# AC

## Solvency

#### I affirm: The appropriation of outer space by private entities via military tracking satellites is unjust.

#### Space congestion violates non-appropriation.

Steer ’20 [Why Outer Space Matters for National and International Security, Dr. Cassandra Steer, <https://www.law.upenn.edu/live/files/10053-why-outer-space-matters-for-national-and>, January 8 2020, Dr. Cassandra Steer is a Mission Specialist with the Australian National University Institute of Space (InSpace), and a lecturer at the Australian National University College of Law specialising in space law, space security and international law. Dr. Steer has more than a decade of international experience teaching at universities in Australia, Europe, North America and South America, and brings a comparative perspective to all her research and teaching. Dr. Steer was formerly Acting Executive Director at the University of Pennsylvania’s Center for Ethics and Rule of Law, where her major focus was the design and delivery of a high level international conference on “The Weaponization of Outer Space: Ethical and Legal Boundaries”. Previously she has held positions as Executive Director of Women in International Security - Canada, Executive Director of the McGill Institute of Air and Space Law, and Senior Lecturer at the University of Amsterdam. She has a degree in philosophy (UNSW); a degree in International and European Law, a degree in Dutch Law, and a PhD in International Criminal Law, all from the University of Amsterdam. In 2011 Dr Steer was a Fulbright Scholar at Cornell Law School, and she has been a Visiting Scholar at McGill Faculty of Law, University of British Columbia Law School, and the Universidad Torcuato Di Tella in Buenos Aires.] [SS]

Negotiated during the Cold War between the two competing superpowers, the 1967 Outer Space Treaty (OST)39 is the framework treaty for all space activities. Space had become the newest domain in which U.S. and Soviet competition for technological and political dominance played out. Both States tested nuclear and electro-magnetic pulses in space in the early years.40 Very quickly, both realized that the effects of the tests were impossible to contain or control in space due to the unique physical environment, and that they were bringing under threat their own satellites. Despite their competitive relationship, the two States were willing to negotiate an important series of general principles in what amounts to a constitutional document for space activities. The importance of the OST can be seen in its first two articles. Article I guarantees freedom of access to and use of space for all. Article II establishes the non-appropriation principle: “Outer space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.” But as recent events indicate, although the OST remains important and relevant in terms of providing restraints and limits on State behavior in space, it cannot prevent States from contesting each other’s capabilities in the space environment. This is especially true given the degree to which modern militaries are dependent on space systems for their daily operations during both peacetime and conflict. Space has become a truly contested environment. According to Article IV of the OST, “the Moon and other celestial bodies shall be used…exclusively for peaceful purposes”; the placement of nuclear weapons or other weapons of mass destruction in orbit around the Earth is prohibited; and the establishment of military bases on the Moon or any other “celestial body,” meaning any natural body in space, is prohibited. With the approval of a budget for the new U.S. Space Command, it appears that military contest in space is on the rise, which may bring under threat the “peaceful purposes” principle of the OST. While Article IV may appear to be far-reaching, it should be noted that it does not reserve the use of space itself for exclusively peaceful purposes, which may be an important but disconcerting loophole in years to come. The preamble of the OST does mention that “space” shall be used for “peaceful purposes” but does not reiterate the all-important adjective “exclusively.” It must be remembered, too, that preambles of treaties are not in themselves binding. They do, however, provide context for interpreting the clauses of a treaty.41 Moreover, the general understanding of the meaning of “peaceful purposes” is that it only prohibits aggressive purposes and does not prohibit other military purposes such as intelligence or even defense against an act of aggression.42 In an age of cross-domain warfare, the ability to target or compromise an adversary’s systems and the fear that adversaries may wish to reciprocate have raised tensions. They have also led to changes in domestic space policies and strategies by all key States and to an escalatory cycleof developing counterspace technologies, or a range of ways in which to target or interfere with each other’s space-based assets. In 2018, Secure World Foundation released a report that details the counterspace capabilities of several countries. The report highlights the growing concern for weaponization against space systems as well as the weaponization of space itself.43 Another way in which space may become more contested in the near future is with respect to commercial rights. The non-appropriation principle mentioned above has come under threat recently, as some see a $5 trillion potential in the space resources mining industry. 44 This industry seeks to extract heavy metals for use in computers and smartphones and, more importantly, to mine the base ingredients that will provide energy and water for future human inhabitants of space stations. These companies have lobbied for national legislation because they saw legal uncertainty surrounding their investments due to the OST prohibitions. In 2015, Congress adopted the Commercial Space Launch Competitiveness Act, which in the eyes of many international lawyers breached the OST. 45 The actstates that any U.S. citizen, which includes U.S. registered companies, shall be entitled to “possess, own, transport, use, and sell (any) asteroid resource or space resource obtained in accordance with applicable law,”46 and also promises to protect the landing rights of any U.S. citizen who first lands on an asteroid. Both promises go against the non-appropriation principle and the freedom of use principle. Luxembourg followed suit in 2017 with the Space Resources Act but went a step further, offering similar legal protection to any corporation with a registered office in Luxembourg,47 thus encouraging a kind of “forum shopping.” There is no doubt that in the near future a legal regime will be needed to support this new industry. However, the steps taken by the United States and Luxembourg have only served to create an even more contested legal environment. The race to access precious resources in space is not only commercially driven; it also is competitive between nation States. In January 2019, China was the first country to successfullyland a rover on the dark side of the moon.48 The Japanese space agency JAXA successfully landed a probe on an asteroid twice in 2019 to collect and analyze subsurface materials. 49 And recently, a spacecraft built by Israeli company SpaceIL crashed upon reaching the moon, which may have been a disappointment to the company and to the nation of Israel. Reaching the moon was an achievement, however. The Israeli Space Agency was providing technical support and is already making plans with SpaceIL for the next attempt.50 While these activities are ostensibly benign and done in the name of scientific exploration, there is historically a high risk of conflict whenever this kind of competition for resources and technological advancement exists. As human activity extends into space, we must recognize this risk and seek ways to regulate our own behavior. c) Space is competitive Space mining is still a technology that is a few decades from being realized. But there are some companies specializing in all things space that have become household names such as SpaceX, Blue Origin, and OneWeb. Although Elon Musk’s company may be most famous for claiming to take us to Mars in the next decades, SpaceX has already pushed many former technological limits in important ways. In 2018, SpaceX successfully launched the Falcon Heavy rocket,51 the largest operational rocket today. This rocket will be able to carry many more satellites in a single launch mission than any competing rocket system, and SpaceX already has a contract to shuttle cargo and soon people to and from the International Space Station (ISS).52 This is important because commercial entities have a much higher risk profile than governments and are able to push the boundaries of technology much faster. Until recently, the United States was paying Russia millions of dollars per launch to shuttle its astronauts and supplies to and from the ISS. Now, a commercial company registered in the United States may soon be doing thatThe competition created by these advances in technology has a positive upward spiral in terms of what is becoming possible in space travel. Both SpaceX and Blue Origin, SpaceX’s main competitor, have been successful at testing launch vehicles that can launch then re-enter Earth’s atmosphere, land at a designated point, and be used again for multiple space flights.53 Falcon 9 will purportedly be able to launch 10 times without any refurbishment.54 This is an incredible feat, and one that redefines what is possible for rocket and spacecraft design. Currently we discard every single rocket and spacecraft that is suitable for human spaceflight after a single flight—the equivalent of discarding every airplane after a single use, except that the costs are much higher. If commercial entities can use a single rocket for multiple flights and to push technological limits in satellite systems, satellite tracking, and human spaceflight, governments may be more inclined to outsource both their civil (NASA) and military space programs to these entities. This makes space a highly competitive sector and brings with it a range of complex issues when it comes to national security and international law, as discussed below in Section III. Beyond these major players, there is an increasing number of commercial entities entering the space market today with offers of services to governments and individuals that are used every day, adding to the competition in space. TV broadcasting, telecommunications, and Internet remain traditional competitive commercial sectors that are dependent on space-based technologies. The most commercially valuable orbits for these services are geostationary, meaning that a satellite orbits the Earth at 36,000km altitude, at the same rate as the spin of the Earth, so that it appears to be stationary above one point on the ground. But the number of orbital slots is limited. Remember that objects are moving at a very high speed in orbit, so this is not about how much “space” there is in space to fill with satellites but rather about how many slots can be assigned within an orbital trajectory to ensure that space traffic management is possible and that the signals being sent from each satellite do not interfere with each other. This is the work of ITU, described above. However, ITU’s task will become even more complicated in the near future, as commercial players such asOneWeb,55 Starlink,56 and others prepare to launch constellations of hundreds or even thousands of satellites in LEO to provide a similar kind of continual Internet or television coverage as those larger satellites in GEO. Lower costs of required technology and the need to launch into GEO result in new competitors to the traditional players that have dominated GEO and new challenges for ITU as well as for space traffic management in general. Beyond these traditional services, more complex services have become critical to our 21st century existence. This includes monitoring climate change, including weather forecasting, multispectral imaging of crops, disaster relief, and ocean temperatures and currents, as well as monitoring the rate of polar ice cap melts. More complex space-enabled defense technologies have also become integral to defense operations, such as missile detection, hypersonics, Radio Frequency interference, protected communications, GPS-guided weapons, and many other precision timing activities. With this increase in space-based services, access to and use of the most valuable orbital slots have become more competitive. Because not all countries have the wherewithal to develop space programs, not all countries have equal access to these commercially valuable orbits and to the technologies offered from space. This may well be in contravention of Article I of the OST, which declares that “outer space…shall be free for exploration and use by all States without discrimination of any kind.” Moreover: “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 [people] ~~mankind~~.” It is unclear what the legal effect is of the phrase “province of all mankind.” It is an emotive turn of phrase, and it suggests that space is intended to be a global commons. However, it is not a legalterm of art.57 There is, therefore, not much enforceability in this article, which has left some developing countries feeling that they are once again cut out of international competition where the rules are set (and often broken) by the biggest players. For this reason, in 1997 the UN General Assembly adopted the “Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries” (otherwise known as the “Space Benefits” Declaration).58 While General Assembly resolutions are not binding, this declaration represents an important political signal that developing countries are fully cognizant of the competitive nature of space operations, both commercially and militarily, and of the impact upon their economies and their security if they are excluded from these activities. This congestion, contestation, and competition in space explain the recent upsurge of attention towards issues of national and international security in the space domain. Understanding the rising tensions requires consideration of the international legal framework that applies to outer space, as discussed in the next section. III. The Legal Framework Applicable to Military Uses of Outer Space National and international security activities are bound by domestic and international laws, and activities in outer space are no different. There are five core space treaties, all of which were drafted and negotiated within a short period of time, between 1965 and 1979, under the auspices of the UN Committee on the Peaceful Uses of Outer Space (COPUOS): the OST, the Astronaut Agreement (sometimes known as the “Return and Rescue” Agreement),59 the Liability Convention,60 the Registration Convention,61 and the Moon Agreement.62 The geopoliticalconditions of the Cold War are what informed these negotiations as much as the technological advances of the space race, a historical and political factor that needs to be kept in mind. But many other branches of international law apply to activities in outer space and are relevant for space security, as discussed below. A. The Five Core Space Treaties and Public International Law As already mentioned, the OST is a framework treaty provides key general principles and outer limits to behavior in space. The key ones have been discussed above such as nonappropriation principle, the peaceful purposes principle, the freedom of access to and use of space, and the prohibition on the placement of nuclear weapons or military bases in orbit around the Earth or on the Moon. However, it is important to note that Article III of the OST states that activities in outer space “shall be in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security.” Thus the entire body of public international law, including the law of treaties, State responsibility, international environmental law, the law of armed conflict, human rights law, and any other branch of international that may have relevance in space, is applicable.63 As a result, there are clear legal restraints on military activities in outer space based on the legal restraints applicable in any other domain.

#### If only wealthy elites can tap the vast resources of outer space, we lock in a permanent and unconscionable inequality. Private space colonization amounts to unchecked exploitation and authoritarian corporate control of future settlements. Spencer ‘17

Spencer, Keith A. [senior editor at Salon]“Against Mars-a-Lago: Why SpaceX's Mars Colonization Plan Should Terrify You.” Salon, Salon.com, 7 Jan. 2020, https://www.salon.com/2017/10/08/against-mars-a-lago-why-spacexs-mars-colonization-plan-should-terrify-you/.

