Chapter 18

Dual-Use as Unintended Policy Driver: The American Bubble

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In the earliest days of the Space Age, the U.S. government, for diverse and pressing policy reasons, elaborated the dual-use distinction. Their view became that space activities could in fact easily be delineated into peaceful civil purposes and clearly military purposes. This distinction in practice ultimately proved unsustainable but was especially convenient for arms control purposes beginning with the 1960s nuclear arms race. The dual-use concept has proven to embody several unanticipated effects which decisively and negatively impact future U.S. engagement in space commerce. This policy arose when the United States was effectively a monopolist with regard to space applications, but has different implications in a globalizing economy.

This paper analyzes, first, the rise of the dual-use concept and its general impact on civil/commercial space applications; second, how that situation changed with the cold war's end and the lessening of security restrictions; and, third, the destabilizing economic effects that have arisen for the United States. This analysis focuses mostly on the American experience, but the dual-use concept proved particularly useful internationally with regard to slowing nuclear proliferation (the Nonproliferation Treaty)[1]; it was extended specifically in 1987 to space launch technologies with the Missile Technology Control Regime (MTCR),[2] and more broadly with the "Wassenear Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies."[3] The latter is more wide-sweeping in its implications for transfer of dual-use technologies.

1. Treaty on the Non-Proliferation of Nuclear Weapons (entered into force 5 March 1970), *http://disarmament.un.org/TreatyStatus.nsf* (accessed 15 October 2006).

2. The original signatories were allies of the United States: Canada, France, Germany, Italy, Japan, and the United Kingdom. *http://www.mtcr.info/english/index.html* (accessed 15 October 2006).

3. The Arrangement "complements and reinforces, without duplication, the existing regimes for non-proliferation of weapons of mass destruction and their delivery systems, by focusing on the threats to international and regional peace and security which may arise from transfers of armaments and sensitive dual-use goods and technologies where the risks are judged greatest. This arrangement is also intended to enhance co-operation to prevent the acquisition of armaments and sensitive dual-use items for military end-uses, if the situation in a region or the behaviour of a state is, or becomes, a cause for serious concern to the Participating States." *http://www.wassenaar.org/publicdocuments/Basic%20documents%202006%20-%20January.doc* (accessed 15 October 2006).

The application areas focused on here include remote sensing (including weather), navigation, and communications satellite policies as the most obvious areas. Launch vehicle restrictions arose later than the others due to other factors. The changes occurring are not merely technological (i.e., improvement in the scale of images provided or accuracy of positioning information or enhanced communications) but are due to the fact that these largely military-initiated and -dominated sectors are becoming engines for economic growth and improvements in productivity. These applications are driving the commercial space sector to become more truly international in scope and operations. Early space visionaries often envisioned a world economically and politically integrated through the use of space applications, but that has not occurred because of national security restraints. Those security restraints have not vanished in the American case, but the global spread of technological competence regarding space technologies has removed the capacity of any single state to control these applications. The image projected by these changes is a cooperative, peaceful world but, for the United States, the political focus remains upon these applications' potential to disrupt the U.S. economy and security operations.

DUAL-USE AS A CONCEPT—BEGINNINGS

From the perspective of the late 1940s and early 1950s, at the cusp of the first Space Age, the dual-use concept was largely irrelevant because the operative assumption was that national space programs would be controlled and led by their military, with whatever civilian presence that developed being clearly subordinate one.[4] The historical U.S. model for nonmilitary participation in space activities was the scientific expedition, such as Lewis and Clark in 1804, led by the military. Wernher von Braun's famous series of articles in *Collier's* assumed that the expeditionary model would continue.[5] This concept faded in the 1960s but has been resurrected by U.S. Air Force space power advocates as a means by which to recapture their control over human spaceflight.[6]

The purely civilian (especially commercial) aspect of space activities existed initially as a theoretical concept, despite Robert Goddard's pioneering research on launch vehicles and early speculation by Arthur Clarke about communications

4. Howard E. McCurdy, *Space and the American Imagination* (Washington, DC: Smithsonian Institution Press, 1997), chapter 1.

5. William E. Burrows, *This New Ocean: The Story of the First Space Age* (New York: Modern Library, 1998), pp. 142–146. For excerpts of the original articles, see John M. Logsdon, ed., *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program, Volume I: Organizing for Exploration* (Washington, DC: U.S. Government Printing Office, 1995), pp. 176–200.

