SUSTAINABLE DEVELOPMENT IN SPACE LAW: ETHICS & ECONOMICS OF HABITATION IN OUTER SPACE

NIU Law Review | Annual Symposium

FRIDAY, APRIL 8, 2022

A HYBRID EVENT EXPERIENCE

ALTGELD HALL | ZOOM

DEKALB, IL 60115

NORTHERN ILLINOIS UNIVERSITY

College of Law

NORTHERN ILLINOIS UNIVERSITY
College of Law

April 8, 2022

Dear Participant:

I am pleased to welcome you to the Annual Symposium sponsored by the Northern Illinois University Law Review. This year's program, "Sustainable Development in Space Law: Ethical and Economic Considerations of Settlement in Outer Space," addresses legal issues surrounding how space law is becoming increasingly important to practicing lawyers due to the significant rise in outer space activity. Each of the symposium's speakers will present their unique, important perspectives on the subject, and we value their participation.

Pursuant to the law school's commitment to engagement, it is important for the law school to serve as an intellectual gathering place for attorneys, judges, and academics to discuss cutting-edge issues. As such, the symposium has been organized to permit active participation by everyone in attendance. You are encouraged to engage in the discussions during the question-and-answer sessions and panel break periods. These dialogues will ensure the sharing of a variety of perspectives on the expansive range of issues addressed by the speakers.

I am confident that your day will not only be enjoyable, but also enhance your knowledge in meaningful ways. We hope to see you again at next year's symposium and further College of Law events in the future.

Sincerely,

Cassandra L. Hill
Dean and Professor

NORTHERN ILLINOIS UNIVERSITY IS AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION INSTITUTION.

NIU Law Review

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Northern Illinois University College of Law
Law Review Symposium

Sustainable Development in Space Law: Ethical and Economic Considerations of Settlement in Outer Space

Speaker Biographies

"International Law in Space"

Christopher Johnson
Space Law Advisor, Secure World Foundation

Christopher Johnson is the Space Law Advisor at the Secure World Foundation, and a Professor of Law (Adjunct) at the Georgetown University Law Center where he co-teaches the Space Law Seminar. He is also a Faculty Member at the International Space University and a Member of the International Institute of Space Law. Mr. Johnson has written widely on space law and policy issues, and represents the Secure World Foundation at the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS).

Mr. Johnson holds a Bachelor's of Art degree from Michigan State University, a Juris Doctor from New York Law School, and an Advanced Masters in Law in Air and Space Law from Leiden University's International Institute of Air and Space Law. He also has professional certificates from New York University's School of Continuing and Professional Studies, the Oxford Institute of Legal Practice, the European Centre for Space Law, the Hague Academy of International Law, and the International Institute of Humanitarian Law.

Mr. Johnson is also a Core Expert and Rule Drafter in the MILAMOS project, an observer at the Hague International Space Resources Governance Working Group, a Field Editor at the Journal of Space Safety Engineering, on the Board of Editors of the journal Air and Space Law, and on the Academic Review Board of the Cambridge International Law Journal.

"The Economics of Space Settlement"

Jim Plaxco
President, Chicago Society for Space Studies

Jim Plaxco is President of the Chicago Society for Space Studies. In addition, he serves as the Economics SME for the National Space Society's Space Ambassadors program and as a NASA JPL Solar System Ambassador.

Mr. Plaxco has previously served as the National Space Society's Director of Information Systems, as NSS Data Protection Officer, as a NSS Vice President, and was twice elected to the NSS Board of Directors. Other relevant non-profit experience includes serving as President of the Northern Illinois Space Advocacy, Vice President of the Planetary Studies Foundation, as a member of the Enterprise in Space Board of Advisors, as Manager of the Enterprise in Space Orbiter Design Contest, and as a judge in a variety of space art contests sponsored by NASA, IAA, and NSS.

"Working in Space: The Final Frontier of Remote Work"

Alyson Decker
Owner, Alyson Claire Law

Alyson Claire Decker is the owner of Alyson Claire Law, a Southern California law practice that specializes in fractional general counsel legal services, private mediations, and space law. Ms. Decker is an experienced general counsel, litigator, board member, executive, space attorney, and an employment law guru.

She currently teaches as an Adjunct Professor at University of La Verne College of Law. Ms. Decker is also a Legal Advisor to Jus Ad Astra, an organization focused on bringing human rights to the stars, and a member of the advisory board for Smokey Hawk Solitons, an aerospace propulsion startup.

"Ethical Considerations for Governments"

Featured Speaker: Adam Greenstone
Agency Counsel for Ethics, NASA

Adam F. Greenstone is NASA's Agency Counsel for Ethics. Mr. Greenstone manages NASA's Government Ethics program, which advises NASA employees and leaders on U.S. Government standards of ethical conduct and related ethics laws. Supported by ethics officials at each NASA Center, NASA's Government Ethics program advances NASA's mission by helping ensure that NASA and its employees maintain the public's trust. Mr. Greenstone has also authored the article "Ethics and public integrity in space exploration," Acta Astronautica, Volume 143 (2018), and serves on the Enterprise Risk Management Committee of the International Astronautical Federation.

Prior to returning to NASA in 2004, where he originally practiced from 1992-97, Mr. Greenstone was the General Counsel and Deputy General Counsel of the Office of Administration, Executive Office of the President. As a career civil service attorney, he provided legal counsel and advice for a range of activities within the Executive Office of the President, including ethics, employment, information disclosure, information security, procurement and the establishment of White House interagency groups. Earlier in his career he served as the law clerk to the Honorable Eugene R. Sullivan, Chief Judge of the United States Court of Military Appeals (now the United States Court of Appeals for the Armed Forces).

Mr. Greenstone is a recipient of NASA's Space Flight Awareness Honoree Award. He earned his Bachelor's degree from Gettysburg College, his Master's degree from the London School of Economics and Political Science, and his law degree from George Washington University. Mr. Greenstone has also participated in executive education at Carnegie Mellon University and Harvard University's Kennedy School of Government. He is admitted to practice law in Pennsylvania, the District of Columbia and New York. Mr. Greenstone also volunteers as a Director on the board of directors of the NASA Federal Credit Union, and is certified as a Financial Risk Manager (FRM) by the Global Association of Risk Professionals.

“Galactic Accessibility: Interplanetary Human Rights Law through Crip Legal Theory”

AJ Link
Research Director, Jus Ad Astra

AJ Link (he/him) is openly autistic. He received his JD from The George Washington University Law School. AJ is currently pursuing an LL.M in Space Law at the University of Mississippi School of Law, while also serving as the inaugural director of The Center for Air and Space Law Task Force on Inclusion, Diversity, and Equity in Aerospace. He works as a research director for the Jus Ad Astra project and serves as president and executive director of the National Disabled Law Students Association, which he co-founded.

AJ has been actively involved with disability advocacy in the Washington, DC area and nationally within the United States. He serves on several advisory boards and steering committees that focus on disability advocacy and broader social justice movements.

SUSTAINABLE DEVELOPMENT IN SPACE LAW: ETHICAL AND ECONOMIC CONSIDERATIONS OF SETTLEMENT IN OUTER SPACE

April 8, 2022 – A Hybrid Event
Altgeld Hall & Zoom

CHRISTOPHER JOHNSON
Space Law Advisor, Secure World Foundation

INTERNATIONAL LAW IN SPACE

International Law in Space

8 April 2022

Christopher D. Johnson

Space Law Advisor
Secure World Foundation

Professor of Law (Adjunct)
Georgetown University Law Center

SECURE WORLD FOUNDATION

1

Overview of this presentation:

This presentation will give an overview of and salient highlights of the international legal regime governing activities in outer space, as found in the 1967 Outer Space Treaty.