When CEO Elon Musk announced last month that his aerospace company SpaceX would be [sending cargo missions](https://www.washingtonpost.com/news/the-switch/wp/2017/09/29/elon-musk-says-his-next-spaceship-could-not-only-take-to-you-the-moon-and-mars-but-from-n-y-to-london-in-29-minutes/?utm_term=.85279aa2076a) to Mars by 2022 — the first step in his tourism-driven colonization plan — a small cheer went up among space and science enthusiasts. Writing in the New York Post, Stephen Carter [called](http://nypost.com/2017/10/07/elon-musks-inspiring-vision-for-reaching-mars-and-the-stars/) Musk’s vision “inspiring,” a salve for politically contentious times. “Our species has turned its vision inward; our image of human possibility has grown cramped and pessimistic,” Carter wrote: "We dream less of reaching the stars than of winning the next election; less of maturing as a species than of shunning those who are different; less of the blessings of an advanced technological tomorrow than of an apocalyptic future marked by a desperate struggle to survive. Maybe a focus on the possibility of reaching our nearest planetary neighbor will help change all that." The Post editorial reflected a growing media consensus that humankind’s ultimate destiny is the colonization of the solar system — yet on a private basis. American government leaders generally agree with this vision. Obama egged on the [privatization of NASA](http://blogs.discovermagazine.com/80beats/2010/02/01/obamas-nasa-budget-so-long-moon-missions-hello-private-spaceflight/) by legislating a policy shift to private commercial spaceflight, awarding government contracts to private companies like SpaceX to shuttle supplies to the International Space Station. “Governments can develop new technology and do some of the exciting early exploration but in the long run it's the private sector that finds ways to make profit, finds ways to expand humanity,” [said](http://www.theregister.co.uk/2012/03/08/nasa_private_space_nasa/) Dr. S. Pete Worden, the director of the NASA Ames Research lab, in 2012. And in a Wall Street Journal [op-ed](https://www.wsj.com/articles/america-will-return-to-the-moonand-go-beyond-1507158341?mod=e2fb) this week, Vice President Mike Pence wrote of his ambitions to bring [American-style capitalism to the stars](https://www.salon.com/2017/08/06/tacoma-the-next-video-game-from-gone-home-creators-imagines-the-gig-economy-in-space/): “In the years to come, American industry must be the first to maintain a constant commercial human presence in low-Earth orbit, to expand the sphere of the economy beyond this blue marble,” Pence wrote. One wonders if these luminaries know their history. There has be no instance in which a private corporation became a colonizing power that did not end badly for everyone besides the shareholders. The East India Company is perhaps the finest portent of Musk’s Martian ambitions. In 1765, the East India Company forced the Mughal emperor to sign a legal agreement that would essentially permit their company to become the de facto rulers of Bengal. The East India Company then collected taxes and used its private army, which was over 200,000 strong by the early 19th century, to repress those who got in the way of its profit margins. “It was not the British government that seized India at the end of the 18th century, but a dangerously unregulated private company headquartered in one small office, five windows wide, in London, and managed in India by an unstable sociopath,” [writes](https://www.theguardian.com/world/2015/mar/04/east-india-company-original-corporate-raiders) William Dalrymple in the Guardian. “It almost certainly remains the supreme act of corporate violence in world history.” The East India Company came to colonize much of the Indian subcontinent. In the modern era, an era in which the right of corporations to do what they want, unencumbered, has become a [sacrosanct](https://www.salon.com/2017/09/19/trumps-interior-secretary-on-national-monuments-sell-em-and-strip-em/) [right](https://www.salon.com/2016/12/15/exxonmobil-ceo-and-trump-pick-rex-tillerson-my-philosophy-is-to-make-money_partner/) in the eyes of many politicians, the lessons of the East India Company seem to have been all but forgotten. As Dalrymple writes: Democracy as we know it was considered an advance over feudalism because of the power that it gave the commoners to share in collective governance. To privately colonize a nation, much less a planet, means ceding governance and control back to corporations whose interest is not ours, and indeed, is always at odds with workers and residents — particularly in a resource-limited environment like a spaceship or the red planet. Even if, as Musk suggests, a private foundation is [put in charge](https://www.jacobinmag.com/2017/02/mars-elon-musk-space-exploration-nasa-colonization) of running the show on Mars, their interests will inherently be at [odds with the workers](http://www.dailykos.com/story/2015/5/5/1372730/-Skylab-and-the-Sit-Down-Strike-in-Space) and employees involved. After all, a private foundation [is not a democracy](https://www.jacobinmag.com/2015/11/philanthropy-charity-banga-carnegie-gates-foundation-development); and as major philanthropic organizations like the Bill and Melinda Gates Foundation [illustrate](https://www.jacobinmag.com/2015/11/philanthropy-charity-banga-carnegie-gates-foundation-development), often [do the bidding](http://www.peterfrase.com/2011/08/the-decay-of-the-capitalist-class/) of their rich donors, and take an [important role in ripening industries](https://www.salon.com/2016/02/21/corporate_reformers_wreck_public_schools_billionaire_foundations_and_wall_street_financiers_are_not_out_to_help_your_kids_learn/) and regions for exploitation by Western corporations. Yet Mars’ colonization is a bit different than Bengal, namely in that it is not merely underdeveloped; it is undeveloped. How do you start an entirely new economy on a virgin world with no industry? After all, Martian resource extraction and trade with Earth is not feasible; the cost of transporting material across the solar system is astronomical, and there are no obvious minerals on Mars that we don’t already have in abundance on Earth. The only basis for colonization of Mars that Musk can conceive of is one based on tourism: the rich pay an amount — Musk quotes the ticket price at [$200,000 if he can get 1 million tourists](https://www.recode.net/2016/9/27/13081488/elon-musk-spacex-mars-colony-space-travel-funding-rocket-nasa) to pay that — that entitles them to a round-trip ticket. And while they’re on Mars and traveling to it, they luxuriate: Musk has [assured](http://www.telegraph.co.uk/science/2017/06/21/elon-musk-create-city-mars-million-inhabitants/) that the trip would be “fun.” This is what makes Musk’s Mars vision so different than, say, the Apollo missions or the International Space Station. This isn’t really exploration for humanity’s sake — there’s not that much science assumed here, as there was in the Moon missions. Musk wants to build the ultimate luxury package, exclusively for the richest among us. Musk isn’t trying to build something akin to Matt Damon’s spartan research base in "The Martian." He wants to build Mars-a-Lago. And an economy based on tourism, particularly high-end tourism, needs employees — even if a high degree of automation is assumed. And as I’ve written about [before](https://www.jacobinmag.com/2017/02/mars-elon-musk-space-exploration-nasa-colonization), that means a lot of labor at the lowest cost possible. Imagine signing away years of your life to be a housekeeper in the Mars-a-Lago hotel, with your communications, water, food, energy usage, even oxygen tightly managed by your employer, and no government to file a grievance to if your employer cuts your wages, harasses you, cuts off your oxygen. Where would Mars-a-Lago's employees turn if their rights were impinged upon? Oh wait, this planet is run privately? You have no rights. Musk's vision for Mars colonization is inherently authoritarian. The potential for the existence of the employees of the Martian tourism industry to slip into something resembling indentured servitude, even slavery, cannot be underestimated. We have government regulations for a reason on Earth — to protect us from the fresh horror Musk hopes to export to Mars. If he's considered these questions, he doesn't seem to care; for Musk, the devil's in the technological and financial details. The social and political are pretty uninteresting to him. This is unsurprising; accounts from those who have worked closely with him hint that he, like many CEOs, [may be a sociopath](http://www.businessinsider.com/working-with-elon-musk-tesla-2015-5). Even as a space enthusiast, I cannot get excited about the private colonization of Mars. You shouldn’t be either. This is not a giant leap for mankind; this is the next great leap in plutocracy. The mere notion that global wealth is so unevenly distributed that a small but sufficient sum of rich people could afford this trip is unsettling, indicative of the era of astonishing economic inequality in which we suffer. Thomas Frank, writing in Harpers, once [wrote of](https://harpers.org/archive/2011/11/the-bleakness-stakes/) a popular t-shirt he sighted while picnicking in a small West Virginia coal town: “Mine it union or keep it in the ground.” The idea, of course, is that the corporations interested in resource extraction do not care whatsoever about their workers’ health, safety, or well-being; the union had their interests at heart, and was able to negotiate for safety, job security, and so on. I’d like to see a similar t-shirt or bumper sticker emerge among scientists and space enthusiasts: “Explore Mars democratically, or keep it in the sky.”

## Advantage

#### New, military specific GPS 3F satellites coming.

Strout 1/9 [What will the US Space Force be able to do with its new GPS III variant? By Nathan Strout , January 9 2022, Nathan Strout is the staff editor at C4ISRNET where he covers the intelligence community., <https://www.defensenews.com/battlefield-tech/space/2022/01/09/what-will-the-us-space-force-be-able-to-do-with-its-new-gps-iii-variant/>] [SS]

WASHINGTON — The U.S. Space Force has yet to launch all of the GPS III satellites at its disposal, but work on new, more powerful versions is already underway. New GPS III Follow-on satellites — or GPS IIIF for short — will continue to improve the constellation’s accuracy and protection against jamming. GPS III satellites are already a substantial upgrade to the current constellation, providing three times greater accuracy and eight times better anti-jamming capability than their predecessors. In addition to introducing a new civil signal that is compatible with other navigation satellite systems, the five GPS III satellites on orbit completed the space component of M-code — an even more secure and accurate signal for military use. The Space Force has launched five of the planned GPS III satellites, and three more have been declared “available for launch” but are waiting in storage with prime contractor Lockheed Martin. The remaining two are undergoing testing. The Space Force has a contract with Lockheed for up to 22 GPS IIIF satellites. The service already exercised contract options for seven GPS IIIF satellites, with the most recent award taking place in October 2021, when Space Systems Command issued $737 million to the company for three more satellites. GPS IIIF satellites will be more advanced than their predecessors. Most notably, the new space systems will prove a new Regional Military Protection capability, a steerable M-code signal that can concentrate the effect in a specified region. RMP can provide up to 60 times greater anti-jamming measures, helping ensure soldiers can access critical position, navigation and timing data in contested environments. Other new features include a laser retroreflector array to increase accuracy; an upgraded nuclear detection detonation system payload; and a search and rescue payload. Starting with the third GPS IIIF space vehicle, the satellites will be built with Lockheed’s LM2100 Combat Bus, specifically designed for military use. The company claims its new bus, which will also be used for the Space Force’s next missile warning satellites, will have greater resiliency and cyber protections, more power, and better propulsion. And thanks to a new port option on the LM2100 bus, it could be possible to upgrade GPS IIIF satellites on orbit. The company’s Augmentation System Port Interface essentially works as a USB port for the satellite, allowing the Space Force to launch new payloads into space that can be plugged into the system.

#### Plan is key to stopping cyberattacks on GPS that escalate with devastating impacts.

Graff ’18 [The New Arms Race Threatening to Explode in Space, <https://www.wired.com/story/new-arms-race-threatening-to-explode-in-space/>, Garrett Graff, 6/26/18, Garrett M. Graff (@vermontgmg) is a contributing editor at WIRED and a director at The Aspen Institute. He is the author of the No. 1 national bestseller The Only Plane in the Sky: An Oral History of 9/11. He can be reached at [garrett.graff@gmail.com](mailto:garrett.graff@gmail.com).] [SS]