6. Simon P. Worden and John E. Shaw, *Whither Space Power? Forging a Strategy for the New Century* (Maxwell Air Force Base, AL: Air University Press, September 2002), pp. 110–112.

using Earth-orbiting satellites. The dominant reality became that the military (the Nazis and Soviets first, later the Americans) controlled the space technology development process, including funding of whatever launch technology was deemed useful. The military's initial and primary interest focused on building more effective and farther-reaching weapons carriers.[7] The wider possibilities for space activities were understood to exist and were the subject of preliminary analysis but all were considered within the paradigm of military control over any space-related technologies that might be developed.[8] In fact, the original thought was that the military itself, through an arsenal system, would control production of such technologies. In the American case, however, the U.S. Air Force had extensive experience with contractors as technology producers under military supervision.

This contractor approach fit better with American ideological proclivities and provided greater flexibility for expansion and contraction of production, it being easier to lay off contractor employees than civil servants employed at an arsenal. One direct consequence of this approach was creation of an aerospace industry that was in place if and when military control loosened. The aeronautical side of the industry was an excellent prototype of a dual-use capability, although it was not thought of in those terms.

Embedded in the beginnings of the Space Age was the shadow of a dual-use concept, but even there the military remained dominant. The rise of space scientists was in part built around the reality that their initial value was as payload providers whose results had direct military relevance, especially improvement in communications and scanning capabilities through better understanding of the ionosphere and other environmental forces impacting radio wave transmissions at different frequencies and thus, by extension, military operations.[9] Beginning with sounding rockets (high-altitude balloons were already in use), scientists found that the ability to leave the atmosphere even briefly to observe atmospheric and celestial events was truly liberating, opening up new vistas of scientific information and understanding. This original relationship explains why the first successful U.S. satellite launch carried a scientific experiment on-board whereas the Soviets' first satellite was basically a transmitter in space, famously annoying the Americans with its repetitive beeping.[10]

7. Walter A. McDougall, . . . *the Heavens and the Earth: A Political History of the Space Age* (New York: Basic Books, 1985), pp. 100–111.

8. Ibid., pp. 116–124.

9. David H. DeVorkin, Science with a Vengeance: How the Military Created the U.S. Space Sciences after World War II (New York: Springer-Verlag, 1992).

10. Paul Dickson, *Sputnik: Shock of the Century* (New York: Berkeley Publishing, 2001), pp. 108–109. The original satellite payload for the Sputnik was downsized in order to ensure that success would occur when the attempt was made to orbit a satellite. Cf. Asif A. Siddiqi, *Sputnik and the Soviet Space Challenge* (Gainesville, FL: University Press of Florida, 2000), pp. 152–170.

Concurrent with these military-dominated development efforts were research efforts within the communications industry exploring the use of satellites for facilitating global communications.[11] These efforts were less publicly visible since the corporations involved, including AT&T ("Ma Bell") and RCA, focused more on securing corporate economic advantage rather than the publicity sought by military services in their quest for Congressional attention. The 1940s and 1950s saw intense public campaigns by the military services to gain appropriations advantages relative to other services. In one sense, these private efforts were more realistically the harbingers of the dual-use concept because they were truly nonmilitary although communications satellites (comsats) possessed obvious military usefulness regardless of their origin.

Therefore, the dual-use concept is premised on a distinction that technologically had no reality but was considered politically critical if weapons of mass destruction (WMD) proliferation threats to world security were to be controlled. This nonproliferation effort focused heavily on missiles or rockets that could deliver weapons with no effective means of defense, although other applications came under similar constraints. However, the biggest political booster of this distinction, President Dwight Eisenhower, saw the dual-use concept's value first with regard to his Herculean struggle to keep the U.S. budget under control (i.e., fiscally balanced).[12] Eisenhower's greatest political nightmare was that the United States would rush off in pursuit of glory in the heavens—a quest that he considered to be of little relevance security-wise.

On 4 October 1957, the first Sputnik launch led to an immediate and vociferous public demand for a U.S. space effort commensurate with that being apparently mounted by the Soviets. The public's demand was fed by a Congress controlled by the president's political adversaries.[13] This situation further inflamed existing rivalries among the three U.S. military services, especially between the Air Force and Army; each eagerly sought to seize outer space as its new area of operations, just as they had previously squabbled over missile systems.[14] With visions of large but separate competing military space programs dancing in his head, Eisenhower moved at once

11. David J. Whalen, *The Origins of Satellite Communications*, 1945–1965 (Washington, DC: Smithsonian Institution Press, 2002). Whalen's argument is that these private efforts got lost in the publicity given to NASA for forays into communications satellite development.