It will also highlight the most important and relevant United Nations fora on discussions and deliberations on space, such as the UN Committee on the Peaceful Uses of Outer Space (COPUOS).

2

Part 1

3

International Space Law

Treaty booklets available in all UN languages at
https://www.unoosa.org/oosa/oosadoc/data/documents/2017/stspace/stspace61rev.2_0.html

4

1967 Outer Space Treaty

The most important source of international space law.

As of 2022, 111 States are party to the Outer Space Treaty.

23 States have signed (but not yet ratified) the Outer Space Treaty.

All of the major, historical space powers, middle space powers, and emerging space powers are party to the Outer Space Treaty.

Treaty booklets available in all UN languages at
https://www.unoosa.org/oosa/oosadoc/data/documents/2017/stspace/stspace61rev.2_0.html

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Principal Elements of the 1967 Outer Space Treaty

Art. 1 – Freedom of exploration and use
Art. 2 – Principle of non-appropriation
Art. 3 – Applicability of international law to space
Art. 4 – Non-weaponization of outer space
Art. 5 – Treatment of astronauts
Art. 6 – International responsibility
Art. 7 – International liability
Art. 8 – Jurisdiction & control
Art. 9 – Cooperation & mutual assistance; due regard

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7

Article One

Freedom of Exploration and Use

8

Article One
Sentence 1

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

*FYI: All highlighting and underlining are mine.

9

Article One
Sentence 2

Outer space, including the Moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.

10

Article One
Sentence 3

There shall be freedom of scientific investigation in outer space, including the Moon and other celestial bodies, and States shall facilitate and encourage international cooperation in such investigation.

11

Article Two

Principle of Non-Appropriation

12

Article Two

Outer space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.

13

Article Three

Applicability of International Law to Space

14

Article Three

States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the Moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international cooperation and understanding.

15

Article Four

Non-Weaponization of Outer Space

16

Article Four
Paragraph 1

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

17

18

Article Four
Paragraph 2
Sentence 1

The Moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes.

19

Article Four
Paragraph 2
Sentence 2

The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on celestial bodies shall be forbidden.

20

Article Four
Paragraph 2
Sentence 3

The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited.

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Article Four
Paragraph 2
Sentence 4

The use of any equipment or facility necessary for peaceful exploration of the Moon and other celestial bodies shall also not be prohibited.

22

Article Five

Treatment of Astronauts

23

Article Five
Paragraph 1

States Parties to the Treaty shall regard astronauts as envoys of mankind in outer space and shall render to them all possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas.

When astronauts make such a landing, they shall be safely and promptly returned to the State of registry of their space vehicle.

24

Article Five
Paragraph 2

In carrying on activities in outer space and on celestial bodies, the astronauts of one State Party shall render all possible assistance to the astronauts of other States Parties.

25

Article Five
Paragraph 3

States Parties to the Treaty shall immediately inform the other States Parties to the Treaty or the Secretary-General of the United Nations of any phenomena they discover in outer space, including the Moon and other celestial bodies, which could constitute a danger to the life or health of astronauts.

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Article Six

International Responsibility

27

Article 6
Sentence 1

States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty.

28

Article 6
Sentence 2

The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty.

29

Article 6
Sentence 3

When activities are carried on in outer space, including the Moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization.

30

Article Seven

International Liability

31

Article 7

Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the Moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies.

32

Article Eight

Jurisdiction and Control

33

Article 8
Sentence 1

A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body.

34

Article 8
Sentence 2

Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth.

35

Article 8
Sentence 3

Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.

36

Article Nine

Cooperation, Mutual Assistance, Due Regard

37

Article 9
Sentence 1

In the exploration and use of outer space, including the Moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of cooperation and mutual assistance and shall conduct all their activities in outer space, including the Moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty.

38

Article 9
Sentence 2

States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose.

39

Article 9
Sentence 3

If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment.

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Article 9
Sentence 4

A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, may request consultation concerning the activity or experiment.

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Articles 10 - 17

42

Articles 10-17

I don't really teach these later articles in the Treaty.

You can read them for yourself.

The later articles are mostly operational formalities about treaty status, amendments, withdrawal, etc.

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Article 12

44

Article 12

All stations, installations, equipment and space vehicles on the Moon and other celestial bodies shall be open to representatives of other States Parties to the Treaty on a basis of reciprocity.

Such representatives shall give reasonable advance notice of a projected visit, in order that appropriate consultations may be held and that maximum precautions may be taken to assure safety and to avoid interference with normal operations in the facility to be visited.

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The United Nations Committee On the Peaceful Uses of Outer Space (COPUOS)

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United Nations System

Six principal organs of the United Nations (in no particular order) [UN Charter, Article 7.1]:

- The General Assembly (UNGA)
- The Security Council (the Permanent 5 are China, France, Russia, UK & USA)*
- The Economic and Social Council (ECOSOC)
- The Trusteeship Council *(suspended in 1994)*
- The International Court of Justice (ICJ)
- The Secretariat

*There are 10 Non-permanent Security Council members (& year their term ends):
Albania (2023) Brazil (2023) Gabon (2023) Ghana (2023) India (2022) Ireland (2022)
Kenya (2022) Mexico (2022) Norway (2022) United Arab Emirates (2023)

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COPUOS in the United Nations System

Main Committees to the United Nations General Assembly (UNGA)

The First Committee	**Disarmament and International Security**
The Second Committee	Economic and Financial
The Third Committee	Social, Cultural, and Humanitarian
The Fourth Committee	**Special Political and Decolonization**
The Fifth Committee	Administrative and Budgetary
The Sixth Committee	Legal

\+ Procedural Committees, and Standing Committees

The **Special Political and Decolonization** Committee deals with a variety of subjects which include those related to decolonization, Palestinian refugees and human rights, peacekeeping, mine action, outer space, public information, atomic radiation and University for Peace.
COPUOS reports to the Special Political and Decolonization Committee (4th Committee).

Meanwhile, the UN Conference on Disarmament (CD) reports to the **Disarmament and International Security Committee (1st Committee)**. However, the CD has been deadlocked for almost 20 years.

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17 December 1966
UN General Assembly First Committee. Arthur J. Goldberg (USA) (left) and E. E. Seaton (Tanzania) (right) addressing the Committee on the Draft Outer Space Treaty.