For decades, America’s satellites had circled Earth at a largely safe remove from the vicissitudes of geopolitics. An informal global moratorium on the testing of anti-satellite weapons had held since 1985; the intervening decades had been a period of post–Cold War peace—and unquestioned American supremacy—high overhead. During those decades, satellites had become linchpins of the American military apparatus and the global economy. By 2007, ships at sea and warplanes in the air had grown reliant on instant satellite communications with ground stations thousands of miles away. Government forecasters relied on weather satellites; intelligence analysts relied on high-­resolution imagery to anticipate and track adversaries the world over. GPS had become perhaps the single most indispensable global system ever designed by humans—the infrastructure upon which the rest of the world’s infrastructure is based. (Fourteen of the 16 infrastructure sectors designated as critical by the Department of Homeland Security, like energy and financial services, rely on GPS for their operation.) Now, Shelton feared, all those satellites overhead had become so many huge, unarmored, billion-dollar sitting ducks. In the decade since China’s first successful anti-satellite missile test, Shelton’s premonition has largely come true: Everything has changed in space. A secretive, pitched arms race has opened up between the US, China, Russia, and, to a lesser extent, North Korea. The object of the race: to devise more and better ways to quickly ~~cripple~~ [hurt] your adversary’s satellites. After decades of uncontested US supremacy, multinational cooperation, and a diplomatic consensus on reserving space for peaceful uses, military officials have begun referring to Earth’s orbit as a new “warfighting domain.” On the ground, the military is starting to retrain pilots, ship captains, and ground troops in fail-safe forms of navigation that don’t rely on GPS—like celestial navigation. The US military must relearn how to fight “unwired” and defend itself in space. “We knew how to do that, and somehow we forgot,” General John E. Hyten, the head of US Strategic Command, said in 2015. When former director of national intelligence James Clapper left office at the end of the Obama administration, he told me that the increasing sophistication of America’s adversaries in space was one of the top three strategic threats he worried about. Clapper’s successor, Dan Coats, warned last spring that “Russia and China remain committed to developing capabilities to challenge perceived adversaries in space, especially the United States.” Since he took office, President Trump has dropped numerous hints of the warnings he’s evidently getting from military and intelligence leaders. During a spring livestream with astronauts aboard the International Space Station, he alluded, obliquely and without context, to the “tremendous military applications in space.” And he has repeatedly floated the idea of creating a new branch of the armed forces specifically for celestial combat—culminating last week with a speech out-and-out ordering the Joint Chiefs of Staff to begin developing plans for a new “Space Force.” But if space is indeed becoming a war-­fighting domain, it’s important to understand the stakes, not just for America’s strategic standing but for the species. A Russo-Sino-American space war could very well end with a ~~crippled~~ [hurt] global economy, inoperable infrastructure, and a planet shrouded by the orbiting fragments of pulverized satellites—which, by the way, could hinder us all on Earth until we figured out a way of cleaning them up. In the aftermath of such a conflict, it might be years before we could restore new constellations of satellites to orbit. Preparing for orbital war has fast become a priority of the US military, but the more urgent priority is figuring out how to prevent it. GROWING UP IN Oklahoma City, William Shelton dreamed of becoming a pilot. He got as far as the Air Force Academy before he discovered his eyes weren’t good enough. So instead he became an astronomical engineer. In 1976 he began serving as a launch facility manager at Vandenberg Air Force Base, the military’s oldest space and missile launch base, perched on the California coast north of Santa Barbara. He arrived just as the Air Force was beginning to understand how crucial space would be to its future: The nation’s first early-warning satellites had been put in orbit with the intention of tracking Soviet missile launches, and satellite imagery was becoming increasingly critical to intelligence gathering. Shelton’s poor eyesight, it turned out, had led him to the center of the Air Force’s new frontier. In August 1990, Shelton, then a young lieutenant colonel, took command of the 2nd Space Operations Squadron in Colorado. When he arrived at his post, the Air Force was busy building a new constellation of satellites—launching new ones from Cape Canaveral in Florida every few months to help fill out what he was told would ultimately be a global system aimed at helping the US improve its navigation and increase the precision of its bombs and missiles. This was the new Global Positioning System, and one of Shelton’s first duties at “2Sops” was to build support and enthusiasm for the new effort. To impress visitors (including the brass), he carried around a demo GPS unit that weighed 10 pounds, cost $3,000, and could tell America’s soldiers, sailors, airmen, and Marines exactly where they were on the surface of the planet. The power of the new system that 2Sops ran was proven faster than anyone imagined. The Gulf War caused a rush of final preparations to get GPS ready for battle. Around 2:30 am on January 17, 1991, GPS-equipped helicopters snuck into Iraq, using the technology to guide themselves through the darkened desert and knock out air defense radars. The first bombing campaign of the war had begun. Reporters marveled at precision-­guided bombs zeroing in on their targets and cruise missiles appearing to turn street corners to hit the right buildings. Shelton had a front-row seat to this transformation. As the technology has improved, so has the precision of GPS. The system originally provided accuracy to within 17 yards; with it, you could pinpoint a specific copse of pine trees. Today, if you’re using a smartphone, it can generally locate an object to within five yards—a resolution fine enough to locate a pair of pine trees within that copse. Soon it could be able to zero in on a pine cone: Research from UC Riverside has demonstrated that the latest tech is reliable to within an inch. And research has shown that 1-millimeter accuracy might be eventually possible—which means that the system could locate an individual seed inside that pine cone. Today, troops on the ground use GPS to navigate foreign streets; drone pilots can program a flight plan from thousands of miles away. And because GPS satellites also house America’s detection system for nuclear detonations, we rely on them to tell us if North Korea launches a nuclear weapon, and to tell our missiles and bombs where to find their targets. “When you look at our American way of war, the strategy is largely underpinned by space assets—navigation, early warning, timing,” Shelton says. And that’s just the military. The creators of GPS probably never intended for the system to become the backbone of daily life, but it has. I visited Colorado while reporting this story and tried to keep tabs on everything I did that relied on GPS. There were the obvious navigational moments—my Uber ride to the airport, my American Airlines flight to Denver, my own Google Maps–guided drive in a rental car to Schriever Air Force Base, outside Colorado Springs. But there were also less obvious instances, like the phone calls I made along the way (cellular networks rely on GPS data to keep their stations synchronized), my stop at the ATM (banks use GPS to track deposits and withdrawals), and the fill-up at the gas station (the credit card system also relies on GPS). Moreover, GPS is no longer the world’s sole geolocating mechanism. Russia, China, and the European Union have now all either deployed or begun working on their own full constellations of navigation satellites, ensuring that they won’t have to rely on the US system. It also means that, in the early moments of a war, it’s a fair bet that satellites—the other guy’s satellites—could be among the first targets. DURING THE COLD War, a US army mountain outpost in the Fulda Gap, the shortest route between East and West Germany, served as an early warning trip wire for a Soviet invasion of Europe. If Russian tanks ever made a surprise attack, NATO planners knew that the soldiers there would likely be the first to find out. Today, the members of 2Sops play a similar role. Deep inside the squat, beige, windowless Building 400 at Schriever Air Force Base—the destination I had plugged into Google Maps during my trip to Colorado—10 people at a time remotely operate the heavenly constellation of GPS satellites that guide Tomahawk cruise missiles to their targets, deliver Lyft passengers to their destinations, and help farmers cultivate their crops. They also watch out for any shocks or attacks on the system. The average GPS operators are in their mid-twenties. During one recent shift, the entire Global Positioning System was being operated by two 19-year-old airmen (who, the Air Force emphasizes, are rigorously trained). Their commander, US Air Force lieutenant colonel Peter Norsky, is in his mid-thirties. Together, they watch over the roughly three dozen GPS satellites, troubleshooting the geolocation system and minding the quirks of each orbiting craft—this one’s damaged solar panels, that one’s balky communications links—as if they were remotely tending a stable full of temperamental horses. As integral as GPS is to daily life, the way it actually works is little understood by most people outside of Schriever Air Force Base. Fundamentally, the function of GPS is to provide the globe with a shared clock. GPS satellites allow phone companies to keep their systems in sync, battleships to chart open waters, and ATMs to time-stamp their transactions by triangulating signals from overhead and measuring how long it takes those signals from different satellites to reach a GPS receiver. Any malfunction in the GPS system threatens to plunge the global economy into chaos. The system works by making daily calculations, employing Newtonian physics and Einsteinian relativity, to minutely tweak the time broadcast from each GPS satellite as it moves through space—the high-tech version of tuning your grandfather clock to within 100-­billionths of a second. Time is, after all, relative; as of January, the time in space was 18 seconds ahead of Earth’s “Coordinated Universal Time,” since space doesn’t recognize the leap seconds that scientists add to terrestrial time to account for the planet’s slowing rotation. Additionally, the time-keeping device on each satellite gives a subtly different reading, the result of variations in their atomic clocks, which tell time by measuring the precise oscillations of an atom. (Some GPS satellites use rubidium atoms, which are highly accurate day to day; some use cesium, which is more accurate over long stretches.) Any malfunction in the GPS system threatens to plunge the global economy into chaos. Fortunately those glitches are rare, but they’re not unheard of. On January 25, 2016, one of 2Sops’ flight commanders, Captain Aaron Blain, was awoken by a call from work in the middle of the night. User reports from around the country suggested that the system’s precision had “wobbled,” making measurements increasingly inaccurate. Blain raced to Schriever in his Ford pickup and found that the constellation’s timing was off by about 13 microseconds. It was an infinitesimal number—over 25,000 times shorter than the blink of an eye—but for the finely tuned GPS it was a yawning crevice. Left uncorrected, the glitch could have ricocheted through the global economy, corrupting not just driving directions but stock trades too. Alongside the rest of his team, Blain worked through the night, chugging Mountain Dew. It took about six hours to locate the problem—a single corrupted measurement—and then individually reset the affected satellites. (Russia’s GPS equivalent, known as Glonass, has suffered even more serious issues. In 2014 it went down for 10 hours, but many Glonass receivers can also use GPS as a backup, so the systemic chaos was limited.) 2Sops averted a benign catastrophe that night, but it seems increasingly worried about what China and Russia are doing up in the heavens, out of sight. It recently doubled the number of airmen who oversee the satellites, so one team can run the GPS constellation while another trains to face worst-case scenarios—what the Pentagon refers to as “a contested, degraded, and ­operationally limited environment.” That is, a space war. IN ONE RESPECT, space is already like a war zone: It’s increasingly shot through with flying shrapnel. By some estimates, there are more than 100 million pieces of debris zipping around in Earth’s orbit. China’s 2007 anti-satellite test is estimated to have created some 150,000 new ones, many too small to be tracked. In 2013, some of those fragments hit a Russian satellite—threatening to add still more debris to the orbital mix. And as commercial ventures like SpaceX and Blue Origin ramp up their space tourism plans, Earth’s orbit is about to get even more crowded with both junk and spacecraft. Scientists say there could be a point at which the density of objects spinning around the planet reaches a threshold—called the Kessler effect—that triggers a runaway cascade of collisions: an entire orbit, in other words, set to Blend. Another tricky thing about space debris is that sometimes it isn’t just debris. A US military program called the Space Surveillance Network carefully tracks and monitors every piece of space junk that’s larger than a softball. That currently amounts to some 20,000 objects—everything from old satellite parts to discarded rocket boosters to a pair of pliers lost during an astronaut’s spacewalk. In 2014, a piece of presumptive space junk known to the US military as Object 2014-28E began to behave strangely. The object, known to be of Russian origin, started to perform complicated maneuvers. “That’s concerning—when you see something that appears to be debris come to life,” Shelton says. Object 2014-28E was, in fact, an autonomous spacecraft capable of veering off course and sidling up to other objects, including American commercial communications satellites. Most Popular White and colored letters scattered on black background GEAR The Best Starting Words to Win at Wordle HARRY GUINNESS Dungeons and Dragons game and pieces laid out on blanket next to rule books CULTURE Tabletop RPG Rule Books Can Be Beautiful and Accessible PEARSE ANDERSON person resting on bed with mobile phone SECURITY 6 Ways to Delete Yourself From the Internet MATT BURGESS Tesla cars parked in rows SECURITY A Teen Took Control of Teslas by Hacking a Third-Party App BRIAN BARRETT ADVERTISEMENT In the years since, Object 2014-28E has been joined by similar space objects of Russian provenance. Analysts fear that they might mark the revival of a Russian program known as Satellite Killer, which was shut down after the Cold War. But it’s difficult, even for US government analysts, to know for certain whether that fear is warranted. The secrecy that surrounds nearly everything space-related makes it hard to assess any adversary’s capabilities. Discerning intentions is especially difficult. “If I wanted to build a satellite that looked very different from its actual mission, that’s not hard to do,” Shelton says. A satellite that maneuvers close to another could be doing a repair job or squaring up for an attack—and it might use the same tools for both. “Small satellites with small grappling arms—they have both military and nonmilitary uses,” says Dean Cheng, who studies China’s military capabilities at the Heritage Foundation. “If I manipulate a satellite’s bits and pieces, I can also rip something out.” The US has also been secretive in developing what may or may not be weapons in space. Last May, the Air Force announced that an unmanned space-shuttle-like vehicle that appears to be classified had completed 718 days orbiting Earth, doing who knows what. As of this May, another OTV was circling the globe, more than 200 days into its mostly classified mission. Todd Harrison, director of the Aerospace Security Project at the Center for Strategic and International Studies in Washington, explains that there are effectively four categories of space weapons: kinetic (aimed at destroying a satellite), nonkinetic (aimed at disabling a satellite without touching it), electromagnetic (aimed at interfering with a satellite’s signals), and cyber (aimed at corrupting the data sent to a satellite). No country can claim sovereignty in orbit. So what counts as an act of territorial aggression? What qualifies as a proportional response? The US tested its own anti-satellite missile in 2008, shooting down an errant spy satellite as it was falling out of orbit. Russia has repeatedly flight-tested a so-called direct ascent weapon, the PL-19 Nudol ballistic missile, which could strike objects in orbit, although it hasn’t conducted a live attack on an orbiting satellite. And in the decade since China shot down its weather satellite in 2007, Beijing has launched multiple ballistic missile tests that extended into orbit. In addition, a trio of Chinese satellites have practiced “close-proximity operations,” similar to those performed by the Russian Object 2014-28E. Anti-satellite weapons form just one part of what China calls shashoujian, or “assassin’s mace” systems, which can be used at the start of an attack to achieve a surprise, decisive advantage over a technologically superior foe. There’s also the growing challenge of cyberattacks on satellites: Chinese hackers have reportedly infiltrated the US weather satellite system, and a Romanian hacker announced that he had accessed the server of one of NASA’s space flight centers. In the past decade, at least two nonmilitary US satellite systems have experienced brief, unattributed glitches tied to hacking attacks. Some actors have begun to exploit the fragility not of satellites themselves, but of the signals they broadcast. By the time the radio signals from a GPS satellite reach Earth from thousands of miles up, they can be easily overridden by a stronger signal broadcast on the same frequency. Simple GPS jammers sell online for $119, but they have a short reach. Militaries appear to be acquiring much more powerful jamming technologies. In 2016, roughly 1,000 planes and 700 vessels at sea reportedly experienced problems with their GPS signals near North Korea, which is believed to have purchased Russian jammers that can be mounted on trucks. Those devices have an effective radius of 30 to 60 miles. The US seems to possess similar technology; a test that went awry near a Navy base in San Diego in 2007 knocked out GPS signals to cell phone network operators for at least two hours. Most Popular White and colored letters scattered on black background GEAR The Best Starting Words to Win at Wordle HARRY GUINNESS Dungeons and Dragons game and pieces laid out on blanket next to rule books CULTURE Tabletop RPG Rule Books Can Be Beautiful and Accessible PEARSE ANDERSON person resting on bed with mobile phone SECURITY 6 Ways to Delete Yourself From the Internet MATT BURGESS Tesla cars parked in rows SECURITY A Teen Took Control of Teslas by Hacking a Third-Party App BRIAN BARRETT More troubling than simple jamming, though, is the rise of “spoofing,” which overrides correct GPS data with a more powerful localized signal that delivers false information to a receiver. In 2013 a team of researchers from the University of Texas at Austin successfully led astray an $80 million yacht in the Mediterranean, overpowering its GPS receivers and sending it onto a new course. The dirty truth about spoofing is that secure channels are no defense against it. “Even our encrypted military GPS receivers can be spoofed,” Harrison says. SHELTON, WHO RETIRED in 2014 after 38 years in the Air Force, lives not far from 2Sops in Colorado; these days he chairs an educational and advocacy nonprofit called the Space Foundation. He still expends a lot of energy worrying about what is happening in the heavens. “We as a nation have been too slow to respond to this threat,” he says. He’s particularly troubled by the failure of the US to procure new space systems. Some GPS satellites are older than the people running them. “Our systems are archaic,” Shelton says. “Because space assets are so expensive, we deploy ‘just enough’; there’s no backup or excess capability.” (The Air Force noted that the GPS constellation consists of more than 30 satellites, which provides some redundancy.) China, by contrast, is investing heavily in its space program, seeing it as a symbol of its growing prominence. As soon as this year, it could land a craft on the never-before-touched far side of the moon. And China’s global navigation satellite system, known as BeiDou, has some capabilities that outmatch even the United States’ GPS. In 2015, China created a new space-­focused military service, known as the People’s Liberation Army Strategic Support Force. Meanwhile, the US relies entirely on Russian rockets to get its astronauts to the Space Station (although NASA has awarded contracts to Boeing and SpaceX to fix that). As Cheng says, “Today China is one of two countries that can put a person into space—and the other country isn’t the United States.” Many of America’s space warriors, as they call themselves, share Shelton’s sense that the US isn’t responding nearly quickly enough to the threat of orbital war. “We needed to be marching faster,” says Deborah Lee James, who served as President Obama’s secretary of the Air Force. “Why aren’t there more space and cyber officers at the top of the Air Force?” Deadly Debris In orbit, trash becomes shrapnel. When objects in space collide—whether by accident or because, say, someone down on Earth has decided to launch a missile at a satellite—it sometimes creates a hail of smaller fragments that fan out across Earth’s orbit. It’s already getting difficult to operate satellites and conduct launches amid all the junk zipping around up there. That’s why, around the world, scientists and engineers are devising ways to pull space junk out of orbit. In April, a SpaceX rocket carried a collection of experimental debris-removal technologies to the International Space Station. During its time in orbit, the satellite will test out nets, harpoons, and drag sails designed to reduce detritus. — Saraswati Rathod 20,000 Pieces of space debris larger than a softball — 500,000 Pieces of debris the size of a marble or larger — 4,300 Number of satellites in space — 72 Percent of satellites that are non­functioning — $1.4 billion Cost of degradation to commercial satellites caused by debris — 2,000 Number of trackable fragments created by the last major satellite collision in 2009 — 160 million Estimated number of pieces of space junk too small to be tracked — Sources: European Space Agency; NASA; Aerospace Corporation Addressing these issues, as James’ question suggests, is not just about throwing money at the space-industrial complex. It involves organizational changes too. The Air Force is building what it calls the nation’s first Space Mission Force, made up of airmen trained to respond to the demands of an orbital war. On the same base as the 2Sops command center, the military has established the National Space Defense Center, which puts representatives from various military and intelligence offices focused on space under a single roof. And the defense authorization bill is full of upgrades to the Air Force’s space-­fighting capabilities, including the creation of an additional Air Force unit responsible for space warfighting operations. Not content to tinker with the Air Force, a growing number of people in Washington—including the commander in chief—have to come to favor creating an entire new military branch dedicated to space operations. In May, during a ceremony honoring West Point’s football team, President Trump told his audience, “We’re getting very big in space, both militarily and for other reasons, and we are seriously thinking of the Space Force.” The comment sounded to many listeners like yet another oddball Trumpian tangent. But then, after reportedly meeting resistance from the Air Force, Trump escalated. At a mid-June meeting of the newly constituted US Space Council, he announced—much to the surprise of his own advisors and the military itself—that he was ordering the Pentagon to move forward. As he said, “I’m hereby directing the Department of Defense and Pentagon to immediately begin the process necessary to establish a Space Force as the sixth branch of the Armed Forces. That’s a big statement. We are going to have the Air Force and we are going to have the Space Force—separate but equal. It’s going to be something.” The Space Force is, of course, not a fait accompli. Any military reorganization has to be approved by Congress—which is not necessarily an easy path. (Last year, a bill that included the creation of just such a new branch of the military passed the US House of Representatives, but that provision was taken out of the Senate version.) And the establishment of a new branch of the military involves a vast set of logistical and structural questions. Yet Trump’s push may speed up a natural evolution toward an independent space branch by years, if not a decade. Space, the president said, was “going to be important monetarily and militarily. We don’t want China and Russia and other countries leading us. We’ve always led.” But where—and to what—are we leading? Part of the challenge in figuring out how to think about space conflict is the sheer complexity of the orbital environment—an arena that has long belonged to nation-states, but that is increasingly becoming a domain of commerce and tourism. How do countries protect their interests up above—and down here? Right now, countries appear to be racing to build their military capabilities—but an arms race isn’t the only answer. The last time an arms race appeared poised to overtake space, the world’s superpowers banded together to sign the 1967 Outer Space Treaty, which banned weapons of mass destruction in space and held that “the moon and other celestial bodies” should be reserved for peaceful purposes. The Outer Space Treaty is still in force, but it is by now full of holes. Legal scholars had a hard time proving that China’s 2007 anti-­satellite test, for instance, violated the agreement. That’s because the missile that China fired was not technically addressed in the 50-year-old treaty. Most Popular White and colored letters scattered on black background GEAR The Best Starting Words to Win at Wordle HARRY GUINNESS Dungeons and Dragons game and pieces laid out on blanket next to rule books CULTURE Tabletop RPG Rule Books Can Be Beautiful and Accessible PEARSE ANDERSON person resting on bed with mobile phone SECURITY 6 Ways to Delete Yourself From the Internet MATT BURGESS Tesla cars parked in rows SECURITY A Teen Took Control of Teslas by Hacking a Third-Party App BRIAN BARRETT Part of what makes space such volatile terrain right now is that it’s hard even to apply the existing laws of war to it. No country can claim sovereignty in orbit, and it’s impossible to occupy territory there. So what counts as an act of territorial aggression? What qualifies as a proportional response? It’s even difficult to say, with certainty, what the physics of war in space will look like. We don’t well understand, for instance, how a kinetic attack on a satellite constellation might spill over into a spiraling Kessler effect. Humans have “millennia of experience in blowing up things on land,” says Laurie Blank, a law professor at Emory University and a specialist in the laws of armed conflict. “We’re still learning the consequences of all these things in space.” Blank recently joined together with an international team of legal experts to create what they’re calling the Woomera Manual on the International Law of Military Space Operations—a kind of rule book for celestial international conflict, one that will endeavor to translate the laws of terrestrial war for space. It’s a daunting task, and the resulting document will be nonbinding. But, Blank says, it’s a necessary first step for anyone who would seek to contain a conflict that has, in some senses, already begun.

