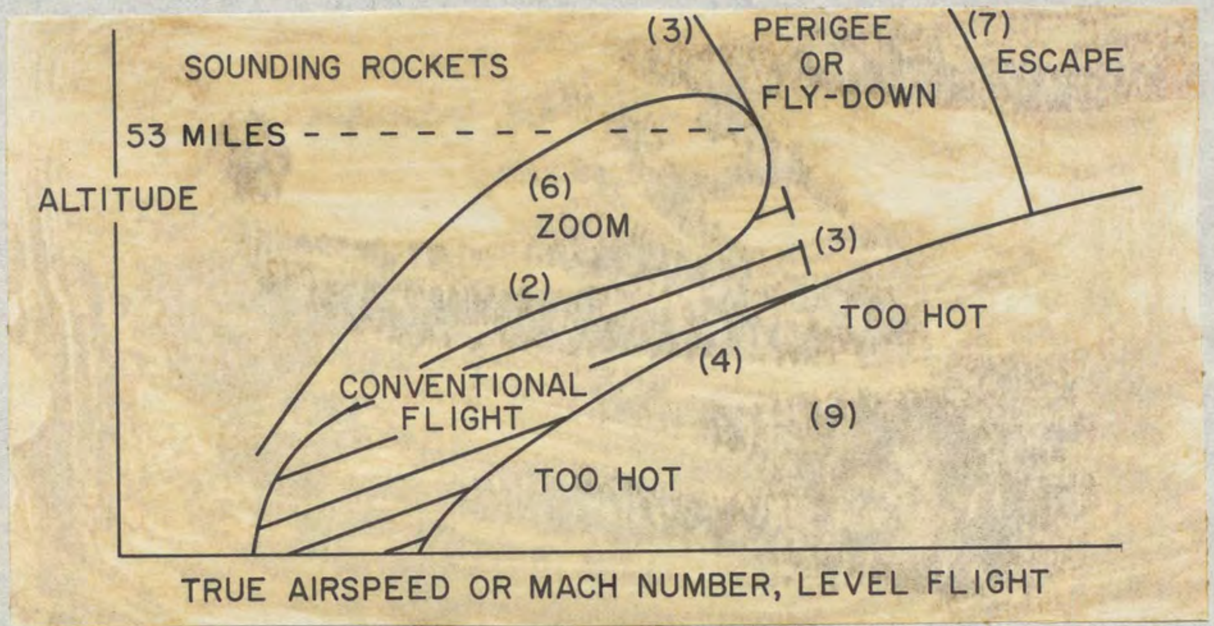

Fig. 16.--Flight Operations as a Function of Speed and Altitude

Technological advances can move line (2) up and to the left a little, and will move line (4) to the right (for transients but probably not for continued flight or practical use). A boost-glide vehicle would operate in and out of the zoom area. An aerospace plane will climb in the conventional corridor, exit across the orbit line (3) to the perigee of a launch (transfer) ellipse and coast on up to apogee for a final burn into orbit, <u>or</u> merely fly up line (2) and (3) into orbit. There will be no "conventional traffic" (as defined) above 55 miles or so, and there probably will be no orbital traffic below 60 miles. The boundary should be within this band of minimum traffic.

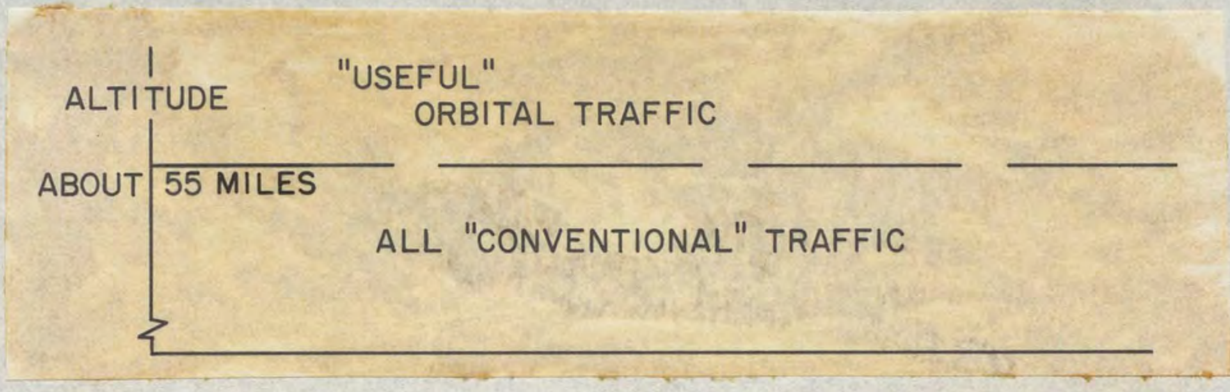

Fig. 17.--Separation Between Air & Space Traffic

Applying the final criteria to the characteristics of the 55-60 mile band, we arrive at the following conclusions.