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History of COPUOS and Space Law

	Instrument
1958	UNGA Res. 1348 (XIII) COPUOS *ad hoc* committee
1959	UNGA Res. 1472 (XIV) COPUOS permanent committee
1961	UNGA Res. 1721 (XVI) *International Cooperation Resolution*
1963	UNGA Res. 1962 (XVIII) *Legal Principles Declaration*
1967	**Outer Space Treaty**
1968	**Rescue Agreement**
1972	**Liability Convention**
1975	**Registration Convention**
1979	**Moon Agreement**
1982	UNGA Res. 37/92 *Direct Broadcasting Principles*
1986	UNGA Res. 41/65 *Remote Sensing Principles*
1992	UNGA Res. 47/68 *Nuclear Power Sources Principles*
1996	UNGA Res. 51/122 *International Cooperation Declaration*
2007	UNGA Res. 62/217 *Space Debris Mitigation Guidelines*
2009	Nuclear Power Sources Safety Framework
2019	Long-term Sustainability Guidelines

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COPUOS Members and Observers

1959: 24 Member States
2022: 100 Member States

Albania, Algeria, Angola, Argentina, Armenia, Australia, Austria, Azerbaijan, Bahrain, Bangladesh, Belarus, Belgium, Benin, Bolivia, Brazil, Bulgaria, Burkina Faso, Cameroon, Canada, Chad, Chile, China, Colombia, Costa Rica, Cuba, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Finland, France, Germany, Ghana, Greece, Hungary, India, Indonesia, Iran, Iraq, Israel, Italy, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Lebanon, Libya, Luxembourg, Malaysia, Mauritius, Mexico, Mongolia, Morocco, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Republic of Korea, Romania, Russian Federation, Rwanda, Saudi Arabia, Senegal, Sierra Leone, Singapore, Slovakia, Slovenia, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syrian Arab Republic, Thailand, Tunisia, Turkey, Ukraine, United Arab Emirates, United Kingdom of Great Britain and Northern Ireland, United States of America, Uruguay, Venezuela & Viet Nam

https://www.unoosa.org/oosa/en/ourwork/copuos/members/evolution.html

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COPUOS Members and Observers

International Intergovernmental and Non-Governmental Observers

AARSE: African Association of Remote Sensing of the Environment; AOCRS: African Organization of Cartography and Remote Sensing; APSCO: The Asia-Pacific Space Cooperation Organization; ARSCAW: Association of Remote Sensing Centres in the Arab World; ASE: Association of Space Explorers; CANEUS-International; CEOS: Committee on Earth Observation Satellites; COSPAR: Committee on Space Research; CRTEAN: Centre Regional de teledetection des Etats de l'Afrique duNord; ESA: European Space Agency; ESF: European Science Foundation, represented by the European Space Sciences Committee; ESO: European Organisation for Astronomical Research in the Southern Hemisphere; ESPI: European Space Policy Institute; EU: European Union; EURISY: European Association for the International Space Year; EUTELSAT-IGO: European Telecommunications Satellite Organization; For All Moonkind; IAA: International Academy of Astronautics; IAASS: International Association for the Advancement of Space Safety; IATA: International Air Transport Association; IAU: International Astronomical Union; Ibero-American Institute of Aeronautic and Space Law and Commercial Aviation; IIASA: International Institute for Applied Systems Analysis; IISL: International Institute of Space Law; ILA: International Law Association; IMSO: International Mobile Satellite Organization; International Astronautical Federation; International Institute for the Unification of Private Law (UNIDROIT); INTERSPUTNIK: International Organization of Space Communications; ISNET: Inter Islamic Network on Space Sciences and Technology; ISO: International Organization of Standardization; ISPRS: International Society for Photogrammetry and Remote Sensing; ISU: International Space University; ITSO: International Telecommunication Satellite Organization; Moon Village Association; NSS: National Space Society; Open Lunar Foundation; PSIPW: Prince Sultan Bin Abdulaziz International Prize for Water; SCOSTEP: Scientific Committee on Solar-Terrestrial Physics;SGAC: Space Generation Advisory Council: Square Kilometre Array Observatory; SWF: Secure World Foundation; TPS: The Planetary Society; UNISEC-Global: University Space Engineering Consortium-Global; WSWA: World Space Week Association

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10 September 1962
Second Session of COPUOS

(first row, left to right):
Ambassador T. P. Plimpton (USA), speaking
Miss. J.A.C. Gutteridge (UK)
Mr. El Sayed Raouf El Reedy (United Arab Republic)
Ambassador Platon Morozov (USSR).

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9 September 1963 Fourth Session of COPUOS
United Nations, New York.

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2014 Scientific and Technical Subcommittee

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2010 COPUOS in the UN Vienna "M" Building,
normally used by the International Atomic Energy Agency (IAEA)

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2010 COPUOS in the UN Vienna "M" Building, normally used by the International Atomic Energy Agency (IAEA)

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2021 COPUOS Schedule

2022 Schedule of work of the Committee and its subsidiary bodies

	Date	*Location*
59th Scientific and Technical Subcommittee	February 7-18, 2022	Vienna
61th Legal Subcommittee	March 29 – April 8, 2022	Vienna
65th Committee on the Peaceful Uses of Outer Space	June 1-10, 2022	Vienna

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Agenda of the Scientific and Technical Subcommittee

2022 Agenda Items at the STSC

1. Adoption of the agenda.
2. Election of the Chair.
3. Statement by the Chair.
4. General exchange of views and introduction of reports submitted on national activities.
5. United Nations Programme on Space Applications.
6. Space technology for sustainable socioeconomic development.
7. Matters relating to remote sensing of the Earth by satellite, including applications for developing countries and monitoring of the Earth's environment.
8. Space debris.
9. Space-system-based disaster management support.
10. Recent developments in global navigation satellite systems.

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Agenda of the Scientific and Technical Subcommittee

2022 Agenda Items at the STSC

11. Space weather.
12. Near-Earth objects.
13. Long-term sustainability of outer space activities.
14. Future role and method of work of the Committee.
15. Use of nuclear power sources in outer space.
16. Space and global health.
17. Examination of the physical nature and technical attributes of the geostationary orbit and its utilization and applications, including in the field of space communications, as well as other questions relating to developments in space communications, taking particular account of the needs and interests of developing countries, without prejudice to the role of the International Telecommunication Union.
18. Draft provisional agenda for the sixtieth session of the Scientific and Technical Subcommittee.
19. Report to the Committee on the Peaceful Uses of Outer Space.

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Working Groups of the Scientific and Technical Subcommittee

1. Working Group of the Whole
2. Working Group on the Use of Nuclear Power Sources in Outer Space
1. Working Group on the Space and Global Health
1. Working Group on the Long Term Sustainability of Outer Space Activities

More at: ***https://www.unoosa.org/oosa/en/ourwork/copuos/working-groups.html***

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26 May 1959
First Session of the Legal Subcommittee. United Nations, New York.

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Agenda of the Legal Subcommittee

2022 Agenda Items at the Legal Subcommittee (LSC)

1. Adoption of the agenda.
2. Statement by the Chair.
3. General exchange of views.
4. Information on the activities of international intergovernmental and non-governmental organizations relating to space law.
5. Status and application of the five United Nations treaties on outer space.
6. Matters relating to:
   a) *The definition and delimitation of outer space;*
   b) *The character and utilization of the geostationary orbit, including consideration of ways and means to ensure the rational and equitable use of the geostationary orbit without prejudice to the role of the International Telecommunication Union.*
7. National legislation relevant to the peaceful exploration and use of outer space.
8. Capacity-building in space law.
9. Review and possible revision of the Principles Relevant to the Use of Nuclear Power Sources in Outer Space.
10. General exchange of information and views on legal mechanisms relating to space debris mitigation and remediation measures, taking into account the work of the Scientific and Technical Subcommittee.

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Agenda of the Legal Subcommittee

2022 Agenda Items at the Legal Subcommittee (LSC)

11. General exchange of information on non-legally binding United Nations instruments on outer space.
12. General exchange of views on the legal aspects of space traffic management.
13. General exchange of views on the application of international law to small-satellite activities.
14. General exchange of views on potential legal models for activities in exploration, exploitation and utilization of space resources.
15. Proposals to the Committee on the Peaceful Uses of Outer Space for new items to be considered by the Legal Subcommittee at its sixtieth-second session.