12. David Callahan and Fred I. Greenstein, "The Reluctant Racer: Eisenhower and U.S. Space Policy," in *Spaceflight and the Myth of Presidential Leadership*, Roger D. Launius and Howard E. McCurdy, eds. (Urbana, IL: University of Illinois Press, 1997), pp. 31–39.

13. For example, Senate Majority Leader Lyndon Johnson opened committee hearings on the question of the American space program and what was to be done in the fall of 1957. Robert A. Divine, *The Sputnik Challenge: Eisenhower's Response to the Soviet Satellite* (New York: Oxford University Press, 1993), pp. 41–76; Eugene M. Emme, "Presidents and Space," in *Between Sputnik and the Shuttle: New Perspectives on American Astronautics*, Frederick C. Durant, III, ed. (San Diego, CA: American Astronautical Society, 1981), pp. 16–23.

14. David N. Spires, *Beyond Horizons: A Half Century of Air Force Space Leadership* (Peterson Air Force Base, CO: Air Force Space Command, U.S. Air Force, 1997), pp. 21–38.

to first, stop the interservice rivalry, and second, to cut off any military aspirations for pursuing human spaceflight, the most expensive and difficult of space activities. All of this domestic activity occurred against an international background where the global nuclear arms race loomed as an enormously expensive contest with no end in sight, except possibly Armageddon. Eisenhower was definitely not interested in having this nuclear arms race spread to the heavens, raining death from space. Plus, Eisenhower had severe doubts as to the military usefulness of outer space in terms of weapons.

Cutting off a potential interservice rivalry was politically easier than stopping the political rush to start a human spaceflight program. The Air Force had earlier been awarded control over land-based, long-range ballistic missiles; the competitive Army missile effort had been reduced to developing short-range or tactical missiles.[15] This decision, however, had come only after years of bitter service infighting but was only put in place just prior to the first satellite launch. The president further confronted the political reality that his original effort to stymie the Army's growing space efforts had come a cropper when the first Vanguard launch (a civilian program run by the Naval Research Lab) failed to leave the pad in December 1957—a perfectly dismal response to two Soviet successes with their larger and physically more impressive Sputniks. Prior to the Vanguard launch, the administration had hedged its bets by authorizing the Army Ballistic Missile Agency team, led by Wernher von Braun, to build a back-up launcher and satellite. This cobbled-together effort flew to orbit on 31 January 1958—Explorer I became the first U.S. satellite. The Army had argued in 1956 that it could orbit a satellite immediately but that option was rejected by the administration whose interests were different and more internationally focused.[16] After the very public Vanguard failure, Eisenhower needed the political success symbolized by a successful Explorer launch, but von Braun's and the Army's larger space ambitions, including manned spaceflight, were not encouraged and were finally terminated.

Eisenhower's resistance was premised on two views he held regarding a potential manned spaceflight race: first, the cost was too high given available national resources (remember, balanced budgets), and second, the Army could not be allowed to build up its space efforts in competition with the Air Force. The latter goal was comparatively easily achieved with the Army space program being shut down. That decision was bitterly resisted (almost to the point of active insubordination) but the president was adamant. That left the other piece—the question of a manned space effort run by the Air Force, the victor in the interservice space wars, with visions of a vast space effort to compete with the Soviets across the spectrum of activities.

15. Raymond H. Dawson, "Congressional Innovation and Intervention in Defense Policy: Legislative Authorization of Weapons Systems," *American Political Science Review* 56 (March 1962): pp. 49–50. The dispute began over air defense systems and escalated.

16. Rip Bulkeley, *The Sputniks Crisis and Early United States Space Policy* (Bloomington, IN: Indiana University Press, 1991), pp. 95–101.

The answer to Eisenhower's latter problem came in the form of NASA, killing the proverbial two birds with one stone. NASA became the president's stalking horse for removing the Air Force from the manned space arena. His view was that a manned space program run by a military service would be impossible to control in terms of budget growth because the military could always invoke military necessity in order to stymie any presidential efforts at budget control. The problem of military services end-running around the president to Congress regarding their relative budget share had been a continuing feature of domestic politics in the 1950s, especially since the other party, the Democrats, controlled Congress.[17] Eisenhower's great prestige as the commander of Allied victory in Europe helped him beat back some efforts, but military space activities were literally completely new—the president was considered no more expert than many others. Also, equally relevant was the U.S. desire to slow down the proliferation of nuclear weapons.

NASA became the stalking horse for achieving the president's efforts—first to deflect Air Force ambitions and second to initiate successful arms control. The Air Force part was somewhat easier because, as a military service, it had to have an assigned mission in order to pursue a particular technology or approach. The decision was to transfer all manned or crewed spaceflight operations to the new agency, NASA, established 1 October 1958, leaving the Air Force out of the picture. The decision to make this move had two bases.