#### It’s try or die – new GPS systems make hacking more probable and leads to space war.

Atherton ’18 [GPS III and the demands of a dangerous new space age, <https://www.c4isrnet.com/c2-comms/satellites/2018/12/24/gps-iii-and-the-demands-of-a-dangerous-new-space-age/>, Kelsey Atherton, 12/24/18] [SS]

CAPE CANAVERAL — After an aborted launch Tues., Dec. 18, SpaceX’s Falcon 9 rocket successfully carried its payload into orbit Sun., Dec. 23. With the launch begins the installation of a new constellation of GPS satellites and a looming question over the entire enterprise: Can communications in space be secured by good satellite design alone? “Launch is always a monumental event, and especially so since this is the first GPS satellite of its generation launched on SpaceX’s first national security space mission. As more GPS III satellites join the constellation, it will bring better service at a lower cost to a technology that is now fully woven into the fabric of any modern civilization,” Lt. Gen. John F. Thompson, commander of the Space and Missile Systems Center and Air Force program executive officer for space, said in a released statement. “It keeps GPS the gold standard for positioning, navigation and timing information, giving assured access when and where it matters. This event was a capstone, but it doesn’t mean we’re done. We’re going to run a series of procedures for checkout and test to ensure everything on Vespucci functions as it was designed.” The day the launch was aborted, Vice President Mike Pence announced that the president had signed an order to create U.S. Space Command, a sign that maybe design alone is insufficient for stability in orbit. The memorandum assigns to Space Command, among other responsibilities, “the space‑related responsibilities previously assigned to the Commander, United States Strategic Command.” A Space Command previously existed from 1985 through 2002, when it was reorganized and its responsibilities were folded into Strategic Command. Worth noting, too, is that this is a distinct move from the possible creation of a distinct Space Force as an independent branch. In the meantime, as the administration **debates** how and if it wants to transfer from a subtle to an **explicit militarization** of space, the satellites are going into orbit. GPS III satellites, made by Lockheed Martin, cost $577 million apiece for the first 10. The program’s costs continue to rise, so that unit price may inch upward. Each satellite is over half-a-billion dollars of vital asset, as expense as a half-dozen F-35As. When the Air Force talks about the alternatives it’s developing to GPS constellations, the conversation is often about finding ways to achieve the same effect without the singularly large expensive vulnerable targets. If there is a Plan B for GPS, it might be in clouds of smaller satellites. But GPS III remains Plan A and, for Plan A to work, it has to survive in an increasingly hostile orbit. Here is the threat environment faced by satellites: The United States and China have both destroyed deorbiting satellites of their own with missiles and other nations are developing missiles that might be capable of shooting down satellites. To the extent that a vulnerability to missiles is managed, it is managed by deterrence, the threat of retaliation and the uncontrolled danger that debris in orbit poses to all satellites. Yet it’s the nonkinetic attacks that remain the likely vulnerability and pathway into disrupting the functions of a satellite network. To that end, Lockheed Martin and the Air Force boast that the GPS III satellite has up to eight times improved anti-jamming capabilities, a metric that reveals the threat environment far more than it describes the measures taken against it. Reached for comment, Lockheed Martin decline to comment on what, exactly, was eight-times improved. Adversaries who want to degrade the usefulness of GPS can do so in a variety of ways, and most of them involve obscuring or interfering with the signal. Nations such as Iran and North Korea, as well as expected players China and Russia, have **electronic warfare capabilities** that can interfere with the signals from commercial satellites, though their capability against existing and future military satellites is unknown. Cyber means of satellite interference were demonstrated by the Tamil Tigers in 2007, and other **nonstate actors** may also be able to interfere in a similar way, though one hopes cybersecurity for satellites has improved in the decade since. **Spoofing** signals can also fool GPS receivers into following false and deliberately malicious coordinates. What GPS III’s anti-jamming capabilities acknowledge is that electronic warfare is hardly a terrestrial-only affair. The moves toward a Space Force, a unified Space Command and, even more ominously, an Air Force that declares space a “war-fighting domain” acknowledge the vulnerability of satellites to a variety of means of interference, disruption or destruction poses real security risks to the military narrowly and the functioning of the modern world broadly. What is yet to be determined is if space, like cyber before it, will remain primarily a domain of espionage, surveillance, reconnaissance and electronic warfare, with the satellites regarded as physically inviolate nodes. The alternative is the space becomes a domain for kinetic war fighting, with massive, powerful, **jamming resistant satellites a target for destructive missiles** or other physical means. However it plays out, from the unified Space Command to the launch of GPS III, 2018 marks a change in how the United States views the role of the military in space. What remains to be seen is if the change is durable and how the rest of the world adapts.

#### GPS destruction escalates – nuclear war via miscalc, escalation, and inadverdent escalation.

Acton and McDonald ’21 [Nuclear Command-and-Control Satellites Should Be Off Limits, By JAMES ACTON and THOMAS MACDONALD DECEMBER 10, 2021, <https://www.defenseone.com/ideas/2021/12/nuclear-command-and-control-satellites-should-be-limits/187472/>, James M. Acton is a senior associate in the Nuclear Policy Program at the Carnegie Endowment for International Peace in Washington.] [SS]

When Russia blew up an old satellite with a new missile on November 15, it created an expanding cloud of debris that will menace the outer space environment for years to come. Hypersonic fragments from the collision with Moscow’s ground-launched, anti-satellite weapon risk destroying other satellites used for communications, meteorology, and agriculture. They even pose a danger to China’s Tiangong Space Station and the International Space Station, where personnel—including Russia’s own cosmonauts—were forced to don spacesuits and flee into their escape capsules ahead of approaching debris. But the greatest danger that this careless stunt highlighted is to a different potential target: high-altitude satellites used for nuclear command and control. Those critical satellites face the threat of being attacked by co-orbital anti-satellite weapons, that is, other spacecraft with offensive capabilities. Destroying a nuclear command-and-control satellite, even unintentionally, could lead a conventional conflict to escalate into a nuclear war. As such, the United States, China, and Russia have a shared interest in ensuring the security of each other’s high-altitude satellites. Satellites are integral to the United States’ nuclear command-and-control system. They would be the preferred means to transmit a presidential order to use nuclear weapons and would provide the first warning of an incoming nuclear attack. Russia uses satellites for similar purposes, even if it appears not to rely on them quite as much as the United States. While little is publicly known about China’s nuclear command-and-control system, the U.S. Department of Defense has assessed that China is in the process of developing a space-based early-warning system. The most important nuclear command-and-control satellites—those for communications and early warning—are located in high-altitude orbits. Fortunately, most are strung out about 22,500 miles above the equator—far above the debris from Russia’s ground-launched anti-satellite weapon test. These satellites, however, are growing more vulnerable, particularly to co-orbital anti-satellite weapons. Nuclear command-and-control satellites might be attacked deliberately, as the prelude to a nuclear war. In a conventional conflict, if China, Russia, or the United States decided to use nuclear weapons first—or believed that its opponent was about to do so—it might try to degrade the adversary’s nuclear command-and-control system preemptively. China, for example, might attack U.S. early-warning satellites to weaken the United States’ homeland missile defenses. Conversely, the United States might target Chinese communication satellites to interfere with Beijing’s ability to wield its nuclear forces. In a conventional war, however, nuclear command-and-control satellites might be attacked and threatened for altogether different reasons—creating the risk that nuclear war might be triggered inadvertently. The United States, in particular, is deeply reliant on satellites to enable conventional operations. Moreover, most, if not all, nuclear command-and-control satellites also support nonnuclear missions—making them tempting targets even in a purely conventional conflict. For example, some U.S. satellites transmit orders to both U.S. conventional and nuclear forces. Russia might attack these satellites to try to undermine the United States’ ability to prosecute a conventional war, but with the added and unintended effect of degrading the U.S. nuclear command-and-control system. Washington would be hard pressed to determine the intent behind such attacks. It could easily misinterpret them as preparations for a nuclear war and respond accordingly. It might threaten to use nuclear weapons unless its adversary backed off. In fact, the Trump administration’s nuclear policy explicitly threatened the use of nuclear weapons in precisely this circumstance. The Biden administration can and should remove this threat as part of its ongoing Nuclear Posture Review. To make matters worse, it might not take actual attacks against nuclear command-and-control satellites to spark this kind of escalation. Satellites in high-altitude orbits are periodically moved to different positions to optimize their performance. Especially in a conventional conflict, a repositioning operation that led one spacecraft to approach a nuclear command-and-control satellite might appear to the latter’s owner as the beginning of an attack against its nuclear command-and-control system. Once again, the potential consequences could be catastrophic. “Keep-out zones” around high-altitude satellites would be a straightforward way to mitigate these risks. Specifically, the United States, China, and Russia should agree not to maneuver their spacecraft within a certain distance—we propose 430 miles—of one another’s high-altitude satellites. (Exceptions could be made to accommodate occasional repositioning under tightly controlled conditions. Most importantly, the state conducting the maneuver should warn the others at least 24 hours in advance.) In a conflict, if the belligerents had no intention of attacking each other’s high-altitude satellites, they would have strong reasons of self-interest to respect keep-out zones. If a state did seek to launch such attacks, keep-out zones couldn’t stop it from doing so—but they would buy time that the targeted state could use to try to evade the attack. Negotiating keep-out zones during a conflict, when they would be most useful, would be next-to impossible. So, Washington, Beijing, and Moscow shouldn’t wait—they should start negotiating right away.

#### Space War cause Nuclear War.

Gallagher 15 “Antisatellite warfare without nuclear risk: A mirage” <http://thebulletin.org/space-weapons-and-risk-nuclear-exchanges8346> (interim director of the Center for International and Security Studies in Maryland, previous Executive Director of the Clinton Administration’s CTBT Treaty Committee, an arms control specialist at the State Dept., and a faculty member at Wesleyan)//Elmer

In recent decades, however, as space-based reconnaissance, communication, and targeting capabilities have become integral elements of modern military operations, strategists and policy makers have explored whether carrying out antisatellite attacks could confer major military advantages without increasing the risk of nuclear war. In theory, the answer might be yes. In practice, it is almost certainly no. Hyping threats. No country has ever deliberately and destructively attacked a satellite belonging to another country (though nations have sometimes interfered with satellites' radio transmissions). But the United States, Russia, and China have all tested advanced kinetic antisatellite weapons, and the United States has demonstrated that it can modify a missile-defense interceptor for use in antisatellite mode. Any nation that can launch nuclear weapons on medium-range ballistic missiles has the latent capability to attack satellites in low Earth orbit. Because the United States depends heavily on space for its terrestrial military superiority, some US strategists have predicted that potential adversaries will try to neutralize US advantages by attacking satellites. They have also recommended that the US military do everything it can to protect its own space assets while maintaining a capability to disable or destroy satellites that adversaries use for intelligence, communication, navigation, or targeting. Analysis of this sort often exaggerates both potential adversaries’ ability to destroy US space assets and the military advantages that either side would gain from antisatellite attacks. Nonetheless, some observers are once again advancing worst-case scenarios to support arguments for offensive counterspace capabilities. In some other countries, interest in space warfare may be increasing because of these arguments. If any nation, for whatever reason, launched an attack on a second nation's satellites, nuclear retaliation against terrestrial targets would be an irrational response. But powerful countries do sometimes respond irrationally when attacked. Moreover, disproportionate retaliation following a deliberate antisatellite attack is not the only way in which antisatellite weapons could contribute to nuclear war. It is not even the likeliest way. As was clearly understood by the countries that negotiated the Outer Space Treaty, crisis management would become more difficult, and the risk of inadvertent deterrence failure would increase, if satellites used for reconnaissance and communication were disabled or destroyed. But even if the norm against attacking another country’s satellites is never broken, developing and testing antisatellite weapons still increase the risk of nuclear war. If, for instance, US military leaders became seriously concerned that China or Russia were preparing an antisatellite attack, pressure could build for a pre-emptive attack against Chinese or Russian strategic forces. Should a satellite be struck by a piece of space debris during a crisis or a low-level terrestrial conflict, leaders might mistakenly assume that a space war had begun and retaliate before they knew what had actually happened. Such scenarios may seem improbable, but they are no more implausible than the scenarios that are used to justify the development and use of antisatellite weapons.