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Working Groups of the Legal Subcommittee

1. *Working Group on the Status and Application of the Five United Nations Treaties on Outer Space.*
   Chair: Bernhard Schmidt-Tedd (Germany)

1. *Working Group on the Definition and Delimitation of Outer Space*
   Chair: Prof. José-Monserrat Filho (Brazil) / André Rypl (Brazil)

1. *Working Group on Potential Legal Models Potential Legal models for Activities in the Exploration, Exploitation and Utilization of Space Resources*
   Chair: Prof. Steven Freeland (Australia) / Andrej Miztal (Poland)

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Annual IISL / ECSL Symposium at the Legal Subcommittee

Symposium organized by the International Institute of Space Law (IISL) and the European Centre for Space Law (ECSL)
National Laws and Regulations to Ensure Space Sustainability

Tuesday, 5 April 2022
https://www.unoosa.org/oosa/en/ourwork/copuos/lsc/2022/symposium.html

International Institute of Space Law
https://iislweb.org/

European Centre for Space Law
https://www.esa.int/About_Us/ECSL_European_Centre_for_Space_Law/

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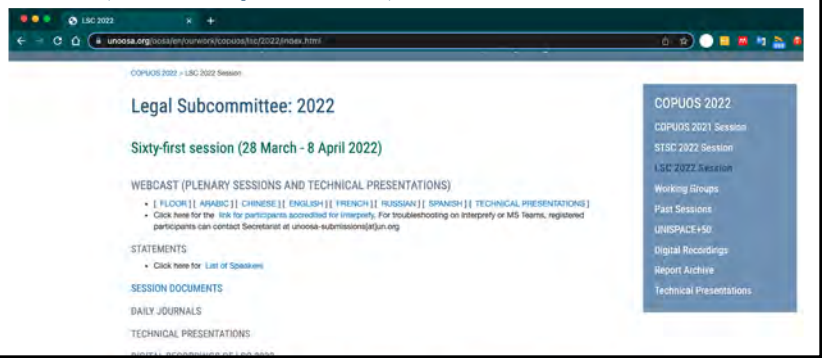
2022 Legal Subcommittee

https://www.unoosa.org/oosa/en/ourwork/copuos/lsc/2022/index.html



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2022 COPUOS Agenda

Agenda Items for the 65nd Session of COPUOS (2022)
June 1–21, 2022

1. Opening of the session.
2. Adoption of the agenda.
3. Statement by the Chair.
4. General exchange of views.
5. Ways and means of maintaining outer space for peaceful purposes.
6. Report of the Scientific and Technical Subcommittee on its fifty-ninth session.
7. Report of the Legal Subcommittee on its sixtieth-first session.
8. Space and sustainable development.
9. Spin-off benefits of space technology: review of current status.
10. Space and water.
11. Space and climate change.
12. Use of space technology in the United Nations system.
13. Future role of the Committee.
14. Space exploration and innovation.
15. "Space2030" agenda.
16. Other matters.
17. Report of the Committee to the General Assembly.

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Thank You
Christopher Johnson
cjohnson@swfound.org
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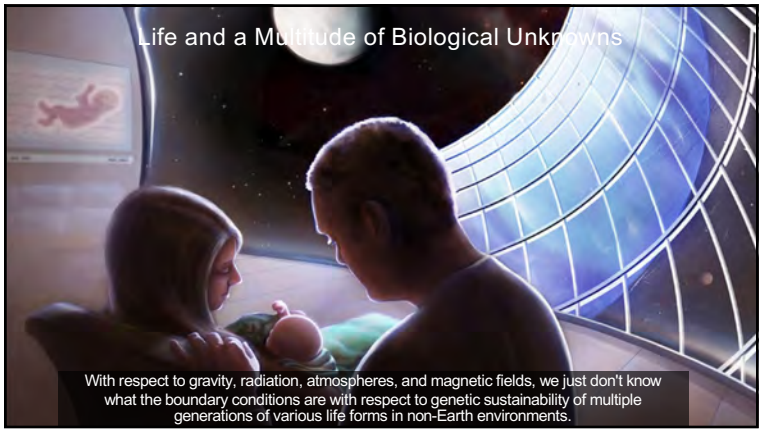
SUSTAINABLE DEVELOPMENT IN SPACE LAW: ETHICAL AND ECONOMIC CONSIDERATIONS OF SETTLEMENT IN OUTER SPACE

April 8, 2022 – A Hybrid Event
Altgeld Hall & Zoom

JIM PLAXCO
President, Chicago Society for Space Studies

THE ECONOMICS OF SPACE SETTLEMENT

1



2

3

Alliance for Space Development March Storm

Alliance for Space Development 2022 Objectives	Citizens' Space Agenda
1. Support commercial development of Low Earth Orbit by fully funding the LEO Commercialization Program including Commercial LEO Destinations (CLD).	
2. Support the Strategic Space Commodities Reserve.	
3. Keep developing and demonstrating Space Solar Power.	
4. Support planetary defense by fully funding NEO Surveyor Mission, a space based telescope optimized for detecting near Earth asteroids.	

Alliance for Space Development — Citizens' Space Agenda 2022

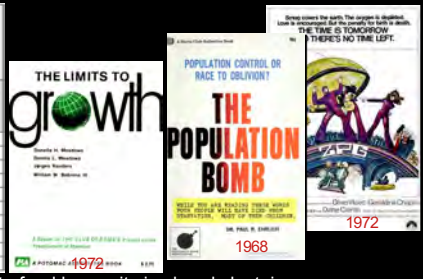
14 meetings with Representative's staff(s)
14 meetings with Senator's staff(s)

4

Some 50 Years ago… Malthusian Predictions

Table 4 Nonrenewable Natural Resources,
Limits To Growth:
A Report For The Club Of Rome's Project On The Predicament Of Mankind
1972

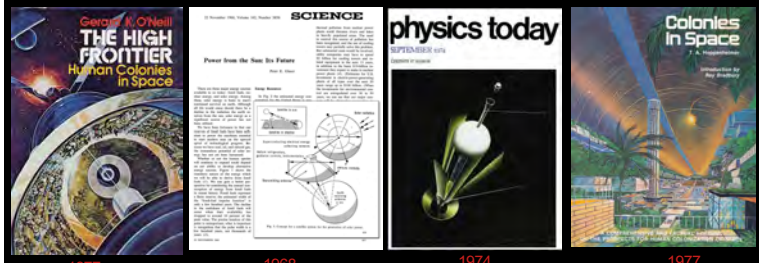
Resource	Static Growth Index Years	Static Growth End Year	Exponential Growth Index Years	Exponential Growth End Year
Aluminum	100	2072	31	2003
Copper	36	2008	21	1993
Gold	11	1983	9	1981
Lead	26	1998	21	1993
Mercury	13	1985	13	1985
Natural Gas	38	2010	22	1994
Petroleum	31	2003	20	1992
Silver	16	1988	13	1985
Tin	17	1989	15	1987
Zinc	23	1995	18	1990



"In fact, the battle to feed humanity is already lost, in the sense that we will not be able to prevent large-scale famines in the next decade or so.",
Paul Ehrlich – The Population Bomb, 1968

5

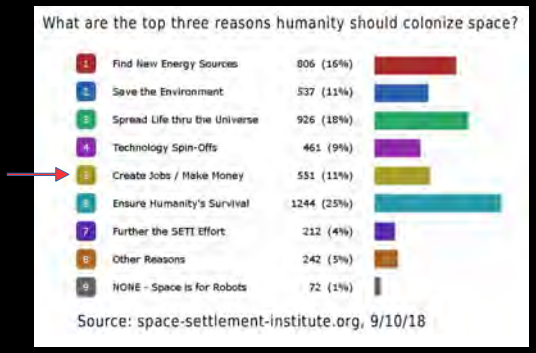
A New Hope: Space



"Careful engineering and cost analysis shows we can build pleasant, self-sufficient dwelling places in space within the next two decades, solving many of Earth's problems."
The Colonization of Space, Gerard K. O'Neill, Physics Today, 1974

6

Why should we pursue space settlement?