First, Eisenhower thought that a civilian agency would be more easily managed in terms of budget, lacking the political clout of the military services. In his assumption of NASA's political weakness, Eisenhower was ultimately correct but mistaken in the short term—the Southern paladins within Congress (especially at the committee level) saw great opportunities for constituency service in terms of creating constituent jobs.[18] When the Mercury program was approved despite Eisenhower's misgivings, the door was opened for Congressional pork. With President Kennedy's announcement of the Apollo program in 1961, NASA entered its Golden Age. Even in its relative political eclipse later, NASA has retained its usefulness for Congress as a source of constituent jobs. [19]

17. Samuel P. Huntington, *The Common Defense: Strategic Programs in National Politics* (New York: Columbia University Press, 1961), pp. 374–378.

18. Robert A. Divine, "Lyndon B. Johnson and the Politics of Space," in *The Johnson Years, Volume 2: Vietnam, the Environment and Science*, Robert A. Divine, ed. (Lawrence, KS: University Press of Kansas, 1990).

19. Eisenhower's resistance to government growth stymied Congressional leaders' desire to create jobs. The creation of NASA presented the golden goose since Eisenhower was constrained by the political pressures to "do something about space." New NASA Centers—Goddard Space Flight Center, Johnson Space Center, Stennis Space Center, and Kennedy Space Center—were established, while former NACA Centers—Langley Research Center, Glenn Research Center, Dryden Flight Research Center, and Ames Research Center—were upgraded and former Army space assets—Marshall Space Flight Center and the Jet Propulsion Lab—were acquired. All kinds of economic opportunities were brought to the southern United States, which historically had a severe deficit of such facilities and industries.

Second and more critical, by transferring manned spaceflight to a nonmilitary agency, the political opportunity existed for establishing outer space as an international sanctuary devoid of space-based weapons. This latter was extremely important for nuclear arms control purposes since, for the first time, the parties were not attempting to remove or restrict weapons already fielded; rather, they were attempting to deny weapons' initial entry into a location. The realm of outer space was defined as the common heritage of mankind, as stated in Article 1 of the so-called Outer Space Treaty:

> The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.

It was not to be an arena for direct military confrontation (Article 4):

> States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner. [20]

This perspective allowed an intense public space race competition between the two nuclear space powers to occur without necessarily leading to a military confrontation.[21] After the Cuban missile crisis in October 1962, the Soviets and Americans were both aware of how fragile the nuclear peace was—a fact which heightened their interest in decreasing confrontation potential. Thus, the race for the lunar surface could end with a clear winner, the United States, but without the hazardous outcome implied by an arms race.

Out of this mishmash of goals and motivations, the concept of dual-use arose as one primary methodology by which all space-related technologies could be evaluated as to whether they possessed significant military implications. This concept created a truly artificial distinction since the only real difference between military and civilian or commercial uses was, at its essence, user intent. The technology remained basically the same but its purposes varied. Military technologies were often more robust in terms of their survivability (i.e., military specifications or "mil-specs"), but the central application remained the same for both.

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20. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (entered into force 10 October 1967), *http://www.state.gov/t/ac/trt/5181.htm* (accessed 15 October 2006).

21. In the interest of this nonmilitary space race, President Richard Nixon has been identified as reshuffling the Apollo crew schedule in order to ensure that a civilian was first to set foot on the lunar surface. Worden and Shaw, pp. 112.

Those with a more Machiavellian orientation might think that another important motivation was economic in that the dual-use concept permitted tightened political control over the dissemination of such technologies. The United States, for example, aggressively protected its monopoly over other Western nations with regard to space lift and any other space technologies they might develop that potentially competed with U.S. economic interests.[22] For example, the launching of experimental communications satellites built by potential economic competitors was resisted until sufficient political pressure was brought to bear, one example being the French-German Symphonie comsat in 1974. Once that political barrier was broken, space communications technologies could now be sent to orbit by other nations, increasing their competitiveness with the United States. Success there, however, did not change the reality that military security-imposed limitations still affected their usefulness. In effect, these externally imposed technological disabilities distinguished the nonmilitary usefulness of the same technologies from the military—the essence of dual-use.

The impact of the dual-use distinction was very real economically because it imposed restrictions upon the usefulness of several space applications in competition with terrestrial-based competitors. Often discussions of space-based commercial applications ignore the existence of robust and established economic competitors. In fact, those competitors either directly or indirectly have impacted development of space applications. Early U.S. policy regarding comsats was driven by awareness that AT&T (the Bell system) and IT&T sought to dominate the new field of space-based communications. Controlling their monopolistic tendencies was a major factor in U.S. policy. Ironically, the pathway chosen solidified their critical role in the field's future development since the initial satellite linkages were to their phone lines.