#### Sudden disappearance of GPS leads to disaster, famine, etc – but alternatives are possible with time and planning.

Hambling ’20 [By David Hambling 4th October 2020, What would the world do without GPS?, <https://www.bbc.com/future/article/20201002-would-the-world-cope-without-gps-satellite-navigation>,] [SS]

We really would be lost without satellite navigation. But is there anything out there that could replace it? And how might we cope without this ubiquitous system? A loss of satellite navigation for five days would cost the UK alone more than £5.1bn ($6.5bn) , according to an assessment by the London School of Economics for the British Government. A failure of the GPS system would also cost the US economy an estimated $1bn (£760m) a day, and up to $1.5bn (£1.1bn) a day if it occurred during planting season for farmers in April and May. But GPS outages are surprisingly common – the military regularly jams it in certain areas while testing equipment or during military exercises. The US Government also regularly performs tests and exercises that lead to disruption of the satellite signal, but also some technical problems lead to worldwide issues. There are, of course, other global navigation satellite systems available – the Russian Glonass, Europe’s Galileo and China’s BeiDou all work on a similar basis to GPS. But increasingly, interference or deliberate jamming can also lead to interruptions in the signals from satellite positioning systems. You might also like: The clocks that rule our world Why it’s not surprising that ships collide Why north is always at the top of maps “The military are coming up against jamming quite frequently now,” says Charley Curry, fellow of the Royal Institute of Navigation and founder of Chronos Technology, which works in this field. The military has especially good reason to be worried. Satellite navigation was originally developed by the Pentagon, and now guides everything from strategic drones and warships down to individual smart bombs and foot soldiers. And it is under threat. A massive solar storm, one like the Carrington Event of 1859, could bring down the entire GPS satellite network Criminals also use GPS jammers, easily bought online, to foil the systems used to track stolen cars, not caring who else is affected in the surrounding area. And there are bigger dangers. “There is also the remote threat that the whole GPS constellation could be rendered inoperable in the initial salvo of a war targeting the US economy by attacking critical infrastructure,” says Humphreys. Natural forces could be similarly disastrous. A massive solar storm, one like the Carrington Event of 1859, could bring down the entire GPS satellite network as surely as a military strike. But if GPS and its international cousins were to suddenly disappear – what alternatives could we turn to in an attempt to keep all our world moving? One possible backup for GPS is a new version of Long Range Navigation (Loran), which was developed during World War Two to guide allied ships while they were crossing the Atlantic. Instead of satellites, however, it consisted of ground-based transmitters with 200-metre (660-feet) tall aerial masts broadcasting radio navigation signals. While good old fashioned maps can help us find our way, many aspects of our modern lives would cease to function without GPS (Credit: Alamy) While good old fashioned maps can help us find our way, many aspects of our modern lives would cease to function without GPS (Credit: Alamy) At first Loran was only accurate to within a few miles, but by the 1970s it could give a location within a few hundred metres. The UK and other countries decommissioned their Loran transmitters in the 2000s when GPS made them redundant, but a modern, enhanced version, known as eLoran could be as accurate as GPS. It uses more advanced transmitters and receivers than the original version, along with a technique known as differential correction – where the signal is monitored by reference stations and corrected – to improve its accuracy. This enhanced version is reportedly capable of pinpointing locations to an accuracy of less than 10m (32 feet). Unlike GPS, it is also able to penetrate buildings and tunnels – primarily because it uses a lower frequency and higher power than satellite signals. The powerful eLoran signals are much harder to jam and there are no vulnerable satellites. But someone would have to fund it. “eLoran is a great technology that could fill nationwide gaps,” says Humphreys, adding “**if there were a commitment** to setting it up and maintaining it”. Other approaches do not require additional infrastructure. Long before radio, sailors navigated with the aid of the sun and stars, using a sextant to measure the angles between them. Celestial navigation continued into the modern age. And surprisingly enough, ballistic missiles like Trident still use astro-navigation during flight. By using fixes from stars it is possible to pinpoint a location on Earth to within a thousand metres or so. Having large numbers of fast-moving objects to get bearings on means that Skymark can achieve greater accuracy than was possible with slow-moving stars But US company Draper Laboratory has developed a new generation of celestial navigation known as Skymark which uses a small, automated telescope to track satellites, the International Space Station and other objects orbiting the Earth along with the stars. Having large numbers of fast-moving objects to get bearings on means that Skymark can achieve greater accuracy than was possible with slow-moving stars. Skymark uses a database of visible satellites – both working satellites and space junk – and has a claimed accuracy of 15m (49ft), making it almost as good as GPS. At times it is capable of greater accuracy, but this depends on how many of these satellites can be seen at once, says Benjamin Lane, group leader of advanced position, navigation and timing instrumentation at Draper. “The best accuracy for celestial navigation with certainty is within a couple of meters,” he says. “One limitation is the size of the satellite references.” Another drawback is that it only works with a clear view of the sky. Using infrared light rather than visible light, which can pass more easily through haze and light cloud, helps a little, but in parts of the northern and southern hemisphere where thick cloud and grey-skies are more common, it is likely to be less useful. Tracking fast moving satellites like the International Space Station has helped to improve the accuracy of celestial navigation (Credit: Alamy) Tracking fast moving satellites like the International Space Station has helped to improve the accuracy of celestial navigation (Credit: Alamy) Perhaps a more day-to-day option might be inertial navigation, which uses a set of accelerometers to work out the exact speed and direction that a vehicle is travelling in to calculate its position. Basic versions are already in common use. “When your car goes into a tunnel and you lose the GPS signal, it’s inertial navigation that keeps your position updated,” says Curry. The problem with inertial navigation is “drift” – the calculated position gets less accurate over time as errors build up, so the inertial navigator in your car is only useful for short GPS interruptions. Drift could be overcome with quantum sensors thousands of times more sensitive than existing devices. In the quantum world, atoms and particles start to behave as both matter and waves, and acceleration alters the properties of this behaviour. French company iXBlue is using this technique to build a device to rival GPS precision, and a team from Imperial College London, working with laser specialists M Squared, demonstrated a prototype portable quantum accelerometer in 2018. The US Department of Transport is now holding a competition to select possible backups for GPS Such quantum sensors are still confined to laboratories and are years away from a usable end product. Optical navigation, in which automated systems with cameras use landmarks like buildings and road junctions, may be with us much sooner. An early version, known as Digital Scene Matching, was developed for cruise missiles. ImageNav, developed by Scientific Systems for the US Air Force, is a modern optical navigation system for aircraft. It has a terrain database of the area being navigated and matches it with input from video cameras to work out its location. ImageNav has been successfully tested on a number of aircraft, but could also find uses in self-driving vehicles. Swedish company Everdrone also recently carried out the first drone delivery between hospitals without using GPS. Their system uses a combination of optical flow – measuring speed by the rate of which scenery passes below – and landmark identification to find its way from point to point with GPS-like precision. Of course, this method relies on have a complete and accurate image database of the area you are navigating, which is likely to require a lot of memory and frequent updates. Inertial navigation is what takes over when in-car navigation devices lose the GPS signal inside tunnels (Credit: Alamy) Inertial navigation is what takes over when in-car navigation devices lose the GPS signal inside tunnels (Credit: Alamy) The UK is developing a backup system for the timing synchronisation services that GPS provides in the form of The National Timing Centre program, the first such national service in the world. When it becomes operational in 2025, it will involve sets of precise atomic clocks at distributed, secure locations across the UK, providing timing signals via cable and radio services. The idea is that if satellite signals go down, there is no single vulnerable centre that could be brought down by an accident, technical glitch or cyberattack. Ultimately no single system may be able to replace the power of satellite navigation systems such as GPS, and we may end up with a mix-and-match of different solutions for ships, planes and cars. The US Department of Transport is now holding a competition to select possible backups for GPS. There is a real question though over **whether any alternative will be in place soon enough**. “There’s now an awareness of the problem, but things are still moving at glacial speed,” says Curry. We are becoming ever more reliant on accurate navigation. Self-driving cars, delivery drones, and flying taxis are expected to appear on and above our roads over the next decade. All of them will be dependent on GPS. As Curry notes, one person with a powerful jammer in a could knock out GPS across an area the size of London from the right place. Unless adequate backup systems are developed, in the future whole cities might grind to a halt at the flick of a switch. When satellite navigation was jammed at Israel’s Ben Gurion airport last year, only the skill of the air traffic controllers prevented serious accidents. The jamming was apparently accidental, originating with Russian forces fighting in Syria, but it highlighted just how dangerous interruptions to the global positioning system – better known as GPS – can be. “There is a growing recognition of the need to protect, toughen, and augment GPS,” says Todd Humphreys, a communications engineer at the University of Texas, Austin. GPS now underpins a surprising amount of our everyday lives. In its simplest form it tells us where on Earth at any time a GPS receiver is. We have them in our mobile phones and cars. They enable boats to navigate their way through difficult channels and reefs, like a modern-day lighthouse. Emergency services now rely upon GPS to locate those in distress. Less obviously, ports would cease to operate, as their cranes need GPS to find the right container to move, and they play a crucial role in logistics operations, allowing car manufacturers and supermarkets to take advantage of just-in-time delivery systems. Without it, our supermarket shelves would be emptier and prices would be higher. The construction industry uses GPS when surveying and fishermen use it to comply with strict regulations, But GPS is not only about identifying locations, it is also about time. The constellation of 30 satellites held in orbit around the Earth all use multiple, extremely precise atomic clocks to synchronise their signals. They allow users to determine the time to within 100 billionths of a second. Mobile phone networks all use GPS time to synchronise their base stations, while financial and banking institutions rely upon it to ensure trades and transfers occur correctly.

#### GPS is key to predicting and helping in every natural disaster.

Witze ’19 [GPS Is Doing More Than You Thought, By Alexandra Witze, Knowable Magazine on October 30, 2019, <https://www.scientificamerican.com/article/gps-is-doing-more-than-you-thought/>] [SS]

. FEEL AN EARTHQUAKE For centuries geoscientists have relied on seismometers, which measure how much the ground is shaking, to assess how big and how bad an earthquake is. GPS receivers served a different purpose—to track geologic processes that happen on much slower scales, such as the rate at which Earth’s great crustal plates grind past one another in the process known as plate tectonics. So GPS might tell scientists the speed at which the opposite sides of the San Andreas Fault are creeping past each other, while seismometers measure the ground shaking when that California fault ruptures in a quake. Most researchers thought that GPS simply couldn’t measure locations precisely enough, and quickly enough, to be useful in assessing earthquakes. But it turns out that scientists can squeeze extra information out of the signals that GPS satellites transmit to Earth. Those signals arrive in two components. One is the unique series of ones and zeros, known as the code, that each GPS satellite transmits. The second is a shorter-wavelength “carrier” signal that transmits the code from the satellite. Because the carrier signal has a shorter wavelength—a mere 20 centimeters—compared with the longer wavelength of the code, which can be tens or hundreds of meters, the carrier signal offers a high-resolution way to pinpoint a spot on Earth’s surface. Scientists, surveyors, the military and others often need a very precise GPS location, and all it takes is a more complicated GPS receiver. ADVERTISEMENT Engineers have also improved the rate at which GPS receivers update their location, meaning they can refresh themselves as often as 20 times a second or more. Once researchers realized they could take precise measurements so quickly, they started using GPS to examine how the ground moved during an earthquake. In 2003, in one of the first studies of its kind, Larson and her colleagues used GPS receivers studded across the western United States to study how the ground shifted as seismic waves rippled from a magnitude 7.9 earthquake in Alaska. By 2011, researchers were able to take GPS data on the magnitude 9.1 earthquake that devastated Japan and show that the seafloor had shifted a staggering 60 meters during the quake. Today, scientists are looking more broadly at how GPS data can help them quickly assess earthquakes. Diego Melgar of the University of Oregon in Eugene and Gavin Hayes of the US Geological Survey in Golden, Colorado, retrospectively studied 12 large earthquakes to see if they could tell, within seconds of the quake beginning, just how large it would get. By including information from GPS stations near the quakes’ epicenters, the scientists could determine within 10 seconds whether the quake would be a damaging magnitude 7 or a completely destructive magnitude 9. newsletter promo Sign up for Scientific American’s free newsletters. Sign Up Researchers along the US West Coast have even been incorporating GPS into their fledgling earthquake early warning system, which detects ground shaking and notifies people in distant cities whether shaking is likely to hit them soon. And Chile has been building out its GPS network in order to have more accurate information more quickly, which can help calculate whether a quake near the coast is likely to generate a tsunami or not. Credit: Knowable Magazine; Source UNAVCO and the GPS Reflections Research Group 2. MONITOR A VOLCANO Beyond earthquakes, the speed of GPS is helping officials respond more quickly to other natural disasters as they unfold. ADVERTISEMENT Many volcano observatories, for example, have GPS receivers arrayed around the mountains they monitor, because when magma begins shifting underground that often causes the surface to shift as well. By monitoring how GPS stations around a volcano rise or sink over time, researchers can get a better idea about where molten rock is flowing. Before last year’s big eruption of the Kilauea volcano in Hawaii, researchers used GPS to understand which parts of the volcano were shifting most rapidly. Officials used that information to help decide which areas to evacuate residents from. GPS data can also be useful even after a volcano has erupted. Because the signals travel from satellites to the ground, they have to pass through whatever material the volcano is ejecting into the air. In 2013, several research groups studied GPS data from an eruption of the Redoubt volcano in Alaska four years earlier and found that the signals became distorted soon after the eruption began. By studying the distortions, the scientists could estimate how much ash had spewed out and how fast it was traveling. In an ensuing paper, Larson called it “a new way to detect volcanic plumes.” She and her colleagues have been working on ways to do this with smartphone-variety GPS receivers rather than expensive scientific receivers. That could enable volcanologists to set up a relatively inexpensive GPS network and monitor ash plumes as they rise. Volcanic plumes are a big problem for airplanes, which have to fly around the ash rather than risk the particles’ clogging up their jet engines. ADVERTISEMENT 3. PROBE THE SNOW Some of the most unexpected uses of GPS come from the messiest parts of its signal—the parts that bounce off the ground. A typical GPS receiver, like the one in your smartphone, mostly picks up signals that are coming directly from GPS satellites overhead. But it also picks up signals that have bounced on the ground you’re walking on and reflected up to your smartphone. For many years scientists had thought these reflected signals were nothing but noise, a sort of echo that muddied the data and made it hard to figure out what was going on. But about 15 years ago Larson and others began wondering if they could take advantage of the echoes in scientific GPS receivers. She started looking at the frequencies of the signals that reflected off the ground and how those combined with the signals that had arrived directly at the receiver. From that she could deduce qualities of the surface that the echoes had bounced off. “We just reverse-engineered those echoes,” says Larson. This approach allows scientists to learn about the ground beneath the GPS receiver—for instance how much moisture the soil contains or how much snow has accumulated on the surface. (The more snow falls on the ground, the shorter the distance between the echo and the receiver.) GPS stations can work as snow sensors to measure snow depth, such as in mountain areas where snowpack is a major water resource each year. The technique also works well in the Arctic and Antarctica, where there are few weather stations monitoring snowfall year-round. Matt Siegfried, now at the Colorado School of Mines in Golden, and his colleagues studied snow accumulation at 23 GPS stations in West Antarctica from 2007 to 2017. They found they could directly measure the changing snow. That’s crucial information for researchers looking to assess how much snow the Antarctic ice sheet builds up each winter—and how that compares with what melts away each summer. ADVERTISEMENT 4. SENSE A SINKING GPS may have started off as a way to measure location on solid ground, but it turns out to be also useful in monitoring changes in water levels. In July, John Galetzka, an engineer at the UNAVCO geophysics research organization in Boulder, Colorado, found himself installing GPS stations in Bangladesh, at the junction of the Ganges and Brahmaputra rivers. The goal was to measure whether the river sediments are compacting and the land is slowly sinking—making it more vulnerable to flooding during tropical cyclones and sea level rise. “GPS is an amazing tool to help answer this question and more,” Galetzka says. In a farming community called Sonatala, on the edge of a mangrove forest, Galetzka and his colleagues placed one GPS station on the concrete roof of a primary school. They set up a second station nearby, atop a rod hammered into a rice paddy. If the ground really is sinking, then the second GPS station will look as if it is slowly emerging from the ground. And by measuring the GPS echoes beneath the stations, the scientists can measure factors such as how much water is standing in the rice paddy during the rainy season. GPS receivers can even help oceanographers and