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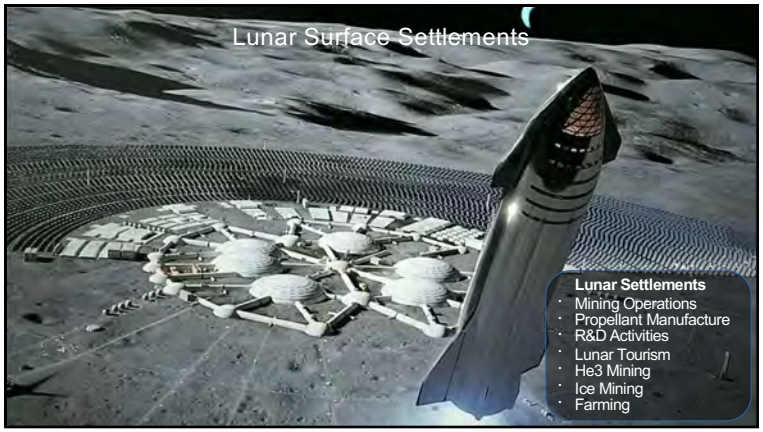
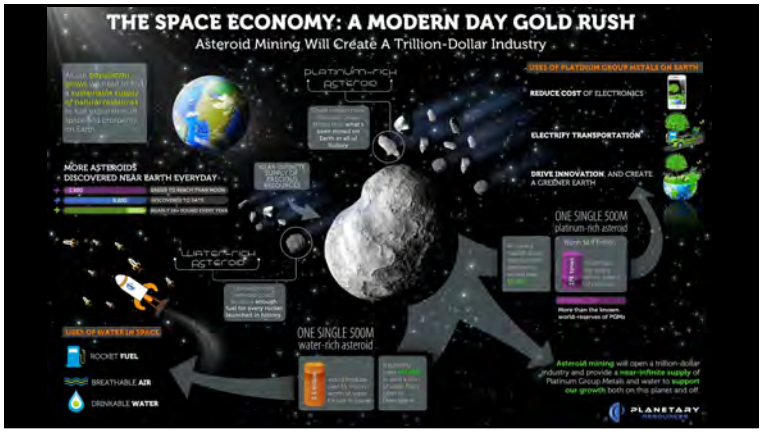
What Will A Million People on Mars by 2050 Mean?

8


Lunar Surface Settlements
Lunar Settlements
Mining Operations
Propellant Manufacture
R&D Activities
Lunar Tourism
He3 Mining
Ice Mining
Farming

9


THE SPACE ECONOMY: A MODERN DAY GOLD RUSH
Asteroid Mining Will Create A Trillion-Dollar Industry
MORE ASTEROIDS DISCOVERED NEAR EARTH EVERYDAY
REDUCE COST OF ELECTRONICS
ELECTRIFY TRANSPORTATION
DRIVE INNOVATION AND CREATE A GREENER EARTH
ONE SINGLE 500M platinum-rich asteroid
ONE SINGLE 500M water-rich asteroid
ROCKET FUEL
BREATHABLE AIR
DRINKABLE WATER
PLANETARY

10


Asteroid Impact Mitigation
Only a spacefaring civilization is adequately prepared to deal with the threat of asteroid/comet impact

11

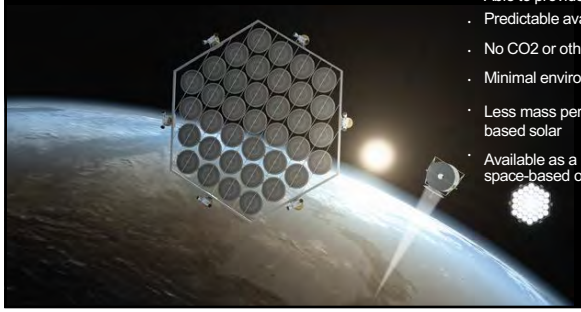

O'Neill Colony
O'Neill Colonies
Materials Processing
vG Manufacturing
vG R&D Activities
SPS Construction
Geoengineering
In-space Asset Servicing
Farming

12

Energy From Space: Space Solar Power

Space Solar Power Benefits:

- Able to provide baseload electricity
- Predictable availability of sunlight
- No CO2 or other gaseous emissions
- Minimal environmental impact
- Less mass per kilowatt than Earth-based solar
- Available as a power source for other space-based operations



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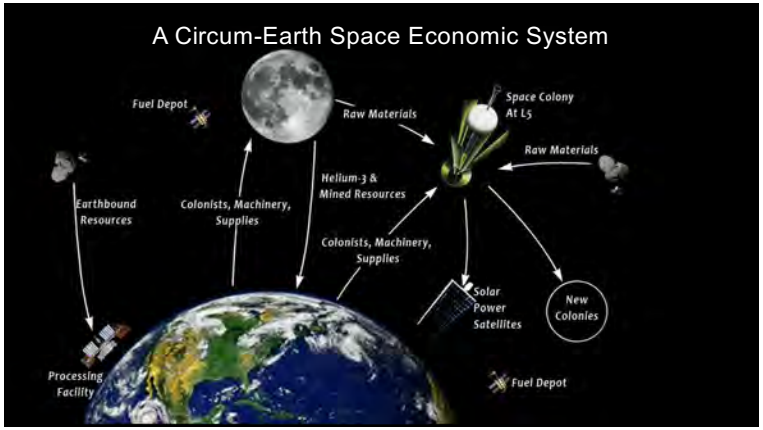
Zero G Research and Manufacturing

Materials Science
Life Science
Specialty Electronics Manufacturing
Specialty Alloys Manufacturing
Specialty Pharmaceuticals Manufacturing
Physics Research

14

A Circum-Earth Space Economic System



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The O'Neill Vision

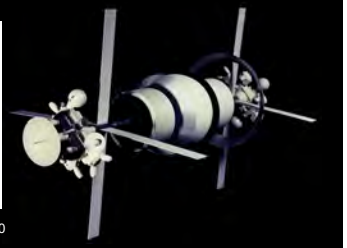
"The Colonization of Space"
Gerard K. O'Neill, Physics Today, Sept. 1974

- Careful engineering and cost analysis shows we can build pleasant, self-sufficient dwelling places in space within the next two decades, solving many of Earth's problems.
- By about 2050... emigration to the colonies could reverse the rise in Earth's population
- ...within another 40 years ... total land area in the colonies would then be more than three times that of Earth.
- if work is begun soon, nearly all our industrial activity could be moved away from Earth's fragile biosphere within less than a century from now.

