Resolved: The appropriation of outer space by private entities is unjust.

**Consequentialism is the default moral theory; it’s the bedrock of all other philosophies**

**Sinott-Armstrong 11** <https://triumphdebate.com/consequentialism/>

Even if consequentialists can accommodate or explain away common moral intuitions, that might seem only to answer objections without yet giving any positive reason to accept consequentialism. However, most people begin with the presumption that we morally ought to make the world better when we can. The question then is only whether any moral constraints or moral options need to be added to the basic consequentialist factor in moral reasoning. (Kagan 1989, 1998) If no objection reveals any need for anything beyond consequences, then consequences alone seem to determine what is morally right or wrong, just as consequentialists claim.

**Rights require utilitarian calculus to determine relative importance**

**Brandt 92** <https://triumphdebate.com/consequentialism/>

Before turning to possible ” deeper” difficulties, let me make just one point favorable to the utilitarian view, that it tells us, in principle, how to find out what are a person’s rights, and how stringent they are, relative to each other, which is much more than can be said of most other theories, unless reliance on intuitions is supposed to be a definite way of telling what a person’s rights are. How does one do this, on the utilitarian theory? The idea, of course, is that we have to determine whether it would maximize long-range expectable utility to include recognition of certain rights in the moral code of a society, or to include a certain right with a certain degree of stringency as compared with other rights. (For instance, it might be optimistic to include a right to life with more stringency than a right to liberty and this with more stringency than the right to pursue happiness.) Suppose, for instance, one wants to know what should be the scope of the “right to life.” Then it would be proper to inquire whether the utility-maximizing moral system would require people to retrain from taking the life of other adults, more positively to support life by providing adequate medical care, to abstain from life-termination for seriously defective infants or to refrain from abortion, to require abstaining from assisting a person with terminal illness in ending his own life if he requests it, to refrain from assisting in the discharge of a sentence of capital punishment, or to refrain from killing combatants in war time and so on. If one wants to know whether the right to life is stronger than the right of free speech on political subjects, it is proper to inquire whether the utility maximizing moral code would prefer free speech to the cost of lives (and in what circumstances).

DA:Private entities alone in space is bad

Private entities will never engage in exploration for the sake of knowledge

**N.a ‘17** <https://www.forbes.com/sites/quora/2017/04/04/the-pros-and-cons-of-privatizing-space-exploration/?sh=102fa5053319>

What are the pros and cons of privatizing space exploration? The premise is too binary. The objective isn’t to hand over space exploration to the private sector. The objective is to expand upon the utilization of space by finding opportunities where the private sector could benefit.

The role of government in space exploration is to do the things that the market can’t support, but the people agree are beneficial. When we send a spacecraft like New Horizons to take close up pictures of Pluto, we do so because, as a people, we understand that science is important. We understand that learning about the universe is good for our society. We understand that knowledge has value for its own sake and that we often cannot predict how that knowledge may have additional practical value at some later time. This kind of exploration simply isn’t practical for the private sector because there isn’t a way to, in the near term, make  a return on the investment.

Imagine how something like the Hubble Space Telescope would work if it was a product of the private sector. In order to be something worth doing, for a private company, there would need to be a way to recoup the cost and to return a profit sufficient to attract the investors that would fund that cost. So, how does one profit from something like the Hubble Space Telescope? One would have to charge researchers to use it and one would have to sell the data obtained from it. Both of those things would impede the progress of science. The American people (via their representatives) decided that we were willing to each pay $1.60 a year to put this giant telescope in space and operate it so that researchers around the world could use it at no cost and so that teachers around the world could uses its images and data, at no cost, to educate their students, and so that every person could gaze upon the wonders that telescope delivered to us and be marveled by our universe. Over 14,000 scientific papers have been published using data from Hubble. Over 1.3 million observations have been made.

There have been profitable technology spinoffs from the Hubble Space Telescope. For example, imaging technology developed for Hubble has found reuse in imaging of breast tissue to make early detections of cancer. But private companies can’t invest the kind of resources needed to build, launch, and operate a spacecraft like New Horizons or a telescope like Hubble with the hope that they’ll find ways to profit, later.

We will continue to need the will of the public to invest in scientific exploration with satisfaction achieved by the knowledge returned. But, there are many ways to utilize space that may be profitable for the private sector and may be inappropriate for government endeavors.

The aviation industry rose up almost overnight during World War I, as the government demanded an ever-growing need for aircraft for war use. But, once the war ended and those contracts started to be canceled, there was a very real risk that the aviation industry would completely implode. There just wasn’t a profitable market in sight. One place where aircraft were needed was postal delivery. The Contract Air Mail Act of 1925 (the Kelly Act) authorized the postmaster general to contract for domestic airmail service with commercial air carriers. This encouraged private companies to startup air freight businesses and compete for contracts. These mail carrying flights became regular and scheduled and bright enterprising entrepreneurs came up with the idea of selling tickets for passengers to ride on these aircraft, along with the mail. Airplanes became larger and as the industry became established and efficient the market grew. People became more trusting and tickets became cheaper, making passenger aviation a normal way to travel. Soon, the air carriers were making enough profit from the passengers that they didn’t really need to carry the mail to stay in business.

The commercial space industry is in a similar early state, today. The government has needs the private sector can fulfill and through those needs is subsidizing the research and development those private entities need to do to develop their technologies to the point where they can affordably meet the appetites of a market. By providing money to companies like SpaceX, Boeing, and Sierra-Nevada to develop human rated spacecraft to ferry our crews to and from ISS, we are helping them develop human rated spacecraft that they can use to take private paying individuals into space. SpaceX recently announced that they have two interested customers willing to pay to ride that Dragon spacecraft to space, around the Moon, and back to Earth.

The more these companies do these things, the more they can amortize the costs. The more they can amortize the costs, the less they need to charge customers. The less they need to charge customers, the larger the potential market of customers. Hopefully, eventually, they will reach a state where they can profit without government business.

At each step along the way, as the public funds the risky and expensive learning process, lessons are learned so that private entities can afford to do similar things. The world’s space agencies have funded the research, development, construction and operation of the International Space Station so that important research that will benefit society can be done. Along the way we have learned a lot about building and operating space stations and private companies like Bigelow have been able to benefit from our investment by using that knowledge to make the first steps into private space stations.

This happens over and over. We learn how to land a probe on a comet or asteroid and the information learned doing that is provided to private entities who have the vision to do similar things for a profit. If we learn how to land on an asteroid, extract a sample, and return it to Earth, they can expand upon that and land on an asteroid, mine that asteroid, and return valuable materials to Earth.

There are areas of space utilization that will be best fulfilled by the private sector and there are areas that are and will continue to be best fulfilled by the public sector. The relationship between the two is symbiotic, not parasitic.

Wealth inequalities are perpetuated by NewSpace actors

**Stockwell ‘20**<https://www.e-ir.info/2020/07/20/legal-black-holes-in-outer-space-the-regulation-of-private-space-companies/>

On 30th April 2020, NASA – the US government’s space agency ­– awarded three private space companies a joint-contract worth $967m to complete a lunar mission by 2024, in what was celebrated as “the last piece that [America] need[s] in order to get to the moon” by NASA administrator Jim Brindestine (The Telegraph, 2020). Yet, whilst this development was widely covered in the media, less coverage has focused on the extent to which existing international legislation surrounding outer space endeavours appropriately applies to private entities. Indeed, the prospect of a corporate foothold within the extra-terrestrial domain has thrown up both a mixture of optimism and concern regarding the potential benefits of expanding capital projects into space (Adolph, 2006; Dickens & Ormrod, 2007).

By adopting the 1967 UN Outer Space Treaty (OST) as an analytical framework in relation to the rise of the so-called US ‘NewSpace’ actors, this essay argues that there are significant legal ambiguities regarding the status of private space companies in orbital space. Such loopholes allow the US government to circumvent its own obligations to the OST, whilst simultaneously undermining the notion of space as a ‘global commons’ through a commodification process. The lack of specificity within the OST surrounding private property rights over extra-terrestrial resources risks the prospect of reinforcing Earth-bound wealth inequalities and US dominance in space, by restricting the potential economic benefits for the broader global citizenry in favour of a narrow class of wealthy American investors. Moreover, the OST’s weak clause regarding the regulation of space surveillance risks the incentivisation of a ‘global panopticon’ network of US satellites. The rise of dual-use technology is blurring the boundaries between military and civilian observations, raising serious ethical concerns over the nature of US space-based data collection. Finally, the increasing number of private satellite constellations is facilitating the possibility of cataclysmic space debris collisions which could exacerbate geopolitical tensions. Such developments are also contributing towards the contamination of the broader space environment in ways that the OST had never envisioned.

The UN Outer Space Treaty and Rise of the ‘NewSpace’ Actors

Although ratified into international law in 1967, the UN Outer Space Treaty (OST) is perhaps still the most relevant piece of legislation for analysing state and non-state entity activity in outer space. Designed to prevent both the militarisation of space and national appropriation of celestial bodies at the height of Cold War tensions, the UN OST holds significant influence as a form of customary international law (Hebert, 2014: 6). Ratified by over 100 nations – including major spacefaring nations such as the United States, Russia and China – the treatyis widely accepted as an authoritative document and has formed the basis for all other space treaties that have succeeded it (Kramer, 2017: 129). This is in contrast to more recent legislation such as the 1972 Moon Treaty designed to promote cooperation in Moon exploration and development, which the US and other major space superpowers have refrained from signing (Adolph, 2006: 968-969).

The type of American actors becoming involved in the realm of outer space has undergone significant diversification. Despite working alongside NASA since the 1950s, commercial enterprises were largely confined to the manufacturing of parts utilised in rockets and other equipment for space activities (Lal, 2016: 63-66). However, the continuous sharp decline in NASA’s overall budget that has occurred since the Apollo 11 moon landing, and the increasing trends towards the privatisation of government functions has drastically altered both the capabilities and the outlooks of private space companies. Indeed, although the space economy is growing overall, global government spending decreased by 1.3% between 2012 and 2013 while commercial-sector growth increased by roughly 7% (Conklin, 2017: 33). Central to the impetus behind this private sector space boom has been the emergence of the so-called ‘NewSpace’ actors – “a broad range of primarily US-based entrepreneurs… who, for more than 30 years, have aimed to commercialise space” (Valentine, 2012: 1046). Driven by a libertarian outlook of economics, and critical of NASA’s historical grip on space exploration, these individuals portray themselves as the pioneers of the ‘final frontier’ who will save humanity from extinction through privately-funded extra-terrestrial missions (Kearnes & van Dooren, 2017: 182).