1. The constraints, freedoms, modes, and missions are naturally separated--atmospheric from space--and will tend to remain separated.

2. Conventional traffic control can be extended up to the boundary, and will include all future point-to-point traffic except boost gliders (that may dip in and back out but can be cleared and flight-followed) and aerospace planes (that can be controlled as conventional aircraft while low). Non-lifting launches and re-entries can be cleared as they are now, by evacuating the area of all conventional traffic.

3. Control of true space traffic and space debris can remain a problem of outer space, with the apparent better

chance of cooperation it now enjoys. The ICAO can _expand_ to the boundary ahead of the conventional traffic, and participate beyond as appropriate.

4. This transition from air to space control is at an altitude of minimum traffic.

5. Sovereignty ends at an altitude above which little is gained by altitude reductions below current accepted space altitudes, and yet the freedom is there to try.

6. Civil and military users of space may need clearances for long climbs and descents, but they will not be caught by sovereignty at practical space altitudes.

7. The boundary at least partially satisfies all parties, does not upset the current status of air and space law or change the security picture to any great extent, and allows future progress above and below exactly as before.

8. Technological advances should not change this break point as the best compromise even though it may get crowded or even overlapped from both sides. If the boundary were established _it_ would guide future development.

Turning back to the original set of problems, this boundary would preserve those solutions already established or begun, enhance the future solution of others by placing them firmly in the space-cooperation domain, and set up or solve the last four, the sticky ones.

The latest data and predictive theory should be used by the scientific community to determine this natural boundary altitude so that peaceful space is separated from the warring world below by technology as well as law.

CHAPTER V

COLLATERAL CONSIDERATIONS

> It being my intention to write a thing which shall be useful to him who apprehends it, it appears to me more appropriate to follow up the real truth of the matter than the imagination of it . . . because he who neglects what is done for what ought to be done sooner effects his ruin than his preservation.
>
> Machiavelli

So far the nations have preserved silence and postponed decision, to prevent a confrontation and allow free research and development. The spirit of cooperation (if it was that) has been badly bent but not challenged, through choice. The acceptance of the boundary suggested here would not jostle the fragile truce in space but would separate space from the more realistic world and airspace below, thus preserving free space above. Reconnaissance, illegal in air and tolerated in space, could become accepted through custom, and help to preserve peace through exposing any build-ups or alerts for war. Meanwhile, however, the realities of faith versus national security require some unilateral decisions and declarations--to keep everybody honest:

1. A devastating nuclear attack from orbit would require either a formation of space bombardment vehicles or many separate vehicles in conjunctive orbits approaching the target simultaneously. The United States should announce

that it reserves the right to destroy formations and objects in conjunctive orbits approaching the United States without prior permission.

2. The United States should announce that any space vehicle not registered with the Secretary General of the United Nations is subject to inspection and possible destruction.

3. The United States should develop for use in space:

a. Anti-ballistic missile systems.

b. Orbital early warning systems.

c. Anti-satellite systems with rendezvous capability and conventional warheads.

d. A manned inspection system for near-space.

It is regrettable that, under the umbrella of peaceful exploration, several nations are preparing for war through space. In many ways, the recent history of space operations and law is similar to the history of the conquest of the air in the late 1800's and early 1900's. World War I has not happened yet in space. In the space regime, however, one side has a decided advantage if constraints are ever applied. Due to her high latitude, the Soviet Union could become a space locked country if the United States, or any other space power, chose to claim the space above itself and did not grant Soviet space missions innocent passage. This potential condition can be used as a lever by the free world, but should be exploited carefully. The condition could be removed by bases near the equator.

Looking ahead, it is to the best interest of all nations to preserve the freedom of space. This can be done, by using the combined knowledge of the legal, scientific, military, and government official communities to develop a careful path of progress that preserves the security of each nation while allowing the continued exploration and peaceful use of space.

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