16

O'Neill's 1974 Cost Estimates for a Model 1 Colony

Estimates Cost of Building a Model 1 Space Colony in 1972 dollars taking 6 years to complete			
ITEM	Unit Cost	Quantity	Total Cost
Launch Vehicles	300,000,000	3	900,000,000
Transport E→ L5 per lb	425	20,000,000	8,500,000,000
People E → L5 per lb	1,000	2,200,000	2,200,000,000
Transport E → M per lb	1,000	6,600,000	6,600,000,000
Equipment for Moon per lb	400	6,000,000	2,400,000,000
Equipment for L5 per lb	180	6,666,667	1,200,000,000
Machines and tools L5 per lb	625	1,760,000	1,100,000,000
Salaries for L5 man-year	50,000	12,000	600,000,000
Salaries for Earth man-year	30,000	240,000	7,200,000,000
Totals			30,700,000,000



- The 1972 median income for men working full time was $10,540
- 2000 space workers for colony construction
- 10,000 population on completion
- Bulk of jobs dedicated to building solar power satellites

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Freeman Dyson's Cost Calculations Updated and Expanded

Expedition	Mayflower	Mormons	Island One L5 Colony	Homesteading the Asteroids
Date	1620	1847	1990	2000
Number of people	103	1,891	10,000	23
Payload (tons)	180	3,500	3,600,000	50
Cost in 1975 $	$6,000,000.00	$15,000,000.00	$96,000,000,000.00	$1,000,000.00
Cost in 2019 $	$28,500,000.00	$71,250,000.00	$456,000,000,000.00	$4,750,000.00
Payload (tons per person)	1.8	2.0	360.0	2.0
Cost per pound in 1975 $	$15.00	$2.00	$13.00	10
Cost per pound in 2019 $	$79.17	$10.18	$63.33	$47.50
Cost per person in 1975 $	$60,000.00	$8,000.00	$9,600,000.00	$40,000.00
Cost per person in 2019 $	$276,699.03	$37,678.48	$45,600,000.00	$206,521.74
Est. Income/Person 1975 $	$20,000.00	$16,000.00	$19,200.00	$20,000.00
Est. Income/Person 2019 $	$92,233.01	$75,356.95	$91,200.00	$103,260.87
Cost in Man years per person	3.0	0.5	500.0	2.0
Cost in Man years per family	7.5	2.5	1500.0	6.0

Title: Pilgrim Fathers, Mormon Pioneers, and Space Colonists: An Economic Comparison
Author: Freeman J. Dyson
Source: Proceedings of the American Philosophical Society, Vol. 122, No. 2 (Apr. 24, 1978),pp. 63-68
Published by: American Philosophical Society

18

ISS vs Island One Build Costs

ISS habitable volume: 388 cubic meters
ISS pressurized volume: 916 cubic meters
ISS truss length: 110 meters
ISS Mass: 460 tons
ISS population: 6

Island One Bernal Sphere - 1g artificial gravity
Diameter: 530 meters
Mass: 3,600,000 tons
Population: 10,000

Cost:
Island One: $456 billion
ISS……..: $150 billion

$ =

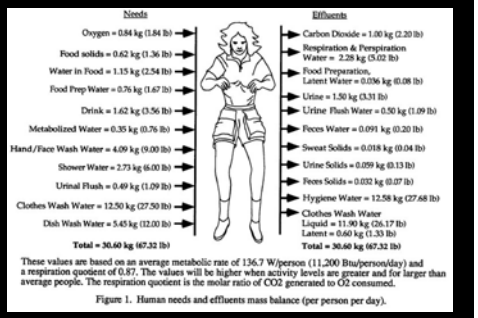
$456,000,000,000 is
2.2% of U.S. 2018 GDP
2,202.9% of NASA 2018 budget

19

It Takes a Lot of Stuff to Keep People Alive

Resource	Amount	Units
Stone	4,276	Kg
Sand and Gravel	3,070	Kg
Coal	2,000	Kg
Cement	297	Kg
Other Non-Metals	243	Kg
Salt	153	Kg
Iron Ore	111	Kg
Phosphate Rock	88	Kg
Clays	64	Kg
Soda Ash	15	Kg
Aluminum	13	Kg
Other Metals	10	Kg
Copper	6	Kg
Lead	5	Kg
Zinc	3	Kg
Manganese	2	Kg
Uranium	0	Kg
TOTAL	10,355	Kg
Natural Gas	2,487	m^3
Petroleum	4	m^3

Minerals consumed by the average person in a year.
Data Source: Minerals Information Institute, 2018



These values are based on an average metabolic rate of 136.7 W/person (11,200 Btu/person/day) and a respiration quotient of 0.87. The values will be higher when activity levels are greater and for larger than average people. The respiration quotient is the molar ratio of CO_2 generated to O_2 consumed.

Figure 1. Human needs and effluents mass balance (per person per day).

The average adult weighs 62 kilograms

20

Living Costs Will Require A Highly Compensated Population Meaning High Labor Costs

Assume a 30 year interest-free mortgage	$45,600,000
Annual mortgage payment will be	$1,520,000
Assuming 28% rule, total income must be	$5,428,571

Source: Abbott and Costello Go to Mars, 1953

21

Solar Power Satellites as Economic Foundation

1979 The SPS Reference System	
Total SPS systems	60
System Output	5gW per SPS, 300gW system total
Deployment Rate	2 SPS per Year
SPS System Life	30 years
SPS Size (km)	10 x 5 x .5
SPS Mass (kg)	35 – 50 x 106
Antenna Diameter (km)	1
Rectenna Size (km)	12 x 15.8
System Assembly Man-years	18,000 using 600 space-workers
Bottom Line Efficiency	< 1 %

Process	Efficiency	watts/km2	Comments
Solar Photon Input (Kw)		1,360,000,000	Eclipse, reflection
Photon Collection	88.00	1,196,800,000	Degradation, environment
Photon Conversion	15.70	187,897,600	DC to RF
Conditioning & Conversion	76.60	143,929,562	Antenna efficiency
Antenna Transmission	96.00	138,892,027	Antenna efficiency
Transmission through Space	99.60	138,336,459	Losses to space
Transmission through Atmosphere	98.00	135,569,730	Losses to scattering, rain
Collection & Conversion	78.30	106,151,098	RF to Electricity
Overall System Efficiency	7.81		The Bottom Line
Electric Output per SPS (Kw)		5,307,554,916	

The system cost of $781 Billion in 1977 ($3.26 Trillion in 2019 using CPI) is not competitive with existing power planet production costs

In IL fo4 2021, avg. electricity cost was $0.126 kWh
On ISS, users of electrcity are charged $2,000.00 kWh (though cost is estimated to be $600.00 kWh)

22

Economic Challenge: The Cost of Systems & Facilities

General contributors to a high cost environment:

- Immature TRL equates to high levels of technological risk
- Complex systems in an extreme environment require extreme engineering
- Maximal levels of system reliability require extreme fault tolerant systems
- Initial and extended lack of economies of scale and scope
- Transportation costs associated with the import of materials and consumables

Life Support Requirements
Air Supply, Purification, Recycling
Water Supply, Recycling
Thermal Management and Climate Control
Food Supply
Energy Supply
Medical Infrastructure/Supply
Waste Processing
Shelters & Lifeboats
Radiation Shielding
Recycle/Resupply Ratio

23

The Transportation Challenge

NASA Space Launch System
209,439 lbs to LEO
> $9,500/lb to $20,500/lb
- $2.2 to 4.3 billion/launch
- ignores $30 billion dev. costs

SpaceX Starship
150,000 lbs to LEO
$10/lb
(Falcon Heavy: $1,000/lb)