Near-Earth Object and Lunar Resource Mining: US Private Property in Space

Lunar rock samples from the Apollo missions containing rare Earth resources, such as Helium-3 which produces more power and less waste than traditional nuclear reactors on Earth, have since fuelled incentives for extra-terrestrial resource mining (Brearley, 2006: 44-46). This was further facilitated by suggestions that near-earth objects (NEOs) like the so-called ‘Anteros asteroid’ could comprise of over five trillion dollars’ worth of magnesium silicate and aluminium (Kramer, 2017: 131).

Envisaging appropriation concerns that might arise from the future extraction of space assets by spacefaring nations, Article II of the UN OST declared that: “Outer space is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means” (UN, 1967). The emphasis on claims of national sovereignty were intimately tied to the Cold War context at the time, where space activities were under the exclusive monopoly of governmental agencies and initiated for goals of military dominance or national prestige (Sachdeva, 2017: 210). However, the privatisation of the space industry that has occurred since the 1980s has meant that the legislation leaves an enormous amount of legal ambiguity and interpretation regarding the regulation of private resource mining in space. As Shaer (2016) demonstrates, the Article II provision fails to address either the exploitation of space for financial gain or the property claims of commercial enterprises (Shaer, 2016: 47).

Nevertheless, Article VI of the UN OST asserts that: “States shall be responsible for national space activities whether carried out by governmental or non-governmental entities” (UN, 1967; own emphasis). Some scholars have suggested that this clause significantly restrains the activities of private space corporations by incentivising states to regulate their domestic organisations for fear of liability concerns (Abeyratne, 1998: 168). However, the US government recently enacted a piece of legislation which exploited this clause, in order to circumvent its own restrictions and strengthen US economic influence in space. The passage of the 2015 SPACE Act enabled US citizens to privately “possess, own, transport, use, and sell the resources” they obtain in outer space, whilst making careful consideration to deny national sovereign claims over such materials (Leon, 2018: 500).

Yet, regardless of whether it is an American private company or public venture, the US is still satisfying its geopolitical interests; by exclusively siphoning off extra-terrestrial resources for American gain, the nation’s soft power is thereby extended at the expense of spacefaring adversaries such as China (Basu & Kurlekar, 2016: 65). Indeed NewSpace actors cleverly played on these strategic concerns prior to the bill’s passage, with billionaire space entrepreneur Robert Bigelow asserting that the biggest danger wasn’t private enterprises on the Moon, but that “America is asleep and does nothing, while China comes along… surveying and laying claim [to the Moon]” (Klinger, 2017: 222).

The US government’s support for private space companies is also likely to lead to the reinforcement of Earth-bound wealth inequalities in space. Many NewSpace actors frame their long-term ambitions in space with strong anthropogenic undertones, by offering the salvation of the human race from impending extinction through off-world colonial developments (Kearnes & Dooren: 2017: 182). Yet, this type of discourse disguises the highly exclusive nature of these missions. Whilst they seem to suggest that there is a stake for ordinary citizens in the vast space frontier, the reality is that these self-described space pioneers are a member of a narrow ‘cosmic elite’ – “founders of Amazon.com, Microsoft, Pay Pal… and a smattering of games designers and hotel magnates” (Parker, 2009: 91).

Indeed, private space enterprises have themselves suggested that they have no obligation to share mineral resources extracted in space with the global community (Klinger, 2017: 208). This is reflected in the speeches of individuals such as Nathan Ingraham, a senior editor at the tech site EngadAsteroid mining, who claimed that asteroid mining was “how [America is] going to move into space and develop the next Vegas Strip” (Shaer, 2016: 50). Such comments highlight a form of what Beery (2016) defines as ‘scalar politics’. In similar ways to the ‘scaling’ of unequal international relations that has constituted our relationship with outer space under the guise of the ‘global commons’ (Beery, 2016: 99), private companies – through their anthropogenic discourse – are scaling existing Earth-bound wealth inequalities and social relations into space by siphoning off extra-terrestrial resources. By constructing their endeavours in ways that appeal to the common good, NewSpace actors are therefore concealing the reality of how commercial resource extraction serves the exclusive interests of their private shareholders at the expense of the vast majority of the global population.

Private Space Corporations and Orbital Surveillance: Dual-Use Satellite Technology

Starting in 2013, the leaking of classified information by former US National Security Agency employee Edward Snowden revealed the extent to which American intelligence agencies were collaborating with the private sector in mass surveillance operations (Bauman et al., 2014). In what has been described as the ‘securitisation’ of society, contemporary states have shifted from “politics to policing and from governing to managing” the public, which has often occurred without the consent or knowledge of their citizens (Petit, 2020: 31). While such practices have conventionally been Earth-bound in nature, the space domain provides an entirely radical and strategically beneficial perspective for conducting surveillance through satellites.

Although many commercial US satellites provide an array of environmental and internet capabilities on Earth, they are also absolutely essential from a national security perspective of maintaining US space superiority (Chatters IV & Crothers, 2009: 257). This is known as the “dual-use” nature of satellites, where civilian and military purposes are blurred into a single observational system and can be adapted for different functions when necessary (Lubojemski, 2019: 128-129). Dual-use satellite technology has been vital for the US military in offering a tactical edge on the battlefield, with 80% of its satellite communications needs being derived from commercial satellites (Hampson, 2017: 7). The reliance on these networks forms a component of the broader US military doctrine of ‘space control’, part of which aims to secure the transmission of commercial satellite data that will prevent the exposure of sensitive military tactics (Peña & Hudgins, 2002).

Whilst the OST does not contain any clauses specifying the rules or regulations of data monitoring in space, any form of malicious or illegal surveillance can be seen to violate Article XI, which requires states to: “Inform the Secretary-General of the United Nations as well as to the public and international scientific community, to the greatest extent feasible and practical, of the nature, conduct, locations and results of [space] activities” (UN, 1967). Yet, legal scholars have claimed that this clause is significantly weak, since states can withhold vital information about their space activities on the basis that the dissemination of such information is neither ‘feasible’ nor ‘practical’ (Chatterjee, 2014: 31-32). The absence of any clear UN guidelines has also meant that American satellite corporations are increasingly capable of refusing to state their intentions, or who their customers are – with the US government being one of these elusive clients.

The 1994 Presidential Decision Decree-23 authorised the US government to require firms to either limit or stop sales of certain satellite images through a process known as ‘shutter control’. It is controversial because it designates the US executive branch the ability to limit publicly accessible information in certain circumstances, possibly violating First Amendment rights (Livingston & Robinson, 2003: 12). During the 2001 War in Afghanistan, the US government bought the rights to all orbital images taken over the theatre of operations by GeoEye’s Ikonos satellite on the grounds of ‘national security’ (The Guardian, 2001). However, media groups accused the government deal of preventing them from informing the public about matters of critical importance that in no way implicated national security, including the independent verification of government claims concerning damage to civilian structures and possible casualties (Livingston & Robinson, 2003: 12). These measures therefore undermined the OST’s Article XI clause by concealing important information to the public when it was feasibly possible, through the guise of national security discourse. At the same time, it allowed the US government to manipulate media coverage of areas it deems to be essential for conditioning public war support in Afghanistan, whilst simultaneously strengthening its space control doctrine.

In many ways this strategy can also be seen as facilitating a ‘global panoptical’ intelligence network (Backer, 2008). By extending the private-public hybrid structure of surveillance into outer space, businesses and governments have the opportunity to observe millions of global citizens unknowingly at any one point – and with it – immense amounts of data. Given that GeoEye received nearly two million dollars in contract-related fees from the US government for its Ikonos pictures (The New York Times, 2001), this could incentivise the commercial satellite industry to continue to restrict data that might serve the interests of citizens globally. As such, satellite imaging may turn into a form of orbital data-siphoning where companies conducting observations in space could sell off their data to the highest bidder, with a concerning disregard for privacy rights. Indeed, the revelations surrounding Cambridge Analytica and Facebook have underscored the extent to which private entities are monetising off the sensitive information of their consumers unknowingly (Balkin, 2018: 2050-2051).

Corporate Space Debris, Security Tensions and Environmental Contamination

Space debris can be defined as non-purposeful man-made objects that reside in space; made up of inactive parts from former space operations and fragmentations of spacecraft, there are nearly 30,000 pieces of debris in the Earth’s orbit (Pellegrino & Stang, 2016: 25). Despite most debris being centimetres or millimetres in size satellites often travel at the speed of a bullet, meaning that a collision between the two could be catastrophic in terms of environmental, mechanical and financial damage (Black & Butt, 2010: 1).

Since the development of the Kessler Syndrome thesis in 1978 – which predicted that space debris may become so dense as to trigger a chain reaction of major collisions – space debris is considered more of a threat to security operations in the near-term than military space activity (Quintana, 2017: 95). Difficulty over determining whether a collision was accidental or a purposeful act further exacerbates this problem, given that “every object in orbit is a threat to everything else in orbit, regardless of its intended function” (Faith, 2012: 86). Such developments have led to the US administration increasingly adopting a securitisation discourse around orbital debris (Bowen, 2014: 47), which may cause concerns as to whether policymakers may react to future American satellite collisions in a militarised manner.

A number of NewSpace actors are likely to complicate these worries even further through recent satellite proposals. Whilst Boeing is proposing a constellation of up to 3,000 satellites, SpaceX has even grander goals of creating a constellation consisting of 4,425 satellites, eventually expanding to 12,000 satellites in the near-future (Kosiak, 2019: 7). Putting this into context, there are currently just around 1,400 active satellites in orbit around the Earth, highlighting the scale of these projects. The collision between a single US privately-owned Iridium satellite and state-owned Russian Cosmos satellite in 2009 underscored not only the sheer amount of debris caused by these collisions – over 1,500 pieces – but also foreshadowed the possible geopolitical tensions that may arise from them (Wang, 2010: 87-88). Given the number of various commercial satellite constellations possibly going into orbit in the near-future, this raises questions over the possibly devastating security hazards they could pose once in orbit or when they eventually become defunct.

Yet the proliferation of these commercial satellite plansalso pose significant environmental issues. Article IX of the OST asserts that: “States shall pursue activities of outer space in a manner that avoids any harmful contamination or adverse environmental changes on Earth” (UN, 1967). However, the use of terms like ‘harmful’ or ‘adverse change’ underscores the lack of specificity over what exactly constitutes environmental damage, or for whom it must refrain from harming. There is also a failure to address the explicit problem of space debris since the discourse is primarily concentrated on chemical effluent pollution, undermining attempts to facilitate the removal of floating wreckage(Gupta, 2016: 26).

