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BACKGROUNDER

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American Missile Defenses and China's Wayward Space Lab: How Much Danger Does Tiangong-1 Reentry Pose?

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Abstract

Sometime in spring 2018, the Chinese space station Tiangong-1 will re-enter the atmosphere. Exactly when—and where—is unclear, and could be dangerous. It is also unclear how much control the Chinese have over Tiangong-1. It is possible that Beijing, if unable to control the spacecraft, would cooperate with the U.S. and other countries in mitigating its effects. In that case, the United States and other nations could provide additional space tracking data. If China does not, or cannot, provide information about its ability to control the space lab's final trajectory, and if it has no national contingency plans on mitigating any possible damage, the United States and its partners should make clear that they will safeguard human life, and also protect their national security.

Sometime in the next several weeks, the Chinese space lab Tiangong-1 will re-enter the atmosphere. The uncertainty of just when this 8.5-ton spacecraft will re-enter reflects the remarkable possibility that this reentry is uncontrolled. And just as it is unclear *when* it will re-enter, it is also unclear *where* it will do so. Although the likelihood is high that it will be over water (if only because most of the Earth's surface is covered in it), that will be small comfort should it come down over a populated area.

China's Manned Space Program

The People's Republic of China (PRC) has expressed interest in manned space flight since the earliest days of the Space Age. Efforts relating to manned space were incorporated in 1986 into Plan 863, the national investment plan for high technology. The PRC's current

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Key Points

- In the next several weeks, the Chinese space station Tiangong-1 will re-enter the atmosphere. Exactly when—and where—is unclear, and could be dangerous. It is unclear how much control the Chinese have over Tiangong-1.
- It is possible that Beijing, if unable to control the spacecraft, would cooperate with the U.S. and other countries in mitigating its effects. China, after all, has been testing missile defense capabilities—and Beijing may choose to employ them to break up its space lab. In that case, the United States and other nations could provide additional space tracking data.
- If China does not, or cannot, provide information about its space lab's final trajectory, and if it has no national contingency plans on mitigating any possible damage, the United States and its partners should indicate that they will act in a manner consistent with safeguarding human life, and also protect their national security and safety.

manned space program, Project 921, took shape in the late 1980s. In 1988, several hundred Chinese specialists began to winnow a variety of possible designs down to two rival approaches: a space shuttle–type craft and a more traditional space capsule design.

In 1989, the merits of the two different designs were debated. The capsule design ultimately won, thanks in part to the political support of leading Chinese scientist Qian Xuesen and in part because of the recognition that China's technological foundations at the time were inadequate for pursuing the more advanced space shuttle approach.[1] In July 1989, Chinese technical leaders decided that any near-term Chinese manned space effort would pursue a space capsule design. A year later, a design review for the spacecraft was apparently completed.[2]

Before the manned space program could proceed, however, China's top political leaders had to give their permission for the then-unprecedented expenditure of billions of renminbi.[3] Premier Li Peng declared:

> Money is a difficult issue. However, for a major nation such as ourselves, it is a resolvable issue. If we are to engage in "manned aerospace," then let us begin with a space capsule. Strive to achieve manned flight by the 50th anniversary of the founding of the nation! The "Gulf War" warns us that, in order to maintain great power status, one must have a certain level of real power. Although we cannot engage in an arms race with the United States, in some areas, we must engage. If our nation is to engage in space capsules, we should start from our own roots![4]

Nonetheless, the amounts were so enormous that it was recognized that proceeding would affect the Chinese Communist Party, as well as the nation and the people. Consequently, according to Chinese sources, all of the members of the Central Special Committee, established to help determine the policies associated with the program, as well as the aerospace leading small group, had to sign the minutes.[5]

On September 21, 1992, the Standing Committee of the Politburo of the Chinese Communist Party, the true governing authority of the PRC, approved the proposal regarding manned spaceflight. Interestingly, Yang Shangkun, president of China, observed that, without a new mission, such as the "two bombs, one satellite" program, there was a real risk that there would be insufficient new blood to succeed the older generation of designers and chief scientists. With that, China's manned space program proceeded into high gear.

By the end of the 1990s, China had launched its first Shenzhou space capsule. This was followed by a series of additional unmanned test shots. In 2003, China launched Shenzhou-V, China's first manned mission, with Lieutenant Colonel Yang Liwei. Colonel Yang orbited the Earth 14 times during his 22 hours in space. Subsequent manned missions followed, approximately one every other year, with China launching a two-man crew and then a three-man crew. In 2012, Chinese astronauts docked with the Tiangong-1, their first manned docking mission (and first mission with a female Chinese astronaut). China has since conducted two other manned missions, one docking with Tiangong-1, the other with the Tiangong-2 space lab.