#### Natural Disasters are an Existential Event.

Wright 18 Pam Wright 1-19-2018 "Extreme Weather Events Have Greatest Likelihood of Threatening Human Existence, Experts Say" <https://weather.com/science/environment/news/2018-01-19-extreme-weather-threatens-human-existence> (M.S. in Meteorology, editor for The Weather Channel)//Elmer

Extreme weather events are the most likely threat to humanity in the next 10 years, experts say. Each year, nearly 1,000 scientists and decision-makers from around the world take a survey to identify and analyze the most pressing risks facing the planet. This year and for the second year in a row, the results of the 2018 Global Risks Report, released Wednesday at the World Economic Forms, revealed extreme weather as the most likely threat to the world over a 10-year period, topping weapons of mass destruction. These were followed by cyber attacks, data fraud or theft and failure of climate change mitigation and adaptation. “Extreme weather events were ranked again as a top global risk by likelihood and impact. Environmental risks, together with a growing vulnerability to other risks, are now seriously threatening the foundation of most of our commons," Alison Martin, group chief risk officer for the Zurich Insurance Group, said in a press release. The survey looked at five environmental risk categories this year: extreme weather events and temperatures; accelerating biodiversity loss; pollution of air, soil and water; failures of climate change mitigation and adaptation; and risks linked to the transition to low carbon. All ranked high in terms of impact and likelihood. "This follows a year characterized by high-impact hurricanes, extreme temperatures and the first rise in CO2 emissions for four years," the authors wrote in the report. "We have been pushing our planet to the brink and the damage is becoming increasingly clear." The report noted that the 2017 hurricane season, which included hurricanes Harvey, Irma and Maria, was the most expensive hurricane season on record. The authors noted that extreme rainfall "can be particularly damaging." "Of the 10 natural disasters that caused the most deaths in the first half of 2017, eight involved floods or landslides," the authors added. "Storms and other weather-related hazards are also a leading cause of displacement, with the latest data showing that 76 percent of the 31.1 million people displaced during 2016 were forced from their homes as a result of weather-related events." The report said extreme heat in California, Chile and Portugal resulted in some of the most extensive wildfires ever recorded in those areas. More than 100 deaths were attributed to wildfires in Portugal, according to the report. Extreme weather will also affect agriculture around the world, which may lead to a food crisis, the report said, adding that the Food and Agriculture Organization of the United Nations says more than 75 percent of the world’s food comes from just 12 plants and five animal species. "It is estimated that there is now a one-in-twenty chance per decade that heat, drought, and flood events will cause a simultaneous failure of maize production in the world’s two main growers, China and the United States," the authors wrote. In addition, fears of “ecological Armageddon” are "being raised by a collapse in populations of insects that are critical to food systems." In terms of the potential in having the greatest impact on humanity over the next 10 years, weapons of mass destruction ranked just above extreme weather, followed by natural disasters, failure of climate change mitigation and adaptation and water crisis. The authors noted that the use of weapons of mass destruction would have catastrophic effects but is a relatively unlikely scenario. Martin said in a World Economic Forum release that she fears the world "may squander the opportunity to move towards a more sustainable, equitable and inclusive future." "Unfortunately we currently observe a 'too-little-too-late' response by governments and organizations to key trends such as climate change," she added. "It’s not yet too late to shape a more resilient tomorrow, but we need to act with a stronger sense of urgency in order to avoid potential system collapse."

#### Volcano explosions cause Civilizational Collapse – Extinction – predicting and mitigating are key.

Pamlin and Armstrong 15, Dennis, and Stuart Armstrong. "Global challenges: 12 risks that threaten human civilization." Global Challenges Foundation, Stockholm (2015). (Entrepreneur and Founder of 21st Century Frontiers, Senior Associate at Chinese Academy of Social Sciences, Visiting Research Fellow at the Research Center of Journalism and Social Development at Renmin University)//Elmer

3.2.2.1 Expected impact disaggregation 3.2.2.2 Probability The eruption which formed the Siberian Traps was one of the largest in history. It was immediately followed by the most severe wave of extinction in the planet’s history, 374 the Permian– Triassic extinction event, 375 where 96% of all marine species and 70% of terrestrial vertebrate species died out. Recent research has provided evidence of a causal link: that the eruption caused the mass extinction.376 There have been many other super-volcanic eruptions throughout history.377 The return period for the largest supervolcanoes (those with a Volcanic Explosivity Index378 of 8 or above) has been estimated from 30,000 years379 at the low end, to 45,000 or even 700,000 years380 at the high end. Many aspects of super-volcanic activity are not well understood as there have been no historical precedents, and such eruptions must be reconstructed from their deposits.381 The danger from super-volcanoes is the amount of aerosols and dust projected into the upper atmosphere. This dust would absorb the Sun’s rays and cause a global volcanic winter. The Mt Pinatubo eruption of 1991 caused an average global cooling of surface temperatures by 0.5°C over three years, while the Toba eruption around 70,000 years ago is thought by some to have cooled global temperatures for over two centuries.382 The effect of these eruptions could be best compared with that of a nuclear war. The eruption would be more violent than the nuclear explosions,383 but would be less likely to ignite firestorms and other secondary effects. Unlike nuclear weapons, a super-volcano would not be targeted, leaving most of the world’s infrastructure intact. The extent of the impact would thus depend on the severity of the eruption - which might or might not be foreseen, depending on improvements in volcanic predictions384 - and the subsequent policy response. Another Siberian Trap-like eruption is extremely unlikely on human timescales, but the damage from even a smaller eruption could affect the climate, damage the biosphere, affect food supplies and create political instability. A report by a Geological Society of London working group notes: “Although at present there is no technical fix for averting supereruptions, improved monitoring, awareness-raising and research-based planning would reduce the suffering of many millions of people.” 385 Though humanity currently produces enough food to feed everyone,386 this supply is distributed extremely unevenly, and starvation still exists. Therefore a disruption that is small in an absolute sense could still cause mass starvation. Mass starvation, mass migration, political instability and wars could be triggered, possibly leading to a civilisation collapse. Unless the eruption is at the extreme end of the damage scale and makes the planet unviable, human extinction is possible only as a consequence of civilisation collapse and subsequent shocks.387

#### Nuke war causes extinction.

* Checked

PND 16. internally citing Zbigniew Brzezinski, Council of Foreign Relations and former national security adviser to President Carter, Toon and Robock’s 2012 study on nuclear winter in the Bulletin of Atomic Scientists, Gareth Evans’ International Commission on Nuclear Non-proliferation and Disarmament Report, Congressional EMP studies, studies on nuclear winter by Seth Baum of the Global Catastrophic Risk Institute and Martin Hellman of Stanford University, and U.S. and Russian former Defense Secretaries and former heads of nuclear missile forces, brief submitted to the United Nations General Assembly, Open-Ended Working Group on nuclear risks. A/AC.286/NGO/13. 05-03-2016. <http://www.reachingcriticalwill.org/images/documents/Disarmament-fora/OEWG/2016/Documents/NGO13.pdf> //Re-cut by Elmer

Consequences human survival 12. Even if the 'other' side does NOT launch in response the smoke from 'their' burning cities (incinerated by 'us') will still make 'our' country (and the rest of the world) uninhabitable, potentially inducing global famine lasting up to decades. Toon and Robock note in ‘Self Assured Destruction’, in the Bulletin of Atomic Scientists 68/5, 2012, that: 13. “A nuclear war between Russia and the United States, even after the arsenal reductions planned under New START, could produce a nuclear winter. Hence, an attack by either side could be suicidal, resulting in self assured destruction. Even a 'small' nuclear war between India and Pakistan, with each country detonating 50 Hiroshima-size atom bombs--only about 0.03 percent of the global nuclear arsenal's explosive power--as air bursts in urban areas, could produce so much smoke that temperatures would fall below those of the Little Ice Age of the fourteenth to nineteenth centuries, shortening the growing season around the world and threatening the global food supply. Furthermore, there would be massive ozone depletion, allowing more ultraviolet radiation to reach Earth's surface. Recent studies predict that agricultural production in parts of the United States and China would decline by about **20 percent** for four years, and by 10 percent for a decade.” 14. A conflagration involving USA/NATO forces and those of Russian federation would most likely cause the deaths of most/nearly all/all humans (and severely impact/extinguish other species) as well as destroying the delicate interwoven techno-structure on which latter-day 'civilization' has come to depend. Temperatures would drop to below those of the last ice-age for up to 30 years as a result of the lofting of up to 180 million tonnes of very black soot into the stratosphere where it would remain for decades. 15. Though human ingenuity and resilience shouldn't be underestimated, human survival itself is arguably problematic, to put it mildly, under a 2000+ warhead USA/Russian federation scenario. 16. The Joint Statement on Catastrophic Humanitarian Consequences signed October 2013 by 146 governments mentioned 'Human Survival' no less than 5 times. The most recent (December 2014) one gives it a highly prominent place. Gareth Evans’ ICNND (International Commission on Nuclear Non-proliferation and Disarmament) Report made it clear that it saw the threat posed by nuclear weapons use as one that at least threatens what we now call 'civilization' and that potentially threatens human survival with an immediacy that even climate change does not, though we can see the results of climate change here and now and of course the immediate post-nuclear results for Hiroshima and Nagasaki as well.

## Framework

#### Pleasure and pain are intrinsic value and disvalue – everything else regresses – robust neuroscience proves

Blum et al. 18 Kenneth Blum, 1Department of Psychiatry, Boonshoft School of Medicine, Dayton VA Medical Center, Wright State University, Dayton, OH, USA 2Department of Psychiatry, McKnight Brain Institute, University of Florida College of Medicine, Gainesville, FL, USA 3Department of Psychiatry and Behavioral Sciences, Keck Medicine University of Southern California, Los Angeles, CA, USA 4Division of Applied Clinical Research & Education, Dominion Diagnostics, LLC, North Kingstown, RI, USA 5Department of Precision Medicine, Geneus Health LLC, San Antonio, TX, USA 6Department of Addiction Research & Therapy, Nupathways Inc., Innsbrook, MO, USA 7Department of Clinical Neurology, Path Foundation, New York, NY, USA 8Division of Neuroscience-Based Addiction Therapy, The Shores Treatment & Recovery Center, Port Saint Lucie, FL, USA 9Institute of Psychology, Eötvös Loránd University, Budapest, Hungary 10Division of Addiction Research, Dominion Diagnostics, LLC. North Kingston, RI, USA 11Victory Nutrition International, Lederach, PA., USA 12National Human Genome Center at Howard University, Washington, DC., USA, Marjorie Gondré-Lewis, 12National Human Genome Center at Howard University, Washington, DC., USA 13Departments of Anatomy and Psychiatry, Howard University College of Medicine, Washington, DC US, Bruce Steinberg, 4Division of Applied Clinical Research & Education, Dominion Diagnostics, LLC, North Kingstown, RI, USA, Igor Elman, 15Department Psychiatry, Cooper University School of Medicine, Camden, NJ, USA, David Baron, 3Department of Psychiatry and Behavioral Sciences, Keck Medicine University of Southern California, Los Angeles, CA, USA, Edward J Modestino, 14Department of Psychology, Curry College, Milton, MA, USA, Rajendra D Badgaiyan, 15Department Psychiatry, Cooper University School of Medicine, Camden, NJ, USA, Mark S Gold 16Department of Psychiatry, Washington University, St. Louis, MO, USA, “Our evolved unique pleasure circuit makes humans different from apes: Reconsideration of data derived from animal studies”, U.S. Department of Veterans Affairs, 28 February 2018, accessed: 19 August 2020, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6446569/>, R.S.

**Pleasure** is not only one of the three primary reward functions but it also **defines reward.** As homeostasis explains the functions of only a limited number of rewards, the principal reason why particular stimuli, objects, events, situations, and activities are rewarding may be due to pleasure. This applies first of all to sex and to the primary homeostatic rewards of food and liquid and extends to money, taste, beauty, social encounters and nonmaterial, internally set, and intrinsic rewards. Pleasure, as the primary effect of rewards, drives the prime reward functions of learning, approach behavior, and decision making and provides the **basis for hedonic theories** of reward function. We are attracted by most rewards and exert intense efforts to obtain them, just because they are enjoyable [10].