The inability of the OST to properly promote environmental considerations in space has been mirrored in the NewSpace community, where there has been a woeful lack of ecological consideration: “The hundreds of articles and books on outer space resource development seldom mention that such actions may adversely affect the environment in ways that will potentially disadvantage their enterprises and the humans that will be required to implement them” (Kramer, 2017: 136). Such images evoke the types of difficulties that private firms have encountered on Earth reconciling capital with the environment in a way that doesn’t damage profit margins (Magdoff & Foster, 2011: 61-66). Yet in doing so, this neglect is only likely to result in the proliferation of extra-terrestrial debris that the UN OST failed to address. Indeed, despite its vastness there is only a narrow region of orbital space that is either useable or beneficial for prolonged human missions (Brearley, 2005: 2), meaning that the increase in space debris from these massive commercial satellite constellations will likely be at the detriment of developing nations who have yet fostered spacefaring capabilities.

Elon Musk’s SpaceX company has already caused complications for Earth-bound astrologists. The brightness of his recent ‘Starlink’ satellite constellation system in comparison to other satellites has been obscuring telescopic images (see Grush, 2020). More concerningly, Starlink may be much more visible during twilight hours which could be problematic in identifying potentially hazardous asteroids in a timely manner (The Verge, 2020). In this sense, whilst private space entrepreneurs are able to increase their profitability from being able to establish constellations, such endeavours are spoiling the scientific work of researchers on Earth that may complicate the monitoring of Earth-based asteroid impacts.

Conclusion: Space as a Global Commodity

Ultimately, this essay has revealed how the UN OST fails to adequately regulate private space enterprises in outer space within an array of activities. Predominately designed from a state-centric perspective, the increasing entanglement of the state apparatus with the private sector is enabling both actors to satisfy their extra-terrestrial interests through legal ambiguities in a way that the treaty never envisaged possible.

Yet, these processes also expose the ways in which the conceptualisation of outer space by both the drafters of the OST and NewSpace actors is intimately connected to Earth-bound social relations and power structures. Whether it be contestations over resources, surveillance or the environment, the concerns raised mirror those taking place on Earth. A product of its time, the OST was broadly concerned with protecting states from damage caused by one another in a tense international terrestrial atmosphere of possible nuclear annihilation, rather than seeking to protect the space environment as an aspiration “in its own right” (Brearley, 2005: 19). Despite framing themselves as the saviours of an anthropogenic extinction, the emphasis of NewSpace entrepreneurs on profit accumulation in space also emulates the types of criticisms private enterprises have faced on Earth, and risk the extension of existing wealth inequalities into the cosmos. The precedent set by NASA in April 2020 that will likely lead to the further involvement of private firms such as SpaceX in space endeavours will therefore serve to restrict public access to the extra-terrestrial domain – and the benefits that may arise from this. Indeed, the notion of outer space as a ‘global commons’ is slowly turning into one of a ‘global commodity’.

DA: Extinction

Human beings are on track to be extinct by 2050; it’s too late for us.

**Schneider-Mayerson 16** <https://lareviewofbooks.org/article/on-extinction-and-capitalism/>

UNLESS YOU’VE DELIBERATELY ignored the accelerating drumbeat of headlines, reports, and nonfiction books that have appeared over the past decade, you’re at least vaguely aware that we are in the midst of the sixth mass extinction in the history of the planet, in which 25 to 40 percent of all species are expected to disappear by 2050. Because extinction is generally a silent, invisible process, we are rarely forced to confront its inherent tragedy and the potentially vast ecological ripples of even a single species’ eradication. When we do, we wonder how we can possibly intervene, individually or collectively. While conservation efforts have widespread support and can boast a few modest (and temporary) victories, they have been overwhelmed by the ongoing wave of anthropogenic annihilation.Which leads to the question that Ashley Dawson’s slim and forceful book, Extinction: A Radical History, aims to answer: how can we stem the tide? By identifying capitalism as the primary culprit, and placing the current mass extinction in the context of ongoing struggles for social and environmental justice, Dawson points  the way toward appropriate forms of conservation for an era of devastating loss.Why has half the planet’s wildlife disappeared over the last 40 years? Why are we losing approximately 100 species every day? The answer, Dawson argues, lies not in the proximate drivers of extinction (deforestation, habitat fragmentation, poaching, overfishing, and climate change) but in the sweeping — historical perspective. Dawson’s training in postcolonial literature makes him keenly aware of the importance of cultural narratives, and he begins with one of the oldest surviving human stories, The Epic of Gilgamesh, which he reads as a legitimizing myth of the deforestation practiced by the ancient Sumerian city-state of Uruk. Population pressures and unsustainable agricultural practices had disastrous consequences for Uruk and the region: the surrounding forest and its creatures, which the god Humbaba had protected, were transformed into desert remarkably quickly. Dawson follows this narrative up to the present day, describing the shifting cultural norms regarding animals and nature from ancient Rome through European colonization.Colonialism had dramatic environmental consequences that scholars have only recently appreciated: colonists transported countless invasive species, forced indigenous peoples into integration in destructive market economies (such as the fur trade), and decimated native cultures that were efficient environmental managers. In addition, Europeans carried with them and attempted to impose cultural beliefs that inspired and permitted their conquest. The ideology of dominating and mastering a passive (feminine) nature was “intended to justify European expropriation of indigenous people and their land” but also “established an exploitative attitude toward flora and fauna” that continues to the present day.Echoing many scholars in the environmental humanities, Dawson argues that much of the proliferating discourse on the Anthropocene (the current era in which humans act as a geologic force) falsely portrays a monolithic “humanity” as a natural architect of mass extinction. It thereby elides the culpability of modern forms of capital accumulation, which were constructed by and primarily benefited wealthy white Northerners. Dawson rightly refuses to see a propensity for environmental degradation as a core element of human nature (if such a thing can be said to exist), noting that cultures and practices of relative sustainability were developed and maintained by indigenous peoples and inhabitants of the global South for millennia. Since our diagnosis of the causes of the contemporary mass extinction necessarily frames our response to it, the question of whether contemporary rapacity equals that of prehistoric homo sapiens sapiens is critical. Dawson points out that this equivalence is not only “historically inaccurate” but “politically disempowering.”What, then, is to be done? Existing and emerging responses to species extinction, Dawson argues, are not only insufficient but might actually exacerbate the problem. Traditional conservation practices — often focused on “saving” charismatic megafauna such as elephants, polar bears, and whales — may be noble endeavors, but they constitute a “paltry bandage over a gaping wound,” a claim that even their fiercest defenders would have to concede. Two novel strategies have attracted a great deal of attention, support, and funding: “rewilding,” which reintroduces key species into large tracts of new wilderness, and “de-extinction,” which proposes to resuscitatate vanished species through genetic engineering. While Dawson finds the former practice relatively harmless, he offers a scathing attack on the latter. De-extinction is potentially disastrous ecologically, he claims, because resuscitated wooly mammoths and passenger pigeons would not only hasten the demise of other species but could themselves suffer and disappear a second time. More broadly, such a Jurassic Park approach constitutes a form of “neoliberal disaster biocapitalism,” in which mass extinction becomes an opportunity for new forms of property, accumulation, and control. (As McKenzie Funk showed in his book Windfall: The Booming Business of Global Warming, climate change presents similar opportunities for eco-profiteering.) Not only are traditional conservation practices, along with rewilding and de-extinction, destined to fail, they offer the false hope that there there are solutions short of fundamental geopolitical transformation.What must be constructed instead, Dawson forcefully argues, is a form of “radical conservation.” This would require recognizing that “the extinction crisis is at once an environmental issue and a social justice issue, one that is linked to long histories of capitalist domination over specific people, animals, and plants.” Dawson’s prescriptions build on initiatives from the global climate justice movement, including the adoption of “degrowth” (minimizing economic growth and consumption), the seizing of assets of major fossil-fuel corporations, and a “Robin Hood” tax on financial transactions, which would fund renewable energy generation, technology transfer to vulnerable nations, and compensation for eco-victims. It is here that Extinction disappoints in its brevity: a fuller explanation of these measures would have offered a useful contribution to the emerging literature on environmental politics in the Anthropocene. Moreover, Dawson is surprisingly nonspecific about the fate of threatened species beyond an abiding faith in the wisdom of the “people of the global South” that might not ultimately be rewarded. Of course, one might also argue that the radical measures Dawson advocates are currently political nonstarters; however, as he notes, “we cannot let the present state of affairs determine our horizon of hope and sense of possibility.”Indeed, the goal of Extinction is to expand our horizons of possibility. Dawson’s raw and sometimes polemical language reflects an emotionally honest response to the incredible violence of species extinction and climate change, as well as a desire to inspire appropriate collective action. While its candor may remind readers of recent eco-apocalyptic meditations (such as Roy Scranton’s Learning to Die in the Anthropocene), Extinction provides an implicit rebuke to their contention that “we’re fucked” and can only accommodate ourselves — philosophically, culturally, psychologically — to a now-inevitable collapse. Though undeniably cathartic, such potentially self-fulfilling claims hide more than they reveal. In particular, they obfuscate historical and present responsibilities for contemporary environmental crises, the buffer provided by wealth, power, and privilege (for nations and individuals), and our ability to mitigate and adapt to whatever changes lie in store.Extinction — and the environmental justice movement that inspires it — seeks to shift our perspective from the beneficiaries of “civilization” to the human and nonhuman victims of its exploitation and ecological destruction. For the millions of species that face extinction, and the billions of comparatively innocent poor and/or indigenous people that suffer from the destabilization and decline of life-supporting ecosystems, radical sociopolitical movements have the potential to slow the dual crises of mass extinction and global climate change. From such a perspective, the question of whether the emergence of an effective anticapitalist environmental politics is “realistic” or “practical” is irrelevant. It is essential. Though thinkers such as Christian Parenti have questioned the value of calling for an unlikely revolution given the “compressed timeframe” of climate change, such demands — and the movements they inspire — can also succeed by advancing alternative perspectives, highlighting neglected issues, and exerting political pressure that can influence public policy and the direction (and speed) of technological development.Extinction is intended as a primer, and it builds on and points readers toward more detailed and nuanced treatments. On the affective dimensions of extinction, readers might consult Thomas van Dooren’s elegant Flight Ways: Life and Loss at the Edge of Extinction, which demonstrates the entanglement and mutual constitution of humans and nonhumans through six heartbreaking stories of avian extinction. On the historical and current relationship between capitalism and that thing we call “the environment,” Jason W. Moore’s Capitalism in the Web of Life: Ecology and the Accumulation of Capital seems poised to become a foundational text, synthesizing environmentalist and Marxist perspectives to argue that capitalism has always been a fundamentally ecological project. Sadly, these and many other innovative and important works in the environmental humanities are aimed primarily at academic readers. Extinction: A Radical History makes a case for being the most accessible and politically engaged examination of the current mass extinction, and is therefore a welcome contribution to the growing literature on this slow-motion calamity. nature of capitalism itself. Whereas recent popular works on extinction (such as Elizabeth Kolbert’s The Sixth Extinction: An Unnatural History) and climate change (such as Naomi Klein’s This Changes Everything: Capitalism vs. The Climate) have shied away from calling for an explicitly anticapitalist environmental politics, Extinction makes a compelling case for its urgent necessity. It does so through an “etiology of the present catastrophe” that combines deft historical synthesis with a careful attention to economic and racial inequality and the legacies of imperialism. Because of its demand for ceaseless expansion and its emphasis on anthropocentric utility as the sole criterion of value, capitalism tends to degrade the conditions of its own material reproduction. In this light, the exploitative features of modern capitalism become “particularly starkly evident when seen through the lens of extinction.”This argument is far from new, but it is buttressed by a valuable — if somewhat compressed and

Climate change, pandemics, and conflict are all active threats.