The Tiangong Space Lab. If China was going to devote such resources to its manned space program, it would not be for a mere handful of missions. Instead, the Chinese have made clear that they are interested in supporting a sustained manned presence. This, in turn, would necessitate a space habitat of some sort since a space capsule is simply too small to allow a prolonged mission. Equally important,

1. Shu Wen, *"Shenzhou-VI" Background and Story* (Beijing, PRC: Chinese Language Press, 2005), pp. 216 and 217, and Zuo Saichun, *Chinese Astronaut Flight Documentary* (Beijing, PRC: People's Publishing House, 2003), p. 34.
2. Shu, *"Shenzhou-VI" Background and Story*, p. 217.
3. $1 = 5.514 RMB in 1992. Zuo Saichun, *Chinese Astronaut Flight Documentary* (Beijing, PRC: People's Publishing House, 2003), p. 37.
4. Zuo Saichun, *Chinese Astronaut Flight Documentary* (Beijing, PRC: People's Publishing House, 2003), p. 37.
5. One source suggests that the minutes of the meeting where Li Peng demanded signatures was for the Fifth Meeting of the Central Special Committee, held on January 8, 1992. Zuo Saichun, *Chinese Astronaut Flight Documentary* (Beijing, PRC: People's Publishing House, 2003), p. 43. Two of the other sources used here state that this occurred at the Seventh Meeting of the Central Special Committee, which was held on August 1 of 1992. Shu, *"Shenzhou-VI" Background and Story*, p. 220, and Shi Lei et. al., *Launching the Shenzhou* (Beijing, PRC: China Machine Press, 2003), p. 11. Given the Chinese method of project nomenclature, it would seem more likely that the January 1992 meeting was seen as more significant.

China would need to practice docking of spacecraft if it wanted to sustain a presence in Earth orbit or to go to any other celestial body, whether the Moon, Mars, or beyond. Consequently, China had to develop a counterpart to its Shenzhou spacecraft, to practice docking maneuvers.

While China has announced its intention of deploying a space station (*taikong zhan*; 太空站) comparable to the 1970s-era American Skylab, it does not currently have a booster capable of supporting such a payload. (Skylab weighed about 85 tons.) So, in the interim, the Chinese developed the Tiangong space labs (*kongjian shiyan shi*; 空间实验室)—much smaller habitats that could support shorter duration missions.

The Tiangong-1 was launched in September 2011. It is comprised of two modules:

- **Resource module.** This section has the craft's solar panels and engines.

- **Experimental module.** This section contains crew quarters. Interestingly, on three-man missions, one Chinese astronaut stayed on the Shenzhou spacecraft, apparently due to space constraints.

Soon after launch, the Chinese conducted an unmanned docking mission, the Shenzhou-VIII mission. It safely tested the various docking components on both the Shenzhou and Tiangong spacecraft. This was followed in June 2012 by the Shenzhou-IX mission, China's first manned orbital docking, and then Shenzhou-X a year later, marking the shortest interval between Chinese manned missions. Both Shenzhou-IX and Shenzhou-X had three-person crews (including one woman on each mission).

The PRC decided to keep the Tiangong-1 station in orbit, despite having apparently completed its planned tasks by the end of 2013. Foreign observers began to question whether the Chinese authorities had, in fact, retained control over the spacecraft, noting that its last orbital maneuver appeared to be in December 2015.[6] On March 21, 2016, the Chinese state-owned press reported that the Tiangong-1 "terminated its data service."[7] In a subsequent *note verbale* to the United Nations in Vienna (where the U.N. Office of Outer Space Affairs is located), the Chinese officially noted that the Tiangong-1 had ceased functioning on March 21, 2016. Unfortunately, none of these statements provides any indication as to whether the Chinese retain any control over the spacecraft.