Pleasure is a passive reaction that derives from the experience or prediction of reward and may lead to a long-lasting state of happiness. The word happiness is difficult to define. In fact, just obtaining physical pleasure may not be enough. One key to happiness involves a network of good friends. However, it is not obvious how the higher forms of satisfaction and pleasure are related to an ice cream cone, or to your team winning a sporting event. Recent multidisciplinary research, using both humans and detailed invasive brain analysis of animals has discovered some critical ways that the brain processes pleasure [14].

Pleasure as a hallmark of reward is sufficient for defining a reward, but it may not be necessary. A reward may generate positive learning and approach behavior simply because it contains substances that are essential for body function. When we are hungry, we may eat bad and unpleasant meals. A monkey who receives hundreds of small drops of water every morning in the laboratory is unlikely to feel a rush of pleasure every time it gets the 0.1 ml. Nevertheless, with these precautions in mind, we may define any stimulus, object, event, activity, or situation that has the potential to produce pleasure as a reward. In the context of reward deficiency or for disorders of addiction, homeostasis pursues pharmacological treatments: drugs to treat drug addiction, obesity, and other compulsive behaviors. The theory of allostasis suggests broader approaches - such as re-expanding the range of possible pleasures and providing opportunities to expend effort in their pursuit. [15]. It is noteworthy, the first animal studies eliciting approach behavior by electrical brain stimulation interpreted their findings as a discovery of the brain’s pleasure centers [16] which were later partly associated with midbrain dopamine neurons [17–19] despite the notorious difficulties of identifying emotions in animals.

Evolutionary theories of pleasure: The love connection BO:D

Charles Darwin and other biological scientists that have examined the biological evolution and its basic principles found various mechanisms that steer behavior and biological development. Besides their theory on natural selection, it was particularly the sexual selection process that gained significance in the latter context over the last century, especially when it comes to the question of what makes us “what we are,” i.e., human. However, the capacity to sexually select and evolve is not at all a human accomplishment alone or a sign of our uniqueness; yet, we humans, as it seems, are ingenious in fooling ourselves and others–when we are in love or desperately search for it.

It is well established that modern biological theory conjectures that **organisms are** the **result of evolutionary competition.** In fact, Richard Dawkins stresses gene survival and propagation as the basic mechanism of life [20]. Only genes that lead to the fittest phenotype will make it. It is noteworthy that the phenotype is selected based on behavior that maximizes gene propagation. To do so, the phenotype must survive and generate offspring, and be better at it than its competitors. Thus, the ultimate, distal function of rewards is to increase evolutionary fitness by ensuring the survival of the organism and reproduction. It is agreed that learning, approach, economic decisions, and positive emotions are the proximal functions through which phenotypes obtain other necessary nutrients for survival, mating, and care for offspring.

Behavioral reward functions have evolved to help individuals to survive and propagate their genes. Apparently, people need to live well and long enough to reproduce. Most would agree that homo-sapiens do so by ingesting the substances that make their bodies function properly. For this reason, foods and drinks are rewards. Additional rewards, including those used for economic exchanges, ensure sufficient palatable food and drink supply. Mating and gene propagation is supported by powerful sexual attraction. Additional properties, like body form, augment the chance to mate and nourish and defend offspring and are therefore also rewards. Care for offspring until they can reproduce themselves helps gene propagation and is rewarding; otherwise, many believe mating is useless. According to David E Comings, as any small edge will ultimately result in evolutionary advantage [21], additional reward mechanisms like novelty seeking and exploration widen the spectrum of available rewards and thus enhance the chance for survival, reproduction, and ultimate gene propagation. These functions may help us to obtain the benefits of distant rewards that are determined by our own interests and not immediately available in the environment. Thus the distal reward function in gene propagation and evolutionary fitness defines the proximal reward functions that we see in everyday behavior. That is why foods, drinks, mates, and offspring are rewarding.

There have been theories linking pleasure as a required component of health benefits salutogenesis, (salugenesis). In essence, under these terms, pleasure is described as a state or feeling of happiness and satisfaction resulting from an experience that one enjoys. Regarding pleasure, it is a double-edged sword, on the one hand, it promotes positive feelings (like mindfulness) and even better cognition, possibly through the release of dopamine [22]. But on the other hand, pleasure simultaneously encourages addiction and other negative behaviors, i.e., motivational toxicity. It is a complex neurobiological phenomenon, relying on reward circuitry or limbic activity. It is important to realize that through the “Brain Reward Cascade” (BRC) endorphin and endogenous morphinergic mechanisms may play a role [23]. While natural rewards are essential for survival and appetitive motivation leading to beneficial biological behaviors like eating, sex, and reproduction, crucial social interactions seem to further facilitate the positive effects exerted by pleasurable experiences. Indeed, experimentation with addictive drugs is capable of directly acting on reward pathways and causing deterioration of these systems promoting hypodopaminergia [24]. Most would agree that pleasurable activities can stimulate personal growth and may help to induce healthy behavioral changes, including stress management [25]. The work of Esch and Stefano [26] concerning the link between compassion and love implicate the brain reward system, and pleasure induction suggests that social contact in general, i.e., love, attachment, and compassion, can be highly effective in stress reduction, survival, and overall health.

Understanding the role of neurotransmission and pleasurable states both positive and negative have been adequately studied over many decades [26–37], but comparative anatomical and neurobiological function between animals and homo sapiens appear to be required and seem to be in an infancy stage.

Finding happiness is different between apes and humans

As stated earlier in this expert opinion one key to happiness involves a network of good friends [38]. However, it is not entirely clear exactly how the higher forms of satisfaction and pleasure are related to a sugar rush, winning a sports event or even sky diving, all of which augment dopamine release at the reward brain site. Recent multidisciplinary research, using both humans and detailed invasive brain analysis of animals has discovered some critical ways that the brain processes pleasure.

Remarkably, there are pathways for ordinary liking and pleasure, which are limited in scope as described above in this commentary. However, there are **many brain regions**, often termed hot and cold spots, that significantly **modulate** (increase or decrease) our **pleasure or** even produce **the opposite** of pleasure— that is disgust and fear [39]. One specific region of the nucleus accumbens is organized like a computer keyboard, with particular stimulus triggers in rows— producing an increase and decrease of pleasure and disgust. Moreover, the cortex has unique roles in the cognitive evaluation of our feelings of pleasure [40]. Importantly, the interplay of these multiple triggers and the higher brain centers in the prefrontal cortex are very intricate and are just being uncovered.

Desire and reward centers

It is surprising that many different sources of pleasure activate the same circuits between the mesocorticolimbic regions (Figure 1). Reward and desire are two aspects pleasure induction and have a very widespread, large circuit. Some part of this circuit distinguishes between desire and dread. The so-called pleasure circuitry called “REWARD” involves a well-known dopamine pathway in the mesolimbic system that can influence both pleasure and motivation.

In simplest terms, the well-established mesolimbic system is a dopamine circuit for reward. It starts in the ventral tegmental area (VTA) of the midbrain and travels to the nucleus accumbens (Figure 2). It is the cornerstone target to all addictions. The VTA is encompassed with neurons using glutamate, GABA, and dopamine. The nucleus accumbens (NAc) is located within the ventral striatum and is divided into two sub-regions—the motor and limbic regions associated with its core and shell, respectively. The NAc has spiny neurons that receive dopamine from the VTA and glutamate (a dopamine driver) from the hippocampus, amygdala and medial prefrontal cortex. Subsequently, the NAc projects GABA signals to an area termed the ventral pallidum (VP). The region is a relay station in the limbic loop of the basal ganglia, critical for motivation, behavior, emotions and the “Feel Good” response. This defined system of the brain is involved in all addictions –substance, and non –substance related. In 1995, our laboratory coined the term “Reward Deficiency Syndrome” (RDS) to describe genetic and epigenetic induced hypodopaminergia in the “Brain Reward Cascade” that contribute to addiction and compulsive behaviors [3,6,41].

Furthermore, ordinary “liking” of something, or pure pleasure, is represented by small regions mainly in the limbic system (old reptilian part of the brain). These may be part of larger neural circuits. In Latin, hedus is the term for “sweet”; and in Greek, hodone is the term for “pleasure.” Thus, the word Hedonic is now referring to various subcomponents of pleasure: some associated with purely sensory and others with more complex emotions involving morals, aesthetics, and social interactions. The capacity to have pleasure is part of being healthy and may even extend life, especially if linked to optimism as a dopaminergic response [42].

Psychiatric illness often includes symptoms of an abnormal inability to experience pleasure, referred to as anhedonia. A negative feeling state is called dysphoria, which can consist of many emotions such as pain, depression, anxiety, fear, and disgust. Previously many scientists used animal research to uncover the complex mechanisms of pleasure, liking, motivation and even emotions like panic and fear, as discussed above [43]. However, as a significant amount of related research about the specific brain regions of pleasure/reward circuitry has been derived from invasive studies of animals, these cannot be directly compared with subjective states experienced by humans.

In an attempt to resolve the controversy regarding the causal contributions of mesolimbic dopamine systems to reward, we have previously evaluated the three-main competing explanatory categories: “liking,” “learning,” and “wanting” [3]. That is, dopamine may mediate (a) liking: the hedonic impact of reward, (b) learning: learned predictions about rewarding effects, or (c) wanting: the pursuit of rewards by attributing incentive salience to reward-related stimuli [44]. We have evaluated these hypotheses, especially as they relate to the RDS, and we find that the incentive salience or “wanting” hypothesis of dopaminergic functioning is supported by a majority of the scientific evidence. Various neuroimaging studies have shown that anticipated behaviors such as sex and gaming, delicious foods and drugs of abuse all affect brain regions associated with reward networks, and may not be unidirectional. Drugs of abuse enhance dopamine signaling which sensitizes mesolimbic brain mechanisms that apparently evolved explicitly to attribute incentive salience to various rewards [45].

Addictive substances are voluntarily self-administered, and they enhance (directly or indirectly) dopaminergic synaptic function in the NAc. This activation of the brain reward networks (producing the ecstatic “high” that users seek). Although these circuits were initially thought to encode a set point of hedonic tone, it is now being considered to be far more complicated in function, also encoding attention, reward expectancy, disconfirmation of reward expectancy, and incentive motivation [46]. The argument about addiction as a disease may be confused with a predisposition to substance and nonsubstance rewards relative to the extreme effect of drugs of abuse on brain neurochemistry. The former sets up an individual to be at high risk through both genetic polymorphisms in reward genes as well as harmful epigenetic insult. Some Psychologists, even with all the data, still infer that addiction is not a disease [47]. Elevated stress levels, together with polymorphisms (genetic variations) of various dopaminergic genes and the genes related to other neurotransmitters (and their genetic variants), and may have an additive effect on vulnerability to various addictions [48]. In this regard, Vanyukov, et al. [48] suggested based on review that whereas the gateway hypothesis does not specify mechanistic connections between “stages,” and does not extend to the risks for addictions the concept of common liability to addictions may be more parsimonious. The latter theory is grounded in genetic theory and supported by data identifying common sources of variation in the risk for specific addictions (e.g., RDS). This commonality has identifiable neurobiological substrate and plausible evolutionary explanations.

Over many years the controversy of dopamine involvement in especially “pleasure” has led to confusion concerning separating motivation from actual pleasure (wanting versus liking) [49]. We take the position that animal studies cannot provide real clinical information as described by self-reports in humans. As mentioned earlier and in the abstract, on November 23rd, 2017, evidence for our concerns was discovered [50]

In essence, although nonhuman primate brains are similar to our own, the disparity between other primates and those of human cognitive abilities tells us that surface similarity is not the whole story. Sousa et al. [50] small case found various differentially expressed genes, to associate with pleasure related systems. Furthermore, the dopaminergic interneurons located in the human neocortex were absent from the neocortex of nonhuman African apes. Such differences in neuronal transcriptional programs may underlie a variety of neurodevelopmental disorders.

In simpler terms, the system controls the production of dopamine, a chemical messenger that plays a significant role in pleasure and rewards. The senior author, Dr. Nenad Sestan from Yale, stated: “Humans have evolved a dopamine system that is different than the one in chimpanzees.” This may explain why the behavior of humans is so unique from that of non-human primates, even though our brains are so surprisingly similar, Sestan said: “It might also shed light on why people are vulnerable to mental disorders such as autism (possibly even addiction).” Remarkably, this research finding emerged from an extensive, multicenter collaboration to compare the brains across several species. These researchers examined 247 specimens of neural tissue from six humans, five chimpanzees, and five macaque monkeys. Moreover, these investigators analyzed which genes were turned on or off in 16 regions of the brain. While the differences among species were subtle, **there was** a **remarkable contrast in** the **neocortices**, specifically in an area of the brain that is much more developed in humans than in chimpanzees. In fact, these researchers found that a gene called tyrosine hydroxylase (TH) for the enzyme, responsible for the production of dopamine, was expressed in the neocortex of humans, but not chimpanzees. As discussed earlier, dopamine is best known for its essential role within the brain’s reward system; the very system that responds to everything from sex, to gambling, to food, and to addictive drugs. However, dopamine also assists in regulating emotional responses, memory, and movement. Notably, abnormal dopamine levels have been linked to disorders including Parkinson’s, schizophrenia and spectrum disorders such as autism and addiction or RDS.

Nora Volkow, the director of NIDA, pointed out that one alluring possibility is that the neurotransmitter dopamine plays a substantial role in humans’ ability to pursue various rewards that are perhaps months or even years away in the future. This same idea has been suggested by Dr. Robert Sapolsky, a professor of biology and neurology at Stanford University. Dr. Sapolsky cited evidence that dopamine levels rise dramatically in humans when we anticipate potential rewards that are uncertain and even far off in our futures, such as retirement or even the possible alterlife. This may explain what often motivates people to work for things that have no apparent short-term benefit [51]. In similar work, Volkow and Bale [52] proposed a model in which dopamine can favor NOW processes through phasic signaling in reward circuits or LATER processes through tonic signaling in control circuits. Specifically, they suggest that through its modulation of the orbitofrontal cortex, which processes salience attribution, dopamine also enables shilting from NOW to LATER, while its modulation of the insula, which processes interoceptive information, influences the probability of selecting NOW versus LATER actions based on an individual’s physiological state. This hypothesis further supports the concept that disruptions along these circuits contribute to diverse pathologies, including obesity and addiction or RDS.