**Sandberg 14** <https://theconversation.com/the-five-biggest-threats-to-human-existence-27053>

In the daily hubbub of current “crises” facing humanity, we forget about the many generations we hope are yet to come. Not those who will live 200 years from now, but 1,000 or 10,000 years from now. I use the word “hope” because we face risks, called existential risks, that threaten to wipe out humanity. These risks are not just for big disasters, but for the disasters that could end history.Not everyone has ignored the long future though. Mystics like Nostradamus have regularly tried to calculate the end of the world. HG Wells tried to develop a science of forecasting and famously depicted the far future of humanity in his book The Time Machine. Other writers built other long-term futures to warn, amuse or speculate.But had these pioneers or futurologists not thought about humanity’s future, it would not have changed the outcome. There wasn’t much that human beings in their place could have done to save us from an existential crisis or even cause one.We are in a more privileged position today. Human activity has been steadily shaping the future of our planet. And even though we are far from controlling natural disasters, we are developing technologies that may help mitigate, or at least, deal with them.

Future imperfectYet, these risks remain understudied. There is a sense of powerlessness and fatalism about them. People have been talking apocalypses for millennia, but few have tried to prevent them. Humans are also bad at doing anything about problems that have not occurred yet (partially because of the availability heuristic – the tendency to overestimate the probability of events we know examples of, and underestimate events we cannot readily recall).If humanity becomes extinct, at the very least the loss is equivalent to the loss of all living individuals and the frustration of their goals. But the loss would probably be far greater than that. Human extinction means the loss of meaning generated by past generations, the lives of all future generations (and there could be an astronomical number of future lives) and all the value they might have been able to create. If consciousness or intelligence are lost, it might mean that value itself becomes absent from the universe. This is a huge moral reason to work hard to prevent existential threats from becoming reality. And we must not fail even once in this pursuit.With that in mind, I have selected what I consider the five biggest threats to humanity’s existence. But there are caveats that must be kept in mind, for this list is not final.Over the past century we have discovered or created new existential risks – supervolcanoes were discovered in the early 1970s, and before the Manhattan project nuclear war was impossible – so we should expect others to appear. Also, some risks that look serious today might disappear as we learn more. The probabilities also change over time – sometimes because we are concerned about the risks and fix them.Finally, just because something is possible and potentially hazardous, doesn’t mean it is worth worrying about. There are some risks we cannot do anything at all about, such as gamma ray bursts that result from the explosions of galaxies. But if we learn we can do something, the priorities change. For instance, with sanitation, vaccines and antibiotics, pestilence went from an act of God to bad public health.1. Nuclear warWhile only two nuclear weapons have been used in war so far – at Hiroshima and Nagasaki in World War II – and nuclear stockpiles are down from their the peak they reached in the Cold War, it is a mistake to think that nuclear war is impossible. In fact, it might not be improbable.The Cuban Missile crisis was very close to turning nuclear. If we assume one such event every 69 years and a one in three chance that it might go all the way to being nuclear war, the chance of such a catastrophe increases to about one in 200 per year.Worse still, the Cuban Missile crisis was only the most well-known case. The history of Soviet-US nuclear deterrence is full of close calls and dangerous mistakes. The actual probability has changed depending on international tensions, but it seems implausible that the chances would be much lower than one in 1000 per year.A full-scale nuclear war between major powers would kill hundreds of millions of people directly or through the near aftermath – an unimaginable disaster. But that is not enough to make it an existential risk. Similarly the hazards of fallout are often exaggerated – potentially deadly locally, but globally a relatively limited problem. Cobalt bombs were proposed as a hypothetical doomsday weapon that would kill everybody with fallout, but are in practice hard and expensive to build. And they are physically just barely possible.The real threat is nuclear winter – that is, soot lofted into the stratosphere causing a multi-year cooling and drying of the world. Modern climate simulations show that it could preclude agriculture across much of the world for years. If this scenario occurs billions would starve, leaving only scattered survivors that might be picked off by other threats such as disease. The main uncertainty is how the soot would behave: depending on the kind of soot the outcomes may be very different, and we currently have no good ways of estimating this. 2. Bioengineered pandemic

Natural pandemics have killed more people than wars. However, natural pandemics are unlikely to be existential threats: there are usually some people resistant to the pathogen, and the offspring of survivors would be more resistant. Evolution also does not favor parasites that wipe out their hosts, which is why syphilis went from a virulent killer to a chronic disease as it spread in Europe.Unfortunately we can now make diseases nastier. One of the more famous examples is how the introduction of an extra gene in mousepox – the mouse version of smallpox – made it far more lethal and able to infect vaccinated individuals. Recent work on bird flu has demonstrated that the contagiousness of a disease can be deliberately boosted.Right now the risk of somebody deliberately releasing something devastating is low. But as biotechnology gets better and cheaper, more groups will be able to make diseases worse.Most work on bioweapons have been done by governments looking for something controllable, because wiping out humanity is not militarily useful. But there are always some people who might want to do things because they can. Others have higher purposes. For instance, the Aum Shinrikyo cult tried to hasten the apocalypse using bioweapons beside their more successful nerve gas attack. Some people think the Earth would be better off without humans, and so on.The number of fatalities from bioweapon and epidemic outbreaks attacks looks like it has a power-law distribution – most attacks have few victims, but a few kill many. Given current numbers the risk of a global pandemic from bioterrorism seems very small. But this is just bioterrorism: governments have killed far more people than terrorists with bioweapons (up to 400,000 may have died from the WWII Japanese biowar program). And as technology gets more powerful in the future nastier pathogens become easier to design.3. SuperintelligenceIntelligence is very powerful. A tiny increment in problem-solving ability and group coordination is why we left the other apes in the dust. Now their continued existence depends on human decisions, not what they do. Being smart is a real advantage for people and organisations, so there is much effort in figuring out ways of improving our individual and collective intelligence: from cognition-enhancing drugs to artificial-intelligence software.The problem is that intelligent entities are good at achieving their goals, but if the goals are badly set they can use their power to cleverly achieve disastrous ends. There is no reason to think that intelligence itself will make something behave nice and morally. In fact, it is possible to prove that certain types of superintelligent systems would not obey moral rules even if they were true.Even more worrying is that in trying to explain things to an artificial intelligence we run into profound practical and philosophical problems. Human values are diffuse, complex things that we are not good at expressing, and even if we could do that we might not understand all the implications of what we wish for.Software-based intelligence may very quickly go from below human to frighteningly powerful. The reason is that it may scale in different ways from biological intelligence: it can run faster on faster computers, parts can be distributed on more computers, different versions tested and updated on the fly, new algorithms incorporated that give a jump in performance.It has been proposed that an “intelligence explosion” is possible when software becomes good enough at making better software. Should such a jump occur there would be a large difference in potential power between the smart system (or the people telling it what to do) and the rest of the world. This has clear potential for disaster if the goals are badly set.The unusual thing about superintelligence is that we do not know if rapid and powerful intelligence explosions are possible: maybe our current civilisation as a whole is improving itself at the fastest possible rate. But there are good reasons to think that some technologies may speed things up far faster than current societies can handle. Similarly we do not have a good grip on just how dangerous different forms of superintelligence would be, or what mitigation strategies would actually work. It is very hard to reason about future technology we do not yet have, or intelligences greater than ourselves. Of the risks on this list, this is the one most likely to either be massive or just a mirage.This is a surprisingly under-researched area. Even in the 50s and 60s when people were extremely confident that superintelligence could be achieved “within a generation”, they did not look much into safety issues. Maybe they did not take their predictions seriously, but more likely is that they just saw it as a remote future problem.4. NanotechnologNanotechnology is the control over matter with atomic or molecular precision. That is in itself not dangerous – instead, it would be very good news for most applications. The problem is that, like biotechnology, increasing power also increases the potential for abuses that are hard to defend against.The big problem is not the infamous “grey goo” of self-replicating nanomachines eating everything. That would require clever design for this very purpose. It is tough to make a machine replicate: biology is much better at it, by default. Maybe some maniac would eventually succeed, but there are plenty of more low-hanging fruits on the destructive technology tree.The most obvious risk is that atomically precise manufacturing looks ideal for rapid, cheap manufacturing of things like weapons. In a world where any government could “print” large amounts of autonomous or semi-autonomous weapons (including facilities to make even more) arms races could become very fast – and hence unstable, since doing a first strike before the enemy gets a too large advantage might be tempting.Weapons can also be small, precision things: a “smart poison” that acts like a nerve gas but seeks out victims, or ubiquitous “gnatbot” surveillance systems for keeping populations obedient seems entirely possible. Also, there might be ways of getting nuclear proliferation and climate engineering into the hands of anybody who wants it.We cannot judge the likelihood of existential risk from future nanotechnology, but it looks like it could be potentially disruptive just because it can give us whatever we wish for.5. Unknown unknownsThe most unsettling possibility is that there is something out there that is very deadly, and we have no clue about it.The silence in the sky might be evidence for this. Is the absence of aliens due to that life or intelligence is extremely rare, or that intelligent life tends to get wiped out? If there is a future Great Filter, it must have been noticed by other civilisations too, and even that didn’t help.Whatever the threat is, it would have to be something that is nearly unavoidable even when you know it is there, no matter who and what you are. We do not know about any such threats (none of the others on this list work like this), but they might exist.Note that just because something is unknown it doesn’t mean we cannot reason about it. In a remarkable paper Max Tegmark and Nick Bostrom show that a certain set of risks must be less than one chance in a billion per year, based on the relative age of Earth.You might wonder why climate change or meteor impacts have been left off this list. Climate change, no matter how scary, is unlikely to make the entire planet uninhabitable (but it could compound other threats if our defences to it break down). Meteors could certainly wipe us out, but we would have to be very unlucky. The average mammalian species survives for about a million years. Hence, the background natural extinction rate is roughly one in a million per year. This is much lower than the nuclear-war risk, which after 70 years is still the biggest threat to our continued existence.The availability heuristic makes us overestimate risks that are often in the media, and discount unprecedented risks. If we want to be around in a million years we need to correct that.