Subsequent Chinese statements suggest that there is a fundamental conceptual difference between how they and others understand "control." Chinese scientists have insisted that the Chinese space authorities are maintaining close monitoring (*jiankong*; 监控) of the spacecraft. They have also noted that they are providing regular updates of the orbital status and that the spacecraft is maintaining its altitude (*zitai wending*; 姿态稳定). This is somewhat different from actually maintaining control over the craft, or being able to control its descent (although Chinese officials also note that the craft will enter a pre-designated ocean area).[8]

While the latter statement is meant to be reassuring, the projected landing zones for the spacecraft indicate that this is by no means a given. The current predictions indicate a potential landing area between 42.7 degrees North latitude and 42.7 degrees South latitude. While this avoids most of North America, Europe, Russia, and China, it nonetheless covers Iran, India, much of Central and northern South America, and Australia.

Policy Implications

As outer space becomes more crowded, proper management of end-of-life for satellites and spacecraft will become more pressing. While many of the newer satellites are "micro-satellites," whose mass will almost certainly disintegrate during reentry, there are a range of larger bodies, including satellites the size of Greyhound buses, which may not do so. China, as noted earlier, has the Tiangong-2 space lab already in orbit.

Under the 1972 Convention on International Liability for Damage Caused by Space Objects, common-

6. Aerospace Corporation, "Tiangong-1 Reentry," http://www.aerospace.org/cords/reentry-predictions/tiangong-1-reentry/ (accessed March 22, 2018).
7. "China's First Spacelab Tiangong-1 Ends Data Service," Xinhua, March 21, 2016, http://www.xinhuanet.com/english/2016-03/21/c_135209671.htm (accessed March 21, 2018).
8. "Will 'Tiangong-1' Crash Into the Earth? Experts: It Will Not Harm Any Land," *Science and Technology Daily*, January 8, 2018, in Chinese, http://news.sina.com.cn/c/nd/2018-01-08/doc-ifyqkarr7834476.shtml (accessed March 21, 2018).

ly known as the Space Liability Convention, states bear responsibility for any object that is launched from their territory. Thus, a satellite, space station, or any other object launched, for example, from the United States, which causes damage, including upon reentry, is the responsibility of the United States, and Washington is liable for any damages that might result. Applied to the case of the Tiangong-1, launched from the Jiuquan Satellite Launch Center in China, any damages are the responsibility of the PRC.

That China is responsible for any damages, however, ignores the question of how to avoid incurring those damages in the first place. While the Chinese authorities hope that the Tiangong-1 will disintegrate during reentry, their apparent inability to establish telemetry with it means that they have no control over it. This, in turn, means that they may not be able to assure that it lands at sea, or away from human habitation.

Should the Chinese determine that the craft will, in fact, land in a dangerous manner, it would be their responsibility to prevent that from occurring. Moreover, as a Chinese spacecraft, it is sovereign Chinese property, and therefore, no action against it is likely to be countenanced without consultation and ideally the permission of the Chinese government. The exception would be a "state of necessity." Should there be a threat to the lives of citizens or a need to prevent serious damage to the natural environment, then "a state of necessity" would justify unilateral action to avoid those consequences.

Beijing, however, has generally been opaque about its space program, and even in this situation it has provided little information. Chinese officials have provided no indication that they know precisely when or where the spacelab will re-enter the Earth's atmosphere, nor have they provided any evidence that they can control the spacecraft's movement. Past Chinese handling of sensitive information, such as the outbreak of SARS, and virtually all information about their space program (such as how much they spend on it) suggest that preserving secrecy trumps any effort to gain international cooperation.

It would therefore behoove the United States and its allies, to consider steps to mitigate the effects of an uncontrolled reentry, to prepare for the possibility of a "state of necessity," that is, in case of a threat to their territory or population. This should ideally be undertaken in cooperation with the PRC. Western governments should request, through bilateral and multilateral channels, information that might be useful to assess the risk of Tiangong-1's reentry jeopardizing their populations and territory. Should the PRC fail to respond to such requests, Beijing has less basis to protest any actions that might be undertaken, should it become necessary to avert danger to territory or citizens.

Project Burnt Frost: A Precedent? In 2008, a defunct U.S. spy satellite, US193, was expected to reenter the Earth's atmosphere. On board was more than 1,000 pounds of toxic hydrazine fuel. The United States decided to employ the AEGIS anti-missile system and the SM-3 missile to intercept US193. By destroying it before reentry, the fuel would burn up harmlessly. Within two months, firing solutions were developed, and the satellite was successfully destroyed on February 20, 2008, by an SM-3 missile fired from the *USS Lake Erie*.