Domestic Implications of Dual-Use

Dual-use space applications are, by definition, useful for civilians but their military potential renders their dissemination problematic. Simply put, during the cold war the domestic economic usefulness of such technologies was, as a matter of policy, subordinated to their potential as a threat enhancer for other nations. Therefore, strict constraints were imposed regarding how useful the application could be made or how widely it was disseminated. The universe of dual-use applications has become large and comprehensive, as can be seen in the various lists generated under the Wassenear Arrangement.[23]

22. Roger Handberg, I*nternational Space Commerce: Building from Scratch* (Gainesville, FL: University Press of Florida, 2006), pp. 52–58; Lorenza Sebesta, *The Availability of American Launchers and Europe's Decision "To Go It Alone*," (Noordwijk, The Netherlands: ESA Publications Division, 1996).

23. The Control Lists generated by the Arrangement include: "List of Dual-Use Goods and Munitions List," which is publicly available on their Web site: *http://www.wassenaar.org* (accessed 15 October 2006).

The reality is that the United States has adhered to a much more restrictive view regarding dual-use technologies. Efforts at loosening those restrictions were underway in the 1990s but were partially reversed with regard to exports when allegations were made that China was stealing U.S. secrets.[24] Congressional action in 1998 led to stricter enforcement of existing International Traffic in Arms Regulations (ITAR) by the Department of State rather than the Department of Commerce, which was deemed to be too willing to facilitate expanded international trade by loosening security restrictions. As a result, the United States returned to a policy similar to that during the cold war, when the trend was toward liberalized global trade of such technologies. Global trade in space applications expanded, but with less and less U.S. participation. American fears were that certain nations were stealing U.S. secrets—many with military implications, since the technologies involved were dual-use.

Launch technologies are the obvious dual-use technology; however, policy makers at first did not consider them critical simply because governments, through their militaries, controlled all the missile launch vehicle derivatives. In fact, not until after the Space Shuttle *Challenger* accident in January 1986 did a private launch sector come into view in the United States.[25] This privatized sector flew legacy launch systems received from the government. Internationally, all major launch vehicles have been government-developed and -owned, even when they were spun off in the Arianespace context as a commercial corporation. Development of new launchers or upgrades of existing ones have thus far always been government-funded and ultimately government-controlled.

Efforts at purely private launchers have been more disappointing than successful, and even the successes (or near-successes such as SpaceX's Falcon series) get sucked into the government orbit.[26] As a result, launch technologies did not pose an issue—the U.S. had an effective monopoly over space launch in the West while the Soviets controlled the rest. As launch technology spread in the form of ballistic missiles rather than space transportation, the United States and other nations concerned with weapons proliferation became alarmed at the fact that rogue and other unsavory states could readily acquire such militarily useful technology. Out of that concern arose the Missile Technology Control Regime (MTCR) in 1987 as the mechanism by which the dissemination of such dual-use technology could be regulated. MTCR attracted only limited support initially but its existence has

24. Christopher Cox, *Report of the Select Committee on U.S. National Security and Military/Commercial Concerns with the People's Republic of China*. House Report 105-851, 25 May 1999 (Washington, DC: U.S. House of Representatives); Joan Johnson-Freese, "Alice in Licenseland: U.S. Satellite Export Controls since 1990," *Space Policy* 16 (July 2000): pp. 195–204.

25. Handberg, International Space Commerce, pp. 82–83.

26. The Commercial Orbital Transportation Services (COTS) demonstration program involves up to $500 million for support of the International Space Station using either the Rocketplane Kistler or Space Exploration Technologies (SpaceX) as the supply vehicles.

been used to leverage other nations into compliance. India's attempted purchase of cryogenic upper-stage engine technologies from Russia was derailed because of Russia's need for Western support and investment to support the newly established Federation. The MTCR has not prevented the dissemination of missile technologies but, similar to nonproliferation treaties, has slowed the process. [27]

Comsats

Communications satellites remain the lodestar of commercial space activity since their applications can generate significant revenues while also being militarily useful. Development of the field was dominated at first by the United States, both technologically and organizationally. Establishment of Intelsat was orchestrated to put the United States in the dominant position—it was defined as the monopoly over international satellite-based communications. In the early years, U.S. satellite manufacturers were favored, but once that monopoly was broken by the Europeans the United States argued that no comsat could be launched that operated outside the purview of Intelsat or later Inmarsat. In time, that broke down with the Canadian Anik satellites and later with regional systems such as Eutelsat and Arabsat, and finally in the commercial comsat vendors, the first being PanAmSat. The opening up of the comsat market made direct broadcast service (DBS) available, which individual consumers or groups can access directly without going through the gateways of the Intelsat system.[28] In addition, comsat companies became increasingly international in their ownership, which restricted U.S. ability to control communications in and out of certain nations. The international nature of these corporations made them less responsive to U.S. demands, although access to U.S. markets could be denied in retaliation.