Nile Cargo Carrier:
ship 1 cubic meter of water
NY to Cairo, Egypt
$0.18/lb

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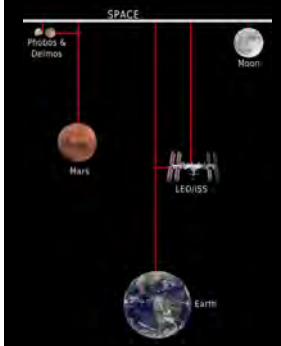
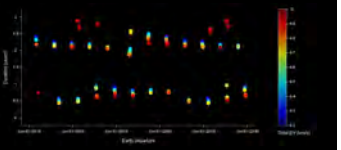
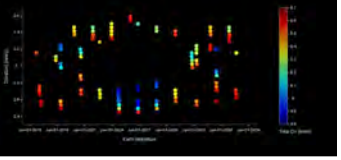
Transportation Challenges



Mars One-Way Trip Launch Windows



Mars Round Trip Launch Windows



25

Transportation Costs and Access to ET Resources

If we had gold bricks stacked up on the surface of the Moon, we couldn't afford to bring them back... There is nothing that we know of in the solar system that is worthwhile going out to get to bring back to the Earth.

Jerry Kulcinski, University of Wisconsin - Madison,
Mining The Moon for Helium-3 - 2007 BBC Documentary
(*At the time gold was $10,000 a pound or $22,046 a kilogram*)

26

Transportation Costs and Human Consumption

- Per the Mars City State Design contest guidelines, the cost of shipping goods:
  Earth to Mars = $500/kg
  Mars to Earth = $200/kg

To import a gallon of milk from Earth to Mars you'd pay
$4.00 for the milk and $1,950.00 to deliver it to Mars
at $500.00 per kilogram or 48,750% of the milk's value

"I don't think it's going to be economical to mine things on Mars and then transport them back to Earth because the transport costs would overwhelm the value of whatever you mined."
Elon Musk

27

Economic Challenge: Transportation Cost Variables

Contributors to a transportation cost challenges:

- Ports and airports don't move BUT planets, moons, and asteroids do
- Energy requirements vary based on the specific orbital path and the gravity environment of the departure and arrival points
- Trip duration depends on the orbital path and the rocket energy available (fuel + thrust profile)
- Human missions require substantial consumables greatly increasing trip mass (space+food+life support+radiation protection+accommodations)
- Fleet utilization rate and transport operation life (# of missions + age)

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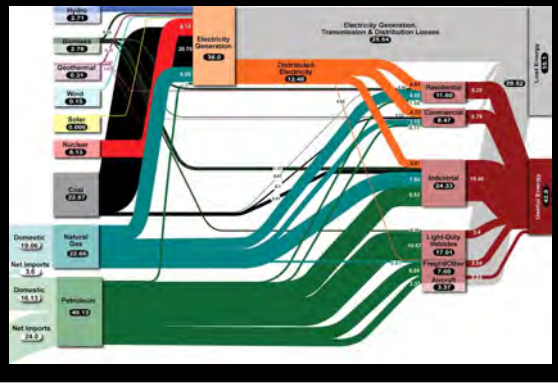
What Will Be Our Source of Energy?

Weekly World News, April 15, 2003

29

A Question of Energy



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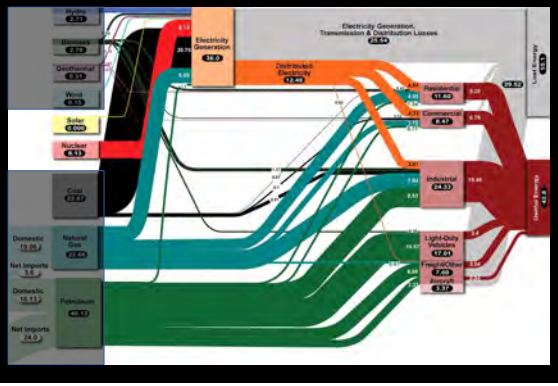
A Question of Energy



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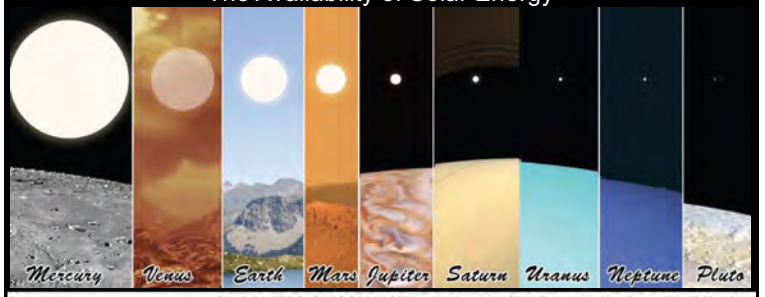
The Availability of Solar Energy



Variable	EARTH	EROS	MARS	CERES	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
Solar Energy Watts per Square Meter	1380.00	653.65	588.05	181.50	51.32	15.14	3.77	1.54	0.89
Solar Energy As a Fraction of Earth's		0.47	0.43	0.13	0.04	0.01	0.00	0.00	0.00
Solar Array Area to Generate 1000 watts	2.88	6.12	6.88	22.04	77.95	264.23	1060.97	2598.13	4485.67

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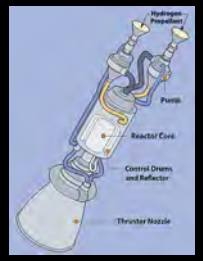
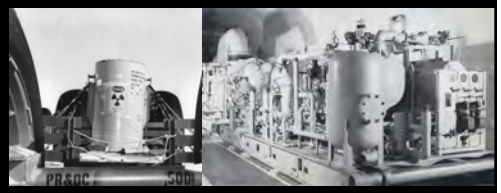
Nuclear Power – The Winning Option



Nuclear Power for Propulsion



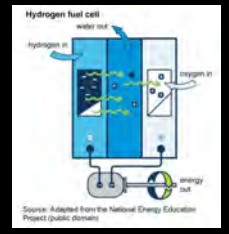
Portable Nuclear Reactors for Baseload Electricity for Settlements and Facilities

33

Economic Challenge: Energy Production and Distribution

Contributors to energy cost challenges:

- Will government policies support the development/use of nuclear power?
- Do local environmental factors make solar reasonable?
- Do local environmental factors make wind, combustion reasonable?
- Will fuel cells be practical for generating electricity?
- How well will energy sources scale up and down?