In sharp contrast to the Chinese 2007 ASAT test, which generated several thousand pieces of debris, much of which remains in orbit, the American interception generated little debris, due to the interception profile. Most of that, moreover, was short-lived, with all debris reentering Earth's atmosphere (and burning up) within 40 days.[9]

Of course, while US193 failed to function, its orbit was better defined. Moreover, because of timely decisions to act, there were months available to develop the firing solution and make any necessary modifications in associated software and hardware. Neither such feature may be available regarding Tiangong-1.

Policy Recommendations

Nonetheless, given the developing situation, the United States and its partners need to prepare for the possibility of mitigating the situation. It is also important to establish and promulgate policies to encourage responsible space behavior. The U.S. and its allies should:

- **Request that the PRC clarify the situation within a defined period.** The United States,

9. Nicole Petrucci, "Reflections on OPERATION BURNT FROST," *Angle of Attack*, March 5, 2017, http://www.airpowerstrategy.com/2017/03/05/burnt-frost/ (accessed March 26, 2018).

along with those states along the Tiangong-1 reentry path, and states capable of providing information and resources to facilitate an interception, should approach the PRC to determine its level of control. Since the Tiangong-1 is sovereign Chinese property, but also China's responsibility under the Space Liability Convention, China should be asked to provide information about exactly where and when the lab will reenter the Earth's atmosphere and where it will likely impact. It is China's responsibility to provide such information to the best of its ability. At a minimum, it should provide confirmation of whether it had control over Tiangong-1 and can determine where and when it will re-enter—this is not an area where it can reasonably claim classification or security requirements.

Moreover, given the limited time available, a time limit should be placed on when China will provide that clarifying information. China should not be allowed to procrastinate or otherwise delay a response to a point where no response is possible. (It is quite likely that there is insufficient time as it is.)

- **Request that the PRC provide information on how it intends to mitigate the situation.** Should the Chinese-provided information credibly indicate that reentry will be over the ocean or an unpopulated area, then all is well and good. Should it suggest an impact over land, however, and especially over populated areas, then China has the responsibility for mitigating the situation, including how it intends to prevent its spacecraft from causing damage or loss of life. It is possible that Beijing can establish control over its wayward lab, but if not, Beijing must inform the international community of this situation.

- **Plan a response with or without China.** It is also possible that Beijing, if unable to control the spacecraft, would cooperate with the United States and other countries in mitigating its effects. China, after all, has been testing missile defense capabilities—and Beijing may choose to employ them to break up its falling space lab. In that case, the United States and other nations may be able to assist the Chinese by providing additional space tracking data.

But if China cannot or will not provide information about its space lab's final trajectory, and if it has no national contingency plans for mitigating any possible damage, the United States and its partners should indicate that they will act in a manner consistent with safeguarding human life and also protect their national security and safety. In particular, any state that might be within the projected impact zone should be able to request the assistance of the United States or other states to intercept the spacelab. Given the mobility of the American missile defense system (AEGIS), it may be possible to deploy AEGIS cruisers and destroyers with suitable software and modified missiles to intercept the errant Tiangong-1 before it begins its final reentry course. By breaking up the craft into smaller elements, this would minimize the chances of large pieces surviving reentry and injuring or killing people on Earth.

Such a move, again, would ideally occur with the permission of the PRC and the invitation of the affected country or countries. The former is essential, since it is Chinese property, but also because, ultimately, China is liable for the damage that its craft might cause. The target states, on the other hand, also have a sovereign right to defend their territory and safeguard the lives of their citizens. They should be able to invite the United States or other mobile missile defense capable states to provide them with assistance. This is especially the case if China either cannot or will not act to limit potential damage.

- **Push for all states to comply by certain "best practices."** It is unclear whether China has the ability to control the reentry of its Tiangong-1 lab, but there is no reason that this should be the case. States should provide regular updates about space systems that are reaching their end of life and which are expected to re-enter the Earth's atmosphere. Equally important, they should have the ability to determine that final trajectory, meaning both a means of communicating with the system and sufficient fuel to direct its final trajectory. This should be incorporated into the Space Liability Convention, to help ensure that there are fewer future Tiangong-1 situations.

Conclusion

A decision by the United States, in conjunction with allies and affected states, to intercept China's wayward space station—if China refuses to cooperate with other nations in helping mitigate the situation—would help reinforce the sense that states need to undertake space activities responsibly. It would also reinforce the idea that mitigating space consequences can be a multinational effort, especially given the span of potentially affected states. Such a move would also serve to address the entire issue of space defenses, especially in an era of proliferating satellites and capabilities.

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