We have to get off the rock if we want to survive.

**Kotecki 18** <https://www.businessinsider.com/stephen-hawking-humans-leave-earth-or-be-annihilated-2018-10>

Stephen Hawking believed humans need to leave the Earth in order to avoid annihilation.In a collection of essays published posthumously on Tuesday, Hawking wrote that climate change and the possibility of nuclear war are putting humans in grave danger, adding that the latter is likely the biggest threat to humanity. The scientist, who died in March, wrote in Brief Answers to the Big Questions that people treat the Earth with "reckless indifference," which could result in our own extinction if we don't find another home."One way or another, I regard it as almost inevitable that either a nuclear confrontation or environmental catastrophe will cripple the Earth at some point in the next 1,000 years," Hawking wrote.

Hawking said it was hard for him to maintain his optimism in light of all the problems in the world, particularly political instability and global warming. The population is becoming too large for this planet, and physical resources are quickly running out, he pointed out. A number of issues — including deforestation, the extinction of animal species, rising temperatures, and lack of water — can be solved, though we are failing to take appropriate action, Hawking wrote.He said scientists have a duty to inform the public about the dangers we face, even as politicians who deny the existence of man-made climate change ignore these warnings. If it hasn't already, global warming may become self-sustaining soon, Hawking wrote. For example, the melting of ice caps in the Arctic and Antarctic could lower the amount of solar energy that reflects back into space, which would then brings the global temperature up even more.The Earth could end up looking a lot like Venus, Hawking said, with sulfuric acid rains and a boiling temperature of 482 degrees Fahrenheit.In addition, a catastrophic asteroid collision is inevitable, Hawking wrote. (The last big impact, believed to have wiped out dinosaurs, occurred 66 million years.) As a more immediate threat, Hawking said he is concerned about a possible nuclear war, saying there are enough nuclear weapons to destroy humans multiple times over.Even if we escape to another planet, it may not be possible to save millions of other species. Their extinction, Hawking said, "will be on our conscience as a race."

Though we have nowhere else to go right now, Hawking said humans are explorers and need to channel their curiosity to find new homes. Scientists have proven the Earth is not flat and brought people to the Moon; now, it is time to explore new solar systems, he wrote."We need to rekindle the excitement of the early days of space travel in the 1960s," Hawking wrote. "Spreading out may be the only thing that saves us from ourselves."

CP: The appropriation of outer space is just

In order for best results, governments and private entities have to work together in the race to colonize space

**Gibbons, 19** <https://tucollegian.org/nasa-private-companies-should-work-together-in-space/>

President Donald Trump recently put out a plan to remove funding of the International Space Station by 2025. To fund the International Space Station through non-federal means, the US government has begun to think about the probability of the privatization of outer space. This would mean that International Space Station, or the ISS, would lose direct federal funding in 2025 and would instead be open to private investment in the system.

An internal NASA document acquired by the “Washington Post” stated, “The decision to end direct federal support for the ISS does not imply that the platform itself will be deorbited at that time — it is possible that industry could continue to operate certain elements or capabilities of the ISS as part of a future commercial platform.”

Not everyone is onboard with this new plan for the ISS. Some scientists at NASA fear this loss of federal control will hinder scientific research

Future private space exploration is not a completely ludicrous concept. Companies such as SpaceX are being to enter the space market as opposed to merely the government. The best solution for the future is that public and private entities, such as NASA and SpaceX, should work together through the exchange of information to help further the United States and the world’s knowledge of outer space.

One of the major problems concerning privatization is that the United States does not have full ownership of the space station. In 1998, the United States, Russia, Japan, the EU and China worked together to launch the station into outer space in several pieces. There are two main components to the ISS. The first is the Russian Orbital Segment, ROS, which contains important elements such as the DMS-R, an EU-created set of of computers which controls the “guidance, navigation and control for the entire Space Station,” according to the NASA website. The other part is the U.S. Orbital Segment, USOS, which is where various laboratories and living quarters for current astronauts are located. This part is currently run by the United States, Japan, the EU and Canada. In addition to this, members of foreign nations, such as South Korea and South Africa, have visited the ISS for various different reasons.

Therefore, it is highly unlikely that the United States could potentially sell off or give private companies access to the space station, as they would be competing with various foreign space agencies. Private entities would have difficulties proposing a deal with not only the United States but the rest of the four important members.

NASA and the work it does are not only important for pure scientific research but also for the economy. The money spent in NASA has had a positive effect on the United States since its inception. A 1972 study, done at Pace College in New York, found that “each dollar spent on R&D by NASA returns an average of slightly over seven dollars in GNP over an eighteen-year period following the expenditure.” While this study may not be recent, it gives a good general impression of the monetary value of NASA.

The money spent on NASA has also been important on many technological breakthroughs that affect the daily lives of average Americans. A 2016 Forbes article stated, “Modern satellite communications, weather forecasting and GPS simply would not exist without space exploration. Modern robotics, computers, digital photography and digital video, fuel cells and many other key technologies received huge boosts from space-related R&D.” The work done by NASA has monumental effects on America not only based on scientific research.

However, some may argue that private industry can do the same job and do it cheaper than the government can. One of the major reasons behind this philosophy is the work currently being done by Elon Musk and his company, SpaceX. A budget proposed by the United States Air Force in 2017 stipulated that a rocket launch in 2020 would cost $422 million to complete using a company known as United Launch Alliance. United Launch Alliance is a company created in 2006 by defense and aviation companies Lockheed Martin and Boeing.

In opposition to this monetary assessment, SpaceX was able to complete a similar military launch for the Air Force for $96.5 million. This would be a difference of almost 300 million dollars. CEO Elon Musk stated on Twitter, “$300 million diff. between SpaceX and Boeing/Lockheed exceeds avg. value of satellite, so flying with SpaceX is basically free.” Through this large difference in price, it could be argued that we should let space travel to be done by private businesses as it would save money for the government and the taxpayers. While the Air Force paid for this bill, one could argue that private businesses should run the International Space Station themselves because they could it do more cheaply than the federal government. An example of this fiscal benefit can be seen through the difference between the old Space Shuttle program, discontinued in 2011, and new commercial resupply launches. Every year the Space Shuttle program was active, it cost the U.S. government 4 billion dollars. Through new commercial resupply ships, it only costs 50 million dollars, a trip, to reach the International Space Station.

The best solution is to find a middle ground between the two entities. The United States government should not remove direct financial attachment to the United States’ part of the Space Station because it poses problems in two areas. The first is that the United States Orbital Segment is beneficial for scientific research for not only the United States but also the rest of the globe. It provides scientific discoveries that are not only academic but economic. The second is that it is a good tool of global diplomacy. In the ISS, various countries of the world work together to produce scientific research and are a good symbol of global diplomacy.

On the concept of private companies in outer space, the United States should work together with private entities to enhance scientific discoveries. Companies should compete with each other in the space field. This would not only promotes new technological discoveries but also lower the cost of space travel. The government and private companies working together could potentially achieve things that they could not do alone.

Only with private and public cooperation can the best results be achieved

**Jones, 18** <https://aerospace.org/sites/default/files/2018-06/Partnerships_Rev_5-4-18.pdf>

Governments seeking to expand their capabilities for satellite communications, navigation, Earth monitoring, exploration systems, and other space applications recognize the significant role that the private sector can play in delivering these capabilities at reduced cost and risk through public-private partnerships (P3s). The government sector generally wants to retain some level of control over key capabilities. P3s can provide significant advantages to government agencies by leveraging commercial efficiencies and innovation while sharing risk with the private sector in exchange for profits linked to performance. As space-related P3s proliferate for capital intensive projects and public-private data-sharing models, understanding key challenges and underlying economic arguments from real-world case studies can help lay the groundwork for future success.

Space exploration does wonders for the economy

See raw resources

**Elvis, 21** <https://aeon.co/essays/asteroid-mining-could-pay-for-space-exploration-and-adventure>

 Asteroids are the remnants of our solar system’s youthful exuberance, the leftover crumbs from when the planets formed. For much of the space age, asteroids were ignored in favour of the far more glamorous planets, and the Moon. The asteroids – dark, misshapen rocks, hard to see and hard to find – have long flown beneath our notice. But that was a mistake. They have a crucial role to play in the future of our species – in fact, the survival and flourishing of humanity are tied up with asteroids. There are three reasons. They bear messages from the beginnings of the solar system, before our Earth came into being, and how we got here matters to where we’re going. They are also hoards of resources that might lead us to a future without scarcity. And last – a minor detail – a single asteroid could wipe us off the face of our planet. Let’s look at each in turn.

Asteroids are the remnants of collisions between some of the first mini-planets (called ‘planetesimals’) that formed in abundance when the solar system was no older than a few million years. As a result, many asteroids are just piles of broken rubble held together by their own weak gravity, about a million times more feeble than the gravity we feel here on Earth. Untangling the eventful history of the solar system is easier with asteroids because they’re unsullied envoys from those turbulent early times. Unlike the planets, nothing much has happened to the asteroids in the past few billion years. And there are millions of them, the vast majority orbiting the Sun between Mars and Jupiter in a band called the ‘Main Belt’.

An animation depicts a mapping of the positions of known near-Earth objects at points in time over the past 20 years, and finishes with a map of all known asteroids as of January 2018. Courtesy of JPL/NASA

Perhaps 10,000 asteroids the size of sports stadiums are on orbits that swing close to Earth. As the dinosaurs would attest, our planet occasionally gets hit. But the results aren’t always a bad thing: it’s looking likely that Earth’s oceans were filled by water brought by asteroids. Along with water, asteroids might even have brought the ingredients of life to Earth in the form of so-called ‘prebiotic’ molecules, including amino acids and, as recently [found](https://www.nasa.gov/press-release/goddard/2019/sugars-in-meteorites/), components of proteins and sugars. Learning more about asteroids means learning more about our origins.

What can we actually do with asteroids? That brings us to my favourite thing about them: their resources. Being an idealistic astrophysicist, my interest is in the money to be made from them. That really is idealistic because, if we can make a profit mining the asteroids, then doing bigger things in space will become a lot cheaper. Capitalism has its faults, but one thing it does well is to make things cheaper. I want to use it as a tool so that we can build far bigger telescopes than we could practically realise today. What do astronomers want? More light! Bigger telescopes! Asteroid mining could make that dream a reality.