In dual-use terms, comsats are available to an even wider group of users, including nations that the United States does not wish to have such access. For comsats, the dual-use argument was weaker and has largely been discarded except by the United States, since the idea of globalization implies and translates into more and more access to the worldwide communications net (never mind the World Wide Web, which is in fact a minor part of it). Proliferation of comsats and their methods of operation have completely undermined U.S. efforts at control since the United States no longer controls the manufacture or launch of such spacecraft. The Europeans are the strongest competitors, but other nations such as Japan and China are developing their manufacturing capabilities.

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27. The standard treatments of U.S. policy regarding Intelsat in the early years can be seen in Joseph N. Pelton, *Global Communications Satellite Policy: INTELSAT, Politics, and Functionalism* (Mt. Airy, MD: Lomond Books, 1974); and Jonathan F. Galloway, *The Politics and Technology of Satellite Communications* (Lexington, MA: Lexington Books, 1972).

28. Ironically, PanAmSat was later acquired by a privatized Intelsat in 2005—a move symbolic of the changed policy environment.

Remote Sensing

The two areas most directly impacted by the dual-use concept are remote sensing and navigation. Clear restrictions were placed on all nonmilitary remote sensing satellites; weather satellites were the major exception, but even there the level of resolution was kept large (i.e., the aperture was kept at the half-mile [kilometer] level or higher rather than at the 3-foot [meter] or less level in order to deny any military usefulness to the images produced). In the late 1960s NASA began looking for space applications that would have social utility; remote sensing was one obvious application because the images produced had great social potential for social purposes, including environmental monitoring in particular.

With the empowerment of the environmental movement in the early 1970s, such a satellite became an obvious route to pursue. The Earth Resources Technology Satellite (renamed Landsat 1) was the result. The fact was that the satellite was deliberately kept less accurate than it could have been, ranging from approximately 131 feet (40 meters) to 246 feet (75 meters) with an approximately 115-mile (185-kilometer) swath depending upon the imager used. The effect was to thwart any attempt at commercialization of the Landsat or equivalent systems. The security-related fear was that a truly commercialized remote sensing approach would allow potential enemies to acquire detailed images at little cost even though they did not own space assets capable of doing the job or any space assets at all.

A series of struggles ensued over the next two decades, reaching their crescendo in the Reagan administration's efforts to commercialize Landsat.[29] That effort failed because, in reality, there was no large commercial market for the images produced—the images had usefulness but their large scale limited what could be observed. On a macro level, the images produced were useful but further advances in Landsat technology were effectively stymied by dual-use considerations. The pictures taken could be manipulated to improve the view, but that was of limited utility despite significant increase in resolution. The reality was that for two decades the remote sensing field was effectively a dead-end in terms of civilian applications. Efforts to open the field to commercial or other players took form in the passage of the Land Remote Sensing Act of 1992.[30] This allowed the entry of commercial interests but did not change the security restrictions, which meant it remained a dead-end until that last part was put in place. The French, with their SPOT Image satellite, were the only international competitor; its images had somewhat greater resolution but also were not considered to be of military significance.

29. For an abbreviated summary of the controversy, see Roger Handberg, *The Future of Space Industry: Private Enterprise and Public Policy* (Westport, CT: Quorum Books, 1995), chapter 4.

30. Pamela E. Mack and Ray A. Williamson, "Observing the Earth from Space," in *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program, Volume III: Using Space*, John Logsdon, ed. (Washington, DC: U.S. Government Printing Office, 1998), pp. 173–176.

This national security dimension weakened in the 1990s as a consequence of two factors, the first Gulf War and the rising U.S. concern about international economic competitors. During the run-up to the 1991 coalition attack on Iraqi forces in Kuwait and Iraq, images from both Landsat and SPOT Image satellites were incorporated into military planning. Their large scale was in fact more useful for some purposes than the images acquired from intelligence satellites, which provided detail but no larger perspective. That usage meant that the security restrictions imposed over the years were in fact less useful than originally thought.