#### **The standard is maximizing expected well being.**

Prefer:

#### **1] outweighs on actor specificity since governments make policies as a whole that benefit and help some people and side constraints freeze action – actor spec outweighs and turns since it’s better than no action, states don’t have wills and intentions since they are not indivuals actors, different agents have different obligations**

#### **2**] use epistemic modesty – multiply probability of the fwk times the magnitude of the impacts – encourages both substantive and phil debates so that we talk about all the offense

3] Role playing as policy makers is key to solving real world problems-so the role of the ballot is to evaluate the hypothetical consequences of the plan and vote for the best hypothetical policy action. Coverstone[[1]](#footnote-1) :

(Alan H., “Acting on Activism: Realizing the Vision of Debate with Pro-social Impact,” Paper presented at the National Communication Association Annual Conference, 11/17/05)

 After all, if democracy means anything, it means that citizens not only have the right, they also bear the obligation to discuss and debate what the government should be doing**.** Absent that discussion and debate, much of **the motivation for personal political activism is** also **lost**. Those who have co-opted Mitchellâ€™s argument for individual advocacy often quickly respond that nothing we do in a debate round can actually change government policy, and unfortunately, an entire generation of debaters has now swallowed this assertion as an article of faith. The best most will muster is, â€œOf course not, but you donâ€™t either!â€ The assertion that nothing we do in debate has any impact on government policy is one that carries the potential to undermine Mitchellâ€™s entire project. If there is nothing we can do in a debate round to change government policy, then we are left with precious little in the way of pro-social options for addressing problems we face. At best, we can pursue some Pilot-like hand washing that can purify us as individuals through quixotic activism but offer little to society as a whole. It is very important to note that Mitchell (1998b) tries carefully to limit and bound his notion of reflexive fiat by maintaining that because it â€œviews fiat as a concrete course of action, it is bounded by the limits of pragmatismâ€ (p. 20). Pursued properly, the debates that Mitchell would like to see are those in which **the relative efficacy of concrete political strategies** for pro-social change **is debated**. In a few noteworthy examples, this approach has been employed successfully, and I must say that I have thoroughly enjoyed judging and coaching those debates. The students in my program have learned to stretch their understanding of their role in the political process because of the experience. Therefore, those who say I am opposed to Mitchellâ€™s goals here should take care at such a blanket assertion. Â¶ However, **contest debate teaches students to combine personal experience with the language of political power.** Powerfulpersonal **narratives unconnected to** political **power are** regularly **co-opted** by those who do learn the language of power. One needlook no further than the annual state of the Union Address where personal story after personal story is used to support the political agenda of those in power. The so-called **role-playing** that public policy contest debates encourage **promotes**active **learning** ofthe vocabulary and levers of **power** in America**.** Imagining the ability to use our own arguments to influence government action is one of the great virtues of academic debate. Gerald Graff (2003) analyzed the decline of argumentation in academic discourse and found a source of student antipathy to public argument in an interesting place.Â¶ Iâ€™m up againstâ€¦their aversion to the role of public spokesperson that formal writing presupposes. Itâ€™s as if such students canâ€™t imagine any rewards for being a public actor or even imagining themselves in such a role. This lack of interest in the public sphere may in turn reflect a loss of confidence in the possibility that the arguments we make in public will have an effect on the world. Todayâ€™s students lack of faith in the power of persuasion reflects the waning of the ideal of civic participation that led educators for centuries to place rhetorical and argumentative training at the center of the school and college curriculum. (Graff, 2003, p. 57)Â¶ The power to imagine public advocacy that actually makes a difference is one of the great virtues of the traditional notion of fiat that critics deride as mere simulation. **Simulation of success**in the public realm **is**far more **empowering** to students than completely abandoning all notions of personal power in the face of governmental hegemony by teaching students that nothing they can do in a contest debate can ever make any difference in public policy.â€ Contest debating is well suited to rewarding public activism if it stops accepting as an article of faith that personal agency is somehow undermined by the so-called role playing in debate. Debate is role-playing whether we imagine government action or imagine individual action. **Imagining myself starting a socialist revolution** in America **is no less of a fantasy than imagining myself** making a difference **on Capitol Hill.** Furthermore, both fantasies influenced my personal and political development virtually ensuring a life of active, pro-social, political participation. Neither fantasy reduced the likelihood that I would spend my life trying to make the difference I imagined**. One fantasy**actually **does make a greater difference: the one that speaks the language of political power.**The **other** fantasy **disables action by making one a laughingstock** to those who wield the language of power.

#### 4] Sweeping claims don’t undercut the Aff. We can advance *contingent* and *particular* knowledge without “Big T” Truths.

PRICE ‘98

(RICHARD PRICE is a former prof in the Department of Anthropology at Yale University. Later, he moved to Johns Hopkins University to found the Department of Anthropology, where he served three terms as chair. A decade of freelance teaching (University of Minnesota, Stanford University, Princeton University, University of Florida, Universidade Federal da Bahia), ensued. This article is co-authored with CHRISTIAN REUS-SMIT – Monash University – European Journal of International Relations Copyright © 1998 via SAGE Publications – http://www.arts.ualberta.ca/~courses/PoliticalScience/661B1/documents/PriceReusSmithCriticalInternatlTheoryConstructivism.pdf)

One of the central departures of critical international theory from positivism is the view that we cannot escape the interpretive moment. As George (1994: 24) argues, ‘the world is always an interpreted “thing”, and it is always interpreted in conditions of disagreement and conflict, to one degree or another’. For this reason, ‘there can be no common body of observational or tested data that we can turn to for a neutral, objective knowledge of the world. There can be no ultimate knowledge, for example, that actually corresponds to reality per se.’ This proposition has been endorsed wholeheartedly by constructivists, who are at pains to deny the possibility of making ‘Big-T’ Truth claims about the world and studiously avoid attributing such status to their findings. This having been said, after undertaking sustained empirical analyses of aspects of world politics constructivists do make ‘small-t’ truth claims about the subjects they have investigated. That is, they claim to have arrived at logical and empirically *plausible* interpretations of actions**,** events or processes**,** and they appeal to the weight of evidence to sustain such claims. While admitting that their claims are always contingent and partial interpretations of a complex world, Price (1995, 1997) claims that his genealogy provides the best account to date to make sense of anomalies surrounding the use of chemical weapons, and Reus-Smit (1997) claims that a culturalist perspective offers the best explanation of institutional differences between historical societies of states. Do such claims contradict the interpretive ethos of critical international theory? For two reasons, we argue that they do not. First, the interpretive ethos of critical international theory is driven, in large measure, by a normative rejection of totalizing discourses, of general theoretical frameworks that privilege certain perspectives over others. One searches constructivist scholarship in vain, though, for such discourses. With the possible exception of Wendt’s problematic flirtation with general systemic theory and professed commitment to ‘science’, constructivist research is at its best when and because it is question driven, with self-consciously contingent claims made specifically in relation to *particular* phenomena, at a *particular* time, based on *particular* evidence, and always open to alternative interpretations. Second, the rejection of totalizing discourses based on ‘big-T’ Truth claims does not foreclose the possibility, or even the inevitability, of making ‘small-t’ truth claims. In fact, we would argue that as soon as one observes and interacts in the world such claims are unavoidable, either as a person engaged in everyday life or as a scholar. As Nietzsche pointed out long ago, we cannot help putting forth truth claims about the world. The individual who does not cannot act, and the genuinely unhypocritical relativist who cannot struggles for something to say and write. In short, if constructivists are not advancing totalizing discourses, and if making ‘small-t’ truth claims is inevitable if one is to talk about how the world works, then it is no more likely that constructivism per se violates the interpretive ethos of critical international theory than does critical theory itself.

#### **5] extinction first**

Pummer 15 [Theron, Junior Research Fellow in Philosophy at St. Anne's College, University of Oxford. “Moral Agreement on Saving the World” Practical Ethics, University of Oxford. May 18, 2015] AT

There appears to be lot of disagreement in moral philosophy. Whether these many apparent disagreements are deep and irresolvable, I believe there is at least one thing it is reasonable to agree on right now, whatever general moral view we adopt: that it is very important to reduce the risk that all intelligent beings on this planet are eliminated by an enormous catastrophe, such as a nuclear war. How we might in fact try to reduce such existential risks is discussed elsewhere. My claim here is only that we – whether we’re consequentialists, deontologists, or virtue ethicists – should all agree that we should try to save the world. According to consequentialism, we should maximize the good, where this is taken to be the goodness, from an impartial perspective, of outcomes. Clearly one thing that makes an outcome good is that the people in it are doing well. There is little disagreement here. If the happiness or well-being of possible future people is just as important as that of people who already exist, and if they would have good lives, it is not hard to see how reducing existential risk is easily the most important thing in the whole world. This is for the familiar reason that there are so many people who could exist in the future – there are trillions upon trillions… upon trillions. There are so many possible future people that reducing existential risk is arguably the most important thing in the world, even if the well-being of these possible people were given only 0.001% as much weight as that of existing people. Even on a wholly person-affecting view – according to which there’s nothing (apart from effects on existing people) to be said in favor of creating happy people – the case for reducing existential risk is very strong. As noted in this seminal paper, this case is strengthened by the fact that there’s a good chance that many existing people will, with the aid of life-extension technology, live very long and very high quality lives. You might think what I have just argued applies to consequentialists only. There is a tendency to assume that, if an argument appeals to consequentialist considerations (the goodness of outcomes), it is irrelevant to non-consequentialists. But that is a huge mistake. Non-consequentialism is the view that there’s more that determines rightness than the goodness of consequences or outcomes; it is not the view that the latter don’t matter. Even John Rawls wrote, “All ethical doctrines worth our attention take consequences into account in judging rightness. One which did not would simply be irrational, crazy.” Minimally plausible versions of deontology and virtue ethics must be concerned in part with promoting the good, from an impartial point of view. They’d thus imply very strong reasons to reduce existential risk, at least when this doesn’t significantly involve doing harm to others or damaging one’s character. What’s even more surprising, perhaps, is that even if our own good (or that of those near and dear to us) has much greater weight than goodness from the impartial “point of view of the universe,” indeed even if the latter is entirely morally irrelevant, we may nonetheless have very strong reasons to reduce existential risk. Even egoism, the view that each agent should maximize her own good, might imply strong reasons to reduce existential risk. It will depend, among other things, on what one’s own good consists in. If well-being consisted in pleasure only, it is somewhat harder to argue that egoism would imply strong reasons to reduce existential risk – perhaps we could argue that one would maximize her expected hedonic well-being by funding life extension technology or by having herself cryogenically frozen at the time of her bodily death as well as giving money to reduce existential risk (so that there is a world for her to live in!). I am not sure, however, how strong the reasons to do this would be. But views which imply that, if I don’t care about other people, I have no or very little reason to help them are not even minimally plausible views (in addition to hedonistic egoism, I here have in mind views that imply that one has no reason to perform an act unless one actually desires to do that act). To be minimally plausible, egoism will need to be paired with a more sophisticated account of well-being. To see this, it is enough to consider, as Plato did, the possibility of a ring of invisibility – suppose that, while wearing it, Ayn could derive some pleasure by helping the poor, but instead could derive just a bit more by severely harming them. Hedonistic egoism would absurdly imply she should do the latter. To avoid this implication, egoists would need to build something like the meaningfulness of a life into well-being, in some robust way, where this would to a significant extent be a function of other-regarding concerns (see chapter 12 of this classic intro to ethics). But once these elements are included, we can (roughly, as above) argue that this sort of egoism will imply strong reasons to reduce existential risk. Add to all of this Samuel Scheffler’s recent intriguing arguments (quick podcast version available here) that most of what makes our lives go well would be undermined if there were no future generations of intelligent persons. On his view, my life would contain vastly less well-being if (say) a year after my death the world came to an end. So obviously if Scheffler were right I’d have very strong reason to reduce existential risk. We should also take into account moral uncertainty. What is it reasonable for one to do, when one is uncertain not (only) about the empirical facts, but also about the moral facts? I’ve just argued that there’s agreement among minimally plausible ethical views that we have strong reason to reduce existential risk – not only consequentialists, but also deontologists, virtue ethicists, and sophisticated egoists should agree. But even those (hedonistic egoists) who disagree should have a significant level of confidence that they are mistaken, and that one of the above views is correct. Even if they were 90% sure that their view is the correct one (and 10% sure that one of these other ones is correct), they would have pretty strong reason, from the standpoint of moral uncertainty, to reduce existential risk. Perhaps most disturbingly still, even if we are only 1% sure that the well-being of possible future people matters, it is at least arguable that, from the standpoint of moral uncertainty, reducing existential risk is the most important thing in the world. Again, this is largely for the reason that there are so many people who could exist in the future – there are trillions upon trillions… upon trillions. (For more on this and other related issues, see this excellent dissertation). Of course, it is uncertain whether these untold trillions would, in general, have good lives. It’s possible they’ll be miserable. It is enough for my claim that there is moral agreement in the relevant sense if, at least given certain empirical claims about what future lives would most likely be like, all minimally plausible moral views would converge on the conclusion that we should try to save the world. While there are some non-crazy views that place significantly greater moral weight on avoiding suffering than on promoting happiness, for reasons others have offered (and for independent reasons I won’t get into here unless requested to), they nonetheless seem to be fairly implausible views. And even if things did not go well for our ancestors, I am optimistic that they will overall go fantastically well for our descendants, if we allow them to. I suspect that most of us alive today – at least those of us not suffering from extreme illness or poverty – have lives that are well worth living, and that things will continue to improve. Derek Parfit, whose work has emphasized future generations as well as agreement in ethics, described our situation clearly and accurately: “We live during the hinge of history. Given the scientific and technological discoveries of the last two centuries, the world has never changed as fast. We shall soon have even greater powers to transform, not only our surroundings, but ourselves and our successors. If we act wisely in the next few centuries, humanity will survive its most dangerous and decisive period. Our descendants could, if necessary, go elsewhere, spreading through this galaxy…. Our descendants might, I believe, make the further future very good. But that good future may also depend in part on us. If our selfish recklessness ends human history, we would be acting very wrongly.” (From chapter 36 of On What Matters)

# 1AR

1. [MBA(Alan,ActingonActivism,[http://home.montgome... 17-2005).doc)]](http://home.montgomerybell.edu/~coversa/Acting%20on%20Activism%20(Nov%2017-2005).doc)%5D)

   An important concern emerges when Mitchell describes reflexive fiat as a contest strategy capable of â€œeschewing the power to directly control external actorsâ€ (1998b, p. 20). [↑](#footnote-ref-1)