The siren call of asteroids for miners is that the Main Belt asteroids contain vast amounts of resources. The iron found in asteroids adds up to some 10 million times the iron that we have in proven reserves on Earth. That’s a lot. It’s enough to build many rings of iron girders all the way around Earth’s orbit, along the lines of the science fiction novel Ringworld (1970) by Larry Niven. Not that a ringworld is a sensible thing to make, but it is a really big ring. More plausibly, with that much iron we could build cities in space, as envisaged by the physicist Gerard K O’Neill in the 1970s. Each of these cities would be big enough for a million people to live in. They would be rotating cylinders, and as a citizen of one you would be walking around inside the cylinder’s surface, feeling a fake gravity from the centrifugal force. That’s the scale of resources we’re talking about.

These vast material supplies could make for an era that people call ‘post-scarcity’, where there’s plenty for everyone, just as there is in the 23rd century of the Star Trek science fiction franchise. The starship crew on Star Trek don’t work to keep themselves fed and housed, that’s taken for granted. They work for adventure and exploration. Asteroid wealth could help all of us take a step towards that happy state.

The problem is how to get started. Iron in space is not going to make for giant profits in the short run. On the ground, it sells for less than $200 a ton. It would be worth more in space, but unfortunately there’s no one to buy huge tonnages of iron in space. To adapt the tagline from the Alien movies – ‘In space, no one can hear you sell.’ It certainly isn’t worth bringing space iron back to Earth since the cost of doing so would far exceed the price it could command. Starting to mine space for resources will have to begin with something so valuable that the cost of obtaining it in space is small by comparison. For now, the best bets are precious metals and – surprise – water.

Precious metals are obvious. Platinum sells for about $33.5 million a ton, and we know from meteorites that some asteroids are richer in platinum than any mine on Earth. That sounds promising. Platinum sales run at about 200 tons, or billions of dollars, per year. The bad news is that ‘richer than any mine on Earth’ is still concentrations of just tens of grams per ton, and extracting those precious grams isn’t easy. We can’t just bring an asteroid near to Earth to start extracting the platinum where we can have heavy machinery to work on it. That would take way too much fuel because, to carry more mass, rockets have to carry exponentially more fuel; unlike airplanes, they don’t get the oxygen for free from their surroundings, they have to pull it along with them. Any refining of platinum will have to be done robotically out in the native orbit of the asteroid. That’s quite a challenge.

Water is a less obvious money-maker. The surprise is that water is also worth millions per ton – if it’s sold in space. Water in space is really useful. It’s good for drinking, and the oxygen in it is good for breathing. You can split the hydrogen from the oxygen in H2O and you’ve got rocket fuel, and water is good at absorbing radiation to protect people from cancer-causing cosmic rays. So, in principle, water in orbit is pretty valuable. The good news is that up to 10 per cent of a water-rich asteroid can be water. It won’t be simple ice, most likely, but will be bound into clays and other rocks. Even better, water is much easier to extract than precious metals. Simply heating up the rock will release water that can then be captured.

How much is space water worth? Until recently, it cost $20 million to get a ton of water into even a low orbit – say, to the International Space Station (ISS). To get a ton of water to a high orbit, like the 24-hour orbit of TV transmitting satellites, would cost about three times as much. SpaceX has started to cut that cost; for now, it’s charging about $3 million a ton to a low orbit on a Falcon 9 rocket. Water from asteroids might be able to compete with those prices and still return a nice profit. But the bad news is that, right now, there’s no one in space who wants to buy water. At least not yet. That might be about to change.

We won’t get to build cities in space unless we can build simpler space stations first, and do so at an affordable cost that can scale. If we have space stations, they will need supplies, especially of water and perhaps construction materials. That demand could create a business delivering these supplies from space instead of from Earth. In this case, the asteroids would have the most to offer. So space stations – particularly commercial space stations – are the key to acquiring asteroid resources.

Why build space stations? There are three primary uses: research, manufacturing and tourism. Research has always been done on the ISS, but facilities and time have been in short supply. In recent years, the equipment has improved a lot, but astronaut time is still scarce. Each astronaut has to look after multiple experiments. Multitalented and smart as the astronauts all are, they simply can’t have all the experience of the scientists whose experiments they’re operating. A lot of effort goes into automating those experiments so that the astronauts aren’t overwhelmed. It would be far more efficient if the scientists who invent the experiments also get to be the ones who carry them out in space. Then their years of experience could be put to good use operating and watching over their studies. Spotting subtle anomalies that could be a sign of a failure, or of a discovery, is much better done in person by experts.

But, until now, scientists didn’t have that opportunity, and they would have likely declined it if offered the chance. That’s because training for a mission to the ISS takes more than two years full-time and requires learning Russian. If you take two years off from doing your research, then you’re no longer at the forefront and you’ll have lost your edge. Few top scientists would risk that, however much fun it might be to float in space. We scientists live for our research.

Fortunately, the new commercial stations will be much easier to train for, taking a couple of months or so, because they’ll have a single manufacturer with consistent, uniform interfaces, and a separate professional crew to deal with maintenance and emergencies. The companies with advanced plans so far are all US-based, so English will be the language used. As English is the [lingua franca](https://aeon.co/essays/how-did-science-come-to-speak-only-english) of science, it poses little challenge to scientists worldwide.

The transport cost of bringing a new heart down to Earth is going to be far less than it’s worth to the recipient

Manufacturing in space has always seemed like a fool’s errand. Whatever you make out there would have to be worth outrageous amounts to cover the shipping costs back to Earth. Now, though, those costs have come down almost 10-fold, with more reductions promised. As a result, a few items do pass that test. Already, there are first tests taking place on the ISS to see if the advantages of manufacturing in almost zero gravity (‘micro-gravity’) are really as great as some have suggested.

The most popular idea is to make super-powerful optical fibres that could carry far more data traffic than current transoceanic fibres can. They could potentially do so more cheaply because they would be simpler: they wouldn’t need repeater stations. Certainly, the demand is there, since there’s no limit to the number of cat videos we must share. These ‘ZBLAN’ optical fibres [showed](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5783277/) dramatic improvements when small amounts were made during brief, half-minute long intervals of weightlessness on a parabolic flight. There are a few companies already trying to make ZBLAN fibres on the ISS. The results must be promising because they went back after their first attempt. A kilogram of fancy optical fibres already sells for about $1 million to $20 million. That will pay for the postage and still give you change!

Another idea is to 3D-print human organs in space. Why? Printing ears on Earth has been done, using a scaffolding that later dissolves away. But some organs are trickier, and scaffolds don’t always work. Without that support, the layers of cells tend to slip and slide out of position, which is not the desired effect for something meant to keep you alive. In micro-gravity, the slipping and sliding should be much smaller. The goal is eventually to be able to print a human heart. A heart weighs less than a kilogram. Even with packaging to keep it healthy, the transport cost of bringing a new heart down to Earth is going to be far less than it’s worth to the recipient. Again, first experiments toward this goal are underway on the ISS.

A finger splint produced by the ISS’s onboard 3D printer. Courtesy of NASA

Tourism in space actually goes back quite a way. The first space tourist was Dennis Tito, a US engineer and entrepreneur, who spent a week or so on board the ISS 20 years ago, in 2001. His ride on a Russian Soyuz spaceship was arranged by Space Adventures Inc, a company set up to get private individuals into space. Since then, there have been six others who flew to space with Space Adventures, though their seats weren’t cheap: each ticket cost tens of millions of US dollars. That price limits the ridership pretty strongly. The hope is that the new spaceships will drop the price to something a little more reasonable, say the price of a nice house. At that price, people – still highly affluent – will start to fill up the commercial space stations. The first few might put up with arduous ways of conserving water that the astronauts on the ISS endure, but if one enterprising space station offers showers and a good toilet, they’ll be able to charge a premium. That in turn will produce a demand for a lot more water, where asteroids might come in handy. And there could be unexpected and subtler benefits of space tourism. More people will experience the ‘overview effect’, in which [seeing](https://aeon.co/essays/psychedelics-can-have-the-same-overview-effect-as-a-space-journey) our planet as one borderless, delicate biosphere increases awareness of the fragility and beauty of life. As many of these space tourists will be wealthy, perhaps a shift in their perspective will have outsized influence.

Axiom Space has had the interiors of their space station curated by the luxury designer Philippe Starck

Space stations have always been extremely expensive items that only governments could afford. The ISS is the leading example. It has been called the most expensive building project ever, at about $100 billion. There are now at least four companies trying to make space stations cheaper with the idea of operating them commercially. COVID-19 shut down one of these ventures, Bigelow Aerospace, but the Sierra Nevada Corporation is a new entrant to the space station game. In addition, there’s United Launch Alliance and, the present leader of the pack, Axiom Space.

Axiom Space will start off attaching the first part of its space station to the ISS in late 2024. Over several years, it will add more pieces until it has enough to stand alone, then it will detach itself and fly as an independent, Axiom-owned space station. In recognition that some of their clientele will be used to five-star hotels, Axiom Space has had the interiors of their space station curated by the luxury designer Philippe Starck. Axiom plans to cut the cost of their station at least 10-fold compared with the ISS. There are many countries that want a human space programme but couldn’t previously afford it. Soon they can. Axiom says that they already have more than 20 countries signed up.

All three of these new for-profit uses for space – research, manufacturing and tourism – will lead to a demand for more material in space. Water is needed for all of them, as well as a lot of construction materials. Will all that material come from Earth? Or will our growing capabilities in space mean that it becomes cheaper to bring some of it from the asteroids?

Getting resources from space profitably is not a slam dunk. The physics makes sense – the energy needed is far less than to bring them up from Earth – but the economics aren’t obvious. Getting entrepreneurs and venture capitalists interested in a new enterprise always depends on increasing the reward and diminishing the risk until they reach a threshold where it’s worth taking the leap. Then again, they can’t wait too long or someone else will beat them to it. Historically, governments have done the high-risk, long-term investment needed to seed new markets. And they’re doing so today for space resources.

It seems a safe bet that a decade from now there will be a bunch of commercial space stations orbiting Earth, and that they will house a growing number of people working and vacationing in space. For many, this will constitute our first step in creating a beyond-Earth society.

If knowledge or greed isn’t motivation enough to set your sights on the asteroids, then the one thing virtually all people agree on is that having humanity wiped off the face of Earth would be bad, at least for us. Of all the multiple threats to humanity’s existence, the only one that we can definitely eliminate is that of a large asteroid slamming into our home planet and killing us off, together with most other species, following the lead of the dinosaurs who were made extinct by an asteroid slamming into the ocean. There’s a T-shirt popular among space cadets that has the slogan ‘Asteroids are nature’s way of saying “How’s that space programme coming along?”’ If we can find all the killer asteroids, then we can divert them to render them harmless. Best to play it safe.