Subsequently, in 1994, the Clinton administration effectively removed any restrictions on the image resolution being sought. That led to an explosion of applications for remote sensing licenses, although economic reality proved much harsher since most applicants lacked the financial resources to make their satellites happen.[31] Ironically, the Department of Defense (DOD) now found this loosening-up to its advantage because the existence of such commercial options meant that the military did not have to build as large a remote sensing fleet as was earlier projected. This became particularly important after the Soviet Union's collapse and the general decline in defense spending (partially reversed after 9/11).

The 11 September 2001 terrorist attack provided evidence as to this new operating environment: for example, in October–December 2001 DOD purchased all Ikonos images of Afghanistan so that others could not gain access. However, the commercial sector remains dependent upon the DOD for its survival given the competition with the aerial surveying industry. Improvements have occurred but delivery of space-based images is still too slow for many customers. Also, the problem of satellite revisit times to take subsequent images still advantages the aerial surveying industry. Further complicating the situation is the existence of a number of international competitors, including the Russians, using military-grade remote sensing data, the French, and, interestingly, the Canadians with their Radarsat system. Clearly, the technology has spread beyond the control of one nation.

Navigation

Navigation represents the clearest example of dual-use applications, since its pedigree was entirely military. What occurs is fairly straightforward; the military are obsessed with knowing their forces' exact location (regardless of the enemy's location). This is particularly true for the Navy, which operates beyond sight of landmarks. Establishing one's position at sea awaited the development of the sextant where one shoots the stars to determine location and accurate clocks. Like a communications satellite, a navigation satellite provides a signal which, when

31. For a broader overview of the global remote sensing market, see John C. Baker, Kevin M. O'Connell, and Ray Williamson, eds., *Commercial Observation Satellites: At the Leading Edge of Global Transparency* (Santa Monica, CA: RAND Corp., 2001).

combined with signals from other navsats, gives one their exact location on Earth's surface. The U.S. Navy pursued such a navsat system first with its Transit system in the 1960s, until the Air Force and Navy combined efforts to build what became known as the NAV GPS system.[32]

Using this combination of radio signals and atomic clocks, the receiver can determine a location on the surface and/or in the air with great exactitude. This application was developed for positioning and search and rescue, although the civilian applications became quickly obvious. For the military, GPS reduced "friendly fire" incidents and other blunders due to the fog of war and facilitated development of GPS-guided munitions, greatly enhancing weapon effectiveness and lethality. The essence of the military transformation hinges on global GPS access.

The degree of precision provided was particularly sensitive because the U.S. military did not want to enhance the ability of America's enemies to find targets employing the same GPS signal. Initially, the United States established two signals (now more)—one very accurate and precise for the military and other authorized users, and a second signal with a deliberate distortion (selective availability, SA) built into that signal.

In response to the shooting down of Korean Airline Flight 007 in 1983 when it strayed into Soviet air space, President Ronald Reagan had ordered the DOD to allow civilian access to the GPS signal. Opening the door to civilian use proved the equivalent to opening Pandora's Box as the military, in time, lost control. Another aspect was that the DOD retained the capacity to completely deny the civilian signal under some conditions due to threat, imminence of war, or actual conflict. This SA function was controversial for non-U.S. users of GPS. Despite the U.S. military's resistance, American and especially Japanese commercial vendors were relatively quickly able to create software that effectively negated the built-in distortion. In fact, the first large military conflict employment of GPS was during the first Iraq war in 1991 when, due to a shortage of military GPS receivers, the United States turned off SA so that commercial receivers given to the troops would work accurately. This decision further dramatized the DOD's waning control over what was becoming a major commercial sector.

Afterwards, the navigation business exploded as more applications were developed that provided even greater precision. One powerful application was the timing function of the navigation satellites (each carries an atomic clock), which is used to control computer networks to allow greater efficiency in moving data across the globe. This enormously increased economic efficiency across large distances in moving information and money transactions. Absolute U.S. control over this critical business resource became a major controversy between the United States and other nations.

32. Handberg, International Space Commerce, chapter 6.

The Europeans, especially, saw SA and DOD control over the turnkey not as security-driven but as further attempts by the American monopolists to protect their economic dominance. The result, after some acrimony, was development of the Galileo satellite radio navigation system as an alternative to the GPS system. This Galileo system, the Europeans say, will not be turned off in a time of military conflict or imminent conflict, although that may not prove out in the long term as the Europeans come to see themselves as becoming more proactive globally, partially replacing the Americans. The DOD's response was initially to reject any change but that view was overridden by President Clinton with the 2 May 2000 removal of distortion from the GPS signal. That decision attempted to forestall the Galileo program or at least make its development proceed more slowly. All such efforts failed, although splits within Europe over various Galileo issues have slowed development. In addition, the Europeans have solicited Galileo participation by non-European nations, including China, a fact that further feeds American concerns.