There are several searches underway for undiscovered, potentially dangerous asteroids. Thanks to the first big survey, Spaceguard, 90 per cent of the dinosaur-killer-sized asteroids out there have already been found. None of them pose any danger for the next century at least. That still leaves an uneasily large number of about 100 extinction-event-sized rocks out there that we haven’t found yet. Smaller, city-killer asteroids are much less well-surveyed for.

To remedy this concern, two new surveys will begin in the next few years, and they will both be more or less done by 2030. They are the Vera C Rubin Observatory ‘Legacy Survey of Space and Time’, which will start scanning the whole sky every few nights from 2023 onwards. Its mission has been complicated by the mushrooming constellations of thousands of internet satellites now being launched by several companies, with SpaceX being the most visible. Hopefully a solution will be found.

The Vera C Rubin Observatory, on a mountain in Chile, will record its image using normal visible light. For asteroids, that light is reflected sunlight. But many asteroids are pitch black, reflecting only a few percent of the sunlight pouring on to their surfaces. How do you find those dark asteroids? The answer is to use the long wavelength – infrared – light they emit because they’re warm: their ‘black body radiation’. NASA is building a special mission just for this purpose. Developed by a team lead by Amy Mainzer, now of the University of Arizona, Tucson, it’s called the Near-Earth Object Surveillance Mission. Starting around 2025, it will scan the sky repeatedly for five years looking for moving objects that are bright in infrared light, and has wavelengths some 10 to 20 times longer than we can see with our eyes. The team’s tagline is ‘Finding Asteroids Before They Find Us.’ Good idea!

This will be the first time that humanity has deliberately changed the orbit of any celestial body

An advantage of using the black body radiation is that it also tells us quite accurately how big each asteroid is. That helps in assessing their threat, as well giving us a first guess at how much they might yield in resources. Combining the two surveys will indicate how much sunlight each asteroid reflects – its ‘albedo’ – and that’s a clue to what they’re made of. We want to know that because a metal asteroid of a given size is more dangerous than one made of rock, and is more difficult to push out of the way. The composition also helps us explore all two dozen types of asteroid out there, the better to decipher the history of our solar system. As a side product, the surveys will pin down their potential value.

By 2030, we’ll have better rockets than we have today. Several are set to fly within five years. They’ll let us reach many more asteroids with more massive payloads to deflect them, study them or mine them.

Also by 2030, several more asteroids will have been visited by our exploration spacecraft. JAXA, the Japanese space agency, and NASA each had recent missions to return samples from carbonaceous asteroids. The Japanese Hayabusa2 went to the spinning-top-shaped asteroid named Ryugu, and NASA’s OSIRIS-REx went to the asteroid called Bennu. Such carbonaceous asteroids are the least changed, we believe, from the time of their formation at the beginning of the solar system’s formation. They are called carbonaceous because they are chockfull of organic (carbon-containing) molecules; many of them also contain quite a lot of water. There are more missions planned to more distant asteroids such as Psyche, a metal asteroid in the Main Belt, and to the Trojan asteroids trailing Jupiter’s orbit.

OSIRIS-REx samples and leaves asteroid Bennu. Courtesy of NASA

Every time we visit an asteroid, it surprises us. Bennu was found to be throwing rocks off its surface as it spun around its axis, and when OSIRIS-REx put down its outstretched arm to grab a sample off the surface, the arm sank half a metre into the asteroid; it stopped going deeper only when the retrorockets fired to stop it. That’s really not how rubble behaves on Earth!

The more we know about asteroids, the more confident we can be that we can deflect their path away from Earth. A NASA mission called DART will make a high-speed impact on the small moon of the asteroid Didymos in late 2022 to see if we can slow down a dangerous asteroid to stop it causing devastation on Earth. (Don’t worry: the target was chosen to be a safe one for us.) This will be the first time that humanity has deliberately changed the orbit of any celestial body. It isn’t likely to be the last.

Once all the good-sized accessible asteroids have been found, their orbits mapped, their sizes known, and at least a good clue found as to what they’re made of, the barriers to mining them will be much lower. After visiting a half dozen asteroids up close, we’ll have learned a great deal about their origins, how to deflect them should one be headed our way, and how to handle them. That will put us in a good place to begin to extract their resources. I predict this will happen right around 2030, when demand for in-space materials should be picking up. The stars seem to be aligning for mining the asteroids. Mining will expand our capabilities in space, especially making it easier to deflect a dangerous asteroid. In a virtuous cycle, those new capabilities will lead us on to greater exploration of the many worlds in our solar system and, with bigger, better telescopes, to the Universe beyond. It should be fun.

See space tourism

**Sheetz, 19** <https://www.cnbc.com/2019/03/18/ubs-space-travel-and-space-tourism-a-23-billion-business-in-a-decade.html>

UBS believes there will be very lucrative ramifications from the space flight efforts currently led by Virgin Galactic, SpaceX and Blue Origin.

A lengthy UBS report published on Sunday found that, in a decade, high speed travel via outer space will represent an annual market of at least $20 billion and compete with long-distance airline flights. Space tourism will be a $3 billion market by 2030, UBS estimates.

“While space tourism is still at a nascent phase, we think that as technology becomes proven, and the cost falls due to technology and competition, space tourism will become more mainstream,” UBS analysts Jarrod Castle and Myles Walton wrote in the note. “Space tourism could be the stepping stone for the development of long-haul travel on earth serviced by space.”

UBS expects the broader space industry, which is worth about $400 billion today, will double to $805 billion by 2030 when accounting for these innovations. While these sub-sectors would be a small part of that, Castle and Walton said “the outlook for the space economy, space tourism and long-haul travel using space has become much more bullish.”

Private space companies “are investing aggressively across the space opportunity,” UBS said, and the firm believes access to space “is the enabler to broader opportunities for investment.”

Revolutionizing long distance travel

Long haul airplane flights that are more than 10 hours in duration would “be cannibalized” by point-to-point flights on rockets, UBS said. The firm pointed to SpaceX’s plans to use the massive Starship rocket it is building to fly as many as 100 people around the world in minutes. SpaceX said that Starship would be able to fly from New York to Shanghai in 39 minutes, rather than the 15 hours it takes currently by airplane.

A rendering of SpaceX’s Big Falcon Rocket (BFR).

SpaceX

UBS estimates that there are more than 150 million passengers a year that fly routes longer than 10 hours. Last year, those routes saw 527,000 routes on airplane that had an average of 309 seats, UBS said.

“If we assume that 5 percent of these flights in the future are serviced by space at $2,500 per trip, the revenue opportunity as of today would be more than $20 billion per year as of today,” UBS said

“Although some might view the potential to use space to service the long-haul travel market as science fiction, we think ... there is a large market,” UBS said.

UBS noted that “it is unlikely that a rocket will carry over 300 people anytime soon,” so the Starship’s capacity of 100 will be the maximum for the foreseeable future. However, UBS believes there may be an “increased frequency of space travel during the day to enable the same volume of passengers,” the firm said.

WATCH NOW

VIDEO01:05

Elon Musk reveals his plan to send passengers anywhere on Earth in under 60 minutes, for the price of a plane ticket

“Given the length of long-haul commercial travel, and the rules around crewing and take-off and landing time slot restrictions at airports, we think a re-usable rocket (especially if not land-based) would have materially better utilisation rates than a commercial plane,” UBS said.

As a result, UBS believes the $20 billion estimate “could prove conservative,” the firm said. More than 10 percent of people in a recent UBS survey said they would choose a spacecraft over an aircraft for long distance travel.

“While the timing of such a long haul service is uncertain, we think our base-case assumptions are conservative,” UBS said.

Space tourism’s market potential

The [billions of dollars](https://www.cnbc.com/2018/01/18/space-companies-got-3-point-9-billion-in-venture-capital-last-year-report.html) pouring into private space companies represents “a high level” of capital formation, UBS said. Even though space tourism “is still nascent,” UBS said they believe the sub-sector “will become mainstream as the technology becomes proven and cost falls.”

To date, space tourism has largely been limited to the few flights organized by U.S.-based Space Adventures. Over the past two decades, the company has flown seven tourists using Russian Soyuz rockets. At a reported cost of more than $20 million per person, the private clients typically spent over a week on board the International Space Station.

But now “there are a number of commercial space ventures to open up suborbital travel,” UBS noted. Virgin Galactic and Blue Origin are leading those efforts, both getting steadily closer to launching paying tourists.

“This area seems to be the market that has the greatest potential to gain traction quickly,” UBS said.

WATCH NOW

VIDEO01:31

Virgin Galactic sends its first test passenger to the edge of space

Virgin Galactic is deep into the development program of its spacecraft. Last month, the space venture owned by [Sir Richard Branson](https://www.cnbc.com/richard-branson/) sent test passenger Beth Moses on Virgin Galactic’s spaceflight – a first for a private U.S. company. Virgin Galactic’s spacecraft holds up to six passengers along with the two pilots. As the company has more than 600 would-be astronauts signed on to launch, Moses’ work is key to preparing Virgin Galactic for commercial operations. Tickets for Virgin Galactic’s flights are priced [at $250,000 each.](https://www.cnbc.com/video/2017/03/02/want-a-ticket-to-space-virgin-galactic-is-at-your-service.html)

UBS believes Virgin Galactic’s business model, as both a tourism company and manufacturer of spaceships, mimics the growth of businesses in the early days of aviation.

“In this way history could repeat itself as United Airlines today can trace back its roots to the Boeing Aircraft & Transport Company,” UBS said.

Blue Origin, the company founded by Amazon CEO Jeff Bezos, is also [nearing its first spaceflights with human passengers.](https://www.cnbc.com/2019/01/23/livestream-jeff-bezos-blue-origin-launches-experiments-for-nasa.html) Blue Origin is developing the New Shepard rocket system for the company’s space tourism business.

As both Virgin Galactic and Blue Origin utilize reusable spacecraft systems, UBS believes the companies will be able to make space tourism “a more common occurrence” as reliability increases and prices decline.

“We estimate space tourism will be a $3 [billion plus per year] opportunity growing at double digit-rates,” UBS said. “This would be similar to what happened in commercial aviation, especially after the rise of low-cost airlines.”