DUAL-USE AND ITS IMPLICATIONS

The point being made here is simple: dual-use considerations directly and heavily impacted American domestic and international commercial space policy—international considerations are what drive the system even though the major economic impacts occur domestically. Those impacts are the unintended consequences of an American policy generated in an earlier period. No nation has been totally deprived of the capacity to acquire needed space applications because of the U.S. prohibitions, especially in the cases of communications, remote sensing, and navigation (and arguably rocket technology). The reality is that these restrictions have had more of an adverse impact on the U.S. economy than elsewhere. The United States is creating a bubble around its space commerce efforts by imposing security-driven restrictions that significantly blunt any U.S. efforts at competing economically in the global marketplace.[33]

Over time, the global spread of space technologies has eliminated U.S. capacity to determine to whom and for what uses the technologies will be available. That raises some interesting implications for the broader question of U.S. security policy. As a general policy concept, dual-use embodies several implications, the most significant of which is keeping the United States secure from its enemies by denying them improved militarily useful technology. What has slipped out of U.S. hands

33. The "bubble analogy" arose during the discussions of the original papers at the Societal Impact conference in September 2006; I regret not writing down who the author of the phrase was at that time. It is used here as shorthand for the isolation of American space industry from the global marketplace due to security restrictions. In other contexts, Joan Johnson-Freese has written and spoken extensively on the effects of the 1998 decision to reimpose security restrictions on U.S. technology exports, including space applications.

is the ability to control dissemination due to the multiplicity of players. Take any major space technology and you can find multiple providers outside the United States. This issue arose first in the 1980s when Japan, for example, was deemed more advanced in a number of militarily relevant technologies than the United States. That situation has grown worse. That translates into a situation in which U.S. space industry runs the risk of becoming less competitive and, by extension, falling behind possible military competitors in terms of application quality.

During the cold war there were two central players with their alliances; now there exist multiple combinations of players who may coalesce in opposition to the United States regarding various issues. The key problem is that the instruments through which America military power is exercised are now exceedingly vulnerable. One of the critical lessons learned, fortunately by analogy and not by attack, is that Earth-orbiting satellites are vulnerable to interference either directly through physical attack, or indirectly through manipulation of their operating programs or disruption of their signals. Proceeding along orbital paths, easily predictable by observation, means that satellites cannot hide. In fact, in orbital space, commercial satellites are growing even more vulnerable to disruption. Growing U.S. military dependence on commercial comsats and remote sensing satellites for critical tasks increases their vulnerability to disruption since commercial vendors find no reason to harden satellites or provide other means of protection. The costs are not justifiable for a commercial venture. The GPS system itself is capable of being jammed by any combatant more sophisticated than Iraq—their efforts in 2003 were not successful, but the way is clear.

The dual-use concept represented one effort at delaying American vulnerability to nations equipped with equivalent military technologies; the economic motivation has persisted even though the security justification has lost its potency. Both have lost their persuasiveness, especially the latter; American companies are now effectively excluded from many international economic opportunities regarding use of space technologies—strong, technologically sophisticated competitors are taking increasing market share in the different sectors of space commerce. The difficulty is that for the United States, change demands a rethinking of what is to be accomplished using space applications. Previously, U.S. policy was to bind others to the United States through security and economic ties, with the latter thought to be the more lasting. Those days are gone. Space history has seen the relative (not absolute) decline of American dominance with the entry of the Russians and the formerly excluded Chinese into the field, along with the rise of the Europeans and others to increasing prominence.

CONCLUSION

Dwight Eisenhower, along with others, effectively fabricated the dual-use concept to solve certain political problems that he otherwise felt would spin out of control. To that end, Eisenhower was successful and dual-use became embedded in U.S. policy thinking, although initially its implications were not entirely clear if the international environment were to change. Over time, the earlier question of security faded in intensity but not out of existence. The emergence of China as a potential rival led to an intensification of dual-use concerns, with the economic component much more publicly muted. Ironically, the result is that China has not been delayed by U.S. actions; the larger effect has been to severely cripple American space industry competitiveness more by inadvertence than by design. The two are now not mutually supportive, as in the beginnings when dual-use allowed the pursuit of American security and economic interests simultaneously. In a world of global economic competitions, balancing the values of economic competitiveness and security is no longer as simple or clear as before.