SpaceX could also see significant cash flow from space tourism, UBS believes, through two different ventures. [Elon Musk’s](https://www.cnbc.com/elon-musk/) company just [completed a historic test flight](https://www.cnbc.com/2019/03/08/spacex-crew-dragon-splashdown-in-the-atlantic-ocean-for-nasa.html) of its Crew Dragon capsule, which will be able to send as many as four astronauts to the space station. UBS estimates that NASA will pay SpaceX about $58 million on average per astronaut, compared to the $81 million per astronaut for flights on Russian Soyuz rockets.

The second SpaceX opportunity is for early flights of Starship to send tourists on missions beyond the Earth’s immediate orbit. In September, Musk announced Japanese billionaire [Yusaku Maezawa signed with SpaceX](https://www.cnbc.com/2018/09/18/spacex-japan-billionaire-yusaku-maezawa-first-tourist-to-fly-to-moon.html) to fly around the moon on Starship. Maezawa expects to fly in 2023, with six to eight guests joining him for the flight.

Space colonization can solve for existential threats

**Kiger, 21** <https://science.howstuffworks.com/10-reasons-space-exploration-matters.htm#pt6>

At the time of the [moon landing](https://science.howstuffworks.com/moon-landing-hoax.htm) in 1969, many people envisioned that by the beginning of the 21st century, space travel would become routine, and we would be visiting other planets in our solar system and perhaps even daring to venture into interstellar space.

Sadly, that future hasn't yet arrived. In fact, some people have started to question whether we need space travel anymore. Wasn't going to the moon good enough? Maybe the U.S. should leave space exploration to private companies -- or even other countries.

But those who've long dreamed of humans becoming a truly [spacefaring](https://science.howstuffworks.com/how-to-build-better-space-explorer.htm) race argue that exploring space provides down-to-earth benefits in areas such as health, mining and security. And more inspirational benefits, too. Here are some of the most compelling arguments for continuing the exploration of space.

[Exploring space to prepare for Earth's future | Thales Group](https://www.thalesgroup.com/en/group/journalist/magazine/exploring-space-prepare-earths-future#:~:text=Space%20exploration%20allows%20us%20to,geological%20evolution%20of%20other%20planets)Already, our ability to put [satellites in space](https://science.howstuffworks.com/question378.htm) is helping us to monitor and combat pressing problems on Earth, from [forest fires](https://science.howstuffworks.com/nature/natural-disasters/wildfire.htm) and oil spills to the depletion of aquifers that people depend upon for drinking water [source: [Fowler](http://www.utexas.edu/know/2014/07/21/anniversary-shows-us-that-nasa-and-space-exploration-are-worth-their-costs/)].

But our burgeoning population, rampant greed and thoughtlessness about environmental consequences have already done pretty severe damage to our planet. According to a 2012 survey of research, most scientists estimate that Earth has a carrying capacity of between 8 and 16 billion – and we already have a population of over 7 billion [source: [UNEP](http://na.unep.net/geas/archive/pdfs/GEAS_Jun_12_Carrying_Capacity.pdf)]. That's led some futurists to argue that we should be preparing to colonize another planet, and soon. Your life -- or those of your descendants -- might depend upon it.

Scientific discoveries from space have real world impacts

**N.a., 20** <https://www.thalesgroup.com/en/group/journalist/magazine/exploring-space-prepare-earths-future#:~:text=Space%20exploration%20allows%20us%20to,geological%20evolution%20of%20other%20planets>.

Space exploration isn’t simply a sign of humanity’s hubris or a brazen desire to find new places to live and new sources of wealth. If we take the risk of venturing beyond our terrestrial home, it’s also to learn more about ourselves and our planet, improve life on Earth, and maybe, just maybe, find or create a new future for our children, says Walter Cugno, Vice President Exploration and Science Domain at Thales Alenia Space.

Why spend such vast sums of money on space exploration and missions to far-distant celestial bodies where most people will never go?

I’d answer that question with a quote from Goethe: “If you want to reach the infinite, then explore every aspect of the finite.” Space is first and foremost a fantastic "playground" for scientists — an endless source of knowledge and learning that’s helping answer some of the key existential questions about Earth’s origins and our place in the Universe.

Space exploration allows us to prove or disprove scientific theories developed on Earth. Studying the solar system, for example, has brought us insights into such phenomena as gravity, the magnetosphere, the atmosphere, fluid dynamics and the geological evolution of other planets.

Scientists today are especially interested in dark matter and dark energy to better understand their role in the hidden mass and accelerating expansion of the Universe. This is the objective of the [Euclid](https://www.thalesgroup.com/en/worldwide/space/news/euclid-design-approved-esa-mission-will-explore-dark-universe)1 mission being developed by the European Space Agency (ESA).

Does space exploration have any more practical benefits?

Many innovations in fields ranging from metals and alloys to biology and medicine are the result of space exploration. Some applications — like ceramic coatings in our kitchens, air purification systems, smoke detectors and scratch-resistant glass — are already part of our daily lives.

Materials tested in space, under unique conditions that are difficult to replicate on Earth, can help us to develop stronger, lighter, higher-performance products. One of the experiments conducted by French ESA astronaut [Thomas Pesquet](https://www.thalesgroup.com/en/worldwide/space/news/what-do-you-want-be-when-you-grow-astronaut) on the International Space Station (ISS2), for example, involved testing innovative materials designed to prevent bacterial growth. These new materials have considerable potential for public health and safety applications in hospitals, public transport and the food industry. The current COVID-19 pandemic brings the importance of this kind of research into sharp focus.

Let me give you another practical example. Long-duration missions are tough on the human body. Astronauts suffer loss of muscle mass and bone density, as well as accelerated wear and tear on the circulation system. Monitoring them in space and after they return to Earth is a chance to learn about the effects of ageing and support research into conditions like osteoporosis.

Drawing on our experience in pressurised modules and orbital infrastructure, we’re currently working on a habitation module that could be used in remote or hostile locations like polar bases, desert camps, military outposts and offshore oil and gas platforms.

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So space is a crucible for innovation?

Yes, but it’s much more than that. Space exploration is a driving force in our efforts to [address the major challenges facing society today](https://www.thalesgroup.com/en/group/magazine/monitoring-earth-and-climate-change-impact-space). It’s educating us about our responsibilities to the Earth and its resources.

How is it doing that?

Astronauts have to survive on limited food, raw materials, sunlight, energy, water and oxygen. Most of the water consumed on the [ISS](https://www.thalesgroup.com/en/worldwide/space/news/spaceforlife-iss-celebrates-20-years-life-space), for example, is derived from urine and other recycled wastewater. So new techniques had to be developed to make sure it’s completely safe to drink.

In 2015, for example, a [Cygnus](https://www.thalesgroup.com/en/worldwide/space/press_release/cygnus-spacecraft-its-way-international-space-station)3 cargo spacecraft carried a 3D printer into orbit to conduct tests under zero-gravity conditions. With this kind of printer, astronauts could eventually produce any spare parts they need directly aboard ship. In October 2020, a Cygnus craft delivered essential supplies to the ISS, including food, water, oxygen, propellant, and space parts. One of the many scientific experiments contained in the cargo module involves the testing of a drug that could be used for the treatment of leukemia. All these experiments being handled by astronauts inside the ISS will be re-used in the near future to improve not only the medical sectors, but many others as well.

The [EDEN ISS](https://www.thalesgroup.com/en/worldwide/space/news/who-will-feed-our-future-mars-explorers) project, meanwhile, aims to develop ways to cultivate food crops in extraterrestrial environments in order to provide food for the ISS and, eventually, for space exploration vehicles and planetary outposts.

Space travel is a great opportunity to test the circular economy. Based on the experience of astronauts, humanity can learn how to better conserve the planet’s resources.

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Space is the stuff of dreams for children and grown-ups alike. Extraterrestrial life and voyages through interstellar space have piqued the imaginations of novelists and filmmakers for decades.They seem to have a particular fascination with Mars. As a scientist, do you appreciate this more mythical aspect of space?

Yes, of course — and I love it. Like many other kids, I used to gaze at the stars on summer evenings and dream of voyages into space. I’m really lucky that my childhood passion has turned into a career.

I don’t know if we’ll one day inhabit Mars, or if science fiction will become science fact and confirm or disprove the tales of Aleksey Tolstoy, Isaac Asimov, Philip K. Dick or Ray Bradbury. The Red Planet continues to fascinate, maybe because it’s the closest contender for becoming a host planet — although it still takes seven to nine months to get there. In any case, this fascination with space exploration is helping drive great strides in our knowledge.

For example, the ExoMars4 [Trace Gas Orbiter](https://www.thalesgroup.com/en/worldwide/space/news/quick-chat-tgo-orbit-mars) (TGO) has been studying the composition of the Martian atmosphere for several years to look for traces of methane, a vital component of life, and determine whether it’s of biological or geological origin. The TGO also serves as a communications relay between Mars and Earth. In 2022, an ExoMars spacecraft will be launched on a seven-month journey to the Red Planet. The aim of the [mission](https://www.thalesgroup.com/en/worldwide-space/science-and-space-exploration/magazine/digging-deep-martian-sub-surface-detect) is to land a a rover on the surface of Mars to search for signs of past life.

The [Mars Sample Return mission](https://www.thalesgroup.com/en/worldwide/space/press_release/thales-alenia-space-selected-airbus-partner-mars-sample-return)5, which is part of an international collaboration led by NASA, will bring back samples from the Red Planet to Earth.

How closely is Thales involved in these missions?

Through Thales Alenia Space, which is 67% owned by the Group and 33% by Leonardo, Thales is a [pivotal partner](https://www.thalesgroup.com/en/global/activities/space) in the most amazing missions [to explore the solar system](https://www.thalesgroup.com/en/worldwide/space/news/thales-alenia-space-space-station-space-exploration). The technologies we’re developing give astronauts the autonomy they need to embark on long missions — missions that currently last over six months on the ISS and could last several years in the case of future crewed missions to Mars or other deep space destinations.

[Moon](https://www.thalesgroup.com/en/group/journalist/magazine/moon-and-beyond-21st-century-space-race) exploration is also key, because it will serve as a forward base for human missions to deep space. Leveraging its long-standing experience in orbital infrastructures, robotics, space transportation systems and exploration, Thales Alenia Space has become a leading partner, providing 3 pressurised modules for the lunar Gateway space station. Gateway is one of the pillars of NASA’s Artemis programme, which aims to land people on the Moon by 2024.

We are also providing the backbone of the spaceship that will take the next man - and the first woman - to the Moon, while studying an innovative human landing vehicle and future solutions to guarantee a permanent human presence on the lunar surface.

So space still inspires you?

It certainly does! Understanding the environment on other planets where humans may one day live, and studying our own biological systems and how materials behave when not influenced by gravity, are crucially important endeavours for our future — and space exploration is helping us to find answers to our questions