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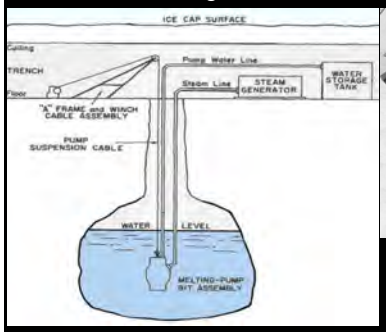
Accessing Resources and Abundance vs Scarcity



Images: U.S Dept. of Defense

Water refresh rate of 10,000 gallons per day

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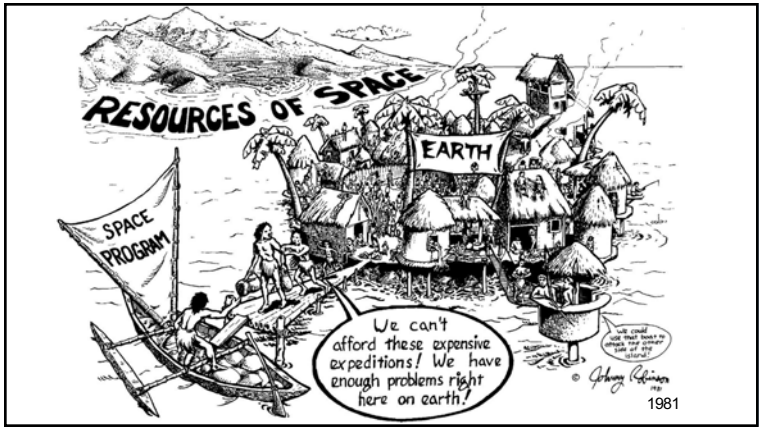

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The Economics of Mining

- Richness of the Ore Source
- Total Quantity of Ore
- Cost of Mining Rights
- Cost of Mine Development
- Ongoing Operational Costs
- Market Price of the Ore
- Future Price Expectations

"Projects such as Robominer with SRI — as well as our Mine iTruck tele-operated mobile explosives manufacturing truck — will enhance mining operations and resources by taking care of our greatest asset, which is people" Juan Andrés Errázuriz, Enaex Group CEO

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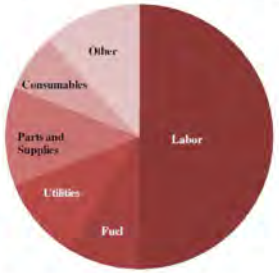
Labor Costs are the Largest Mining Cash Cost Component

Typical Gold Mining Cash Cost Breakdown



Typical Gold Mining Cash Cost Breakdown

Component	Range	Typical
Labor	30% - 55%	50%
Fuel	8% - 10%	9%
Utilities	8% - 11%	10%
Parts & Supplies	8% - 15%	12%
Consumable	14% - 23%	7%
Other	7% - 15%	12%
		100%

CPM Group

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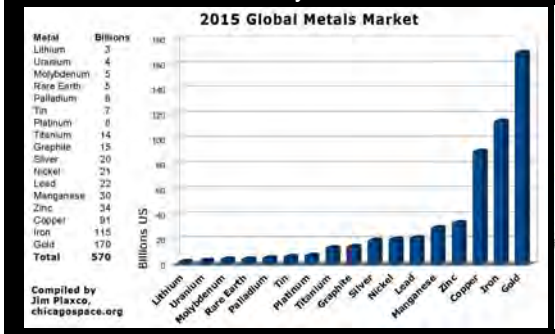
Today's Market for Metals



How does the SCALE of space mining operations necessary to cover costs ALIGN with the Earth market in terms of quantity demanded and market price?

39

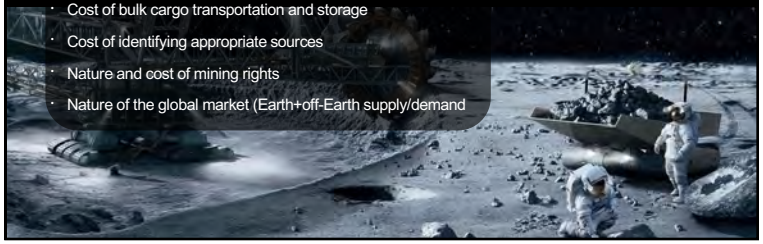
Trillions of Dollars of Resources Just Waiting for Us

40

Economic Challenge: Mining/Processing Resources

Contributors to resource related cost challenges:

- Cost of mining operations
- Cost of processing and refining operations
- Cost of bulk cargo transportation and storage
- Cost of identifying appropriate sources
- Nature and cost of mining rights
- Nature of the global market (Earth+off-Earth supply/demand



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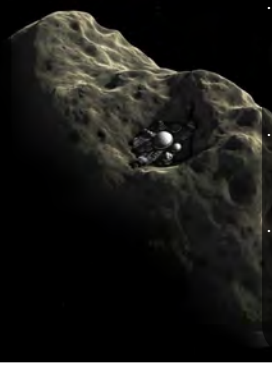
Economic Costs Challenge Summary

- **Energy**
  - Breadth of Alternatives
  - Cost of Production
  - Cost of Distribution
- **Natural Resources**
  - Mining rights
  - Mining costs
  - Processing costs
  - Transportation costs
  - Market conditions



- **Transportation**
  - Cost per kilogram
  - Trip Frequency
  - Trip Duration
- **Living & Manufacturing Facilities**
  - Construction Costs
  - Maintenance Costs
- **Market & Network Effects**
  - **Extent of Supply Chain Integration**
  - **Economies of Scale**
  - **Product Market**

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Porter's Model Applied to Space

Market Entry Factors
- Governance constraints
- Entry costs
- Sunk costs
- Switching costs
- Network effects
- Speed of adjustment
- Economies of scale

Industry Rivalry
- Governance constraints
- Concentration
- Switching costs
- Nature of competition
- Information
- Degree of differentiation

Your Fill-in-the Blank Space Business

Supplier Power Factors
- Governance constraints
- Supplier concentration
- Price of alternate inputs
- Supplier switching costs

Buyer Power Factors
- Governance constraints
- Buyer concentration
- Price of substitutes
- Buyer switching costs

Substitutes & Complements
- Governance constraints
- Price of substitutes
- Price of complements
- Network effects

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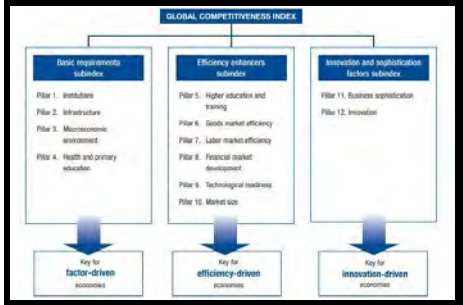
World Economic Forum Defines A Good Economic System



"We define competitiveness as the set of institutions, policies, and factors that determine the level of productivity of an economy, which in turn sets the level of prosperity that the country can earn."

World Economic Forum Global Competitiveness Report 2015–2016

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World Bank Defines A Good Economic System

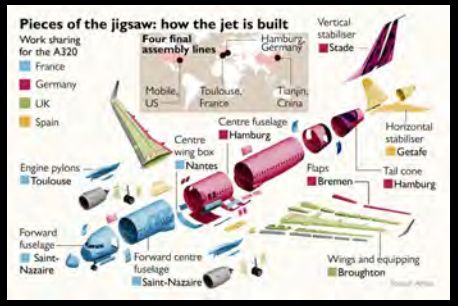
Economy	Global Rank	Starting a Business	Dealing with Permits	Getting Electricity	Registering Property	Getting Credit	Protecting Minority Investors	Paying Taxes	Trading across Borders	Enforcing Contracts	Resolving Insolvency
New Zealand	1	1	7	48	2	1	3	9	63	23	36
Singapore	2	4	5	19	21	37	3	7	47	1	27
Hong Kong SAR	3	5	1	3	51	37	7	2	29	31	45
Denmark	4	45	4	21	11	48	28	8	1	14	6
Korea, Rep.	5	33	12	2	40	67	25	21	36	2	11
United States	6	55	24	64	39	4	36	25	39	17	2
Georgia	7	2	21	42	5	15	7	14	45	12	64
United Kingdom	8	18	23	8	41	37	7	27	33	34	14
Norway	9	25	22	44	15	94	21	34	22	3	5
Sweden	10	39	31	10	9	80	28	31	18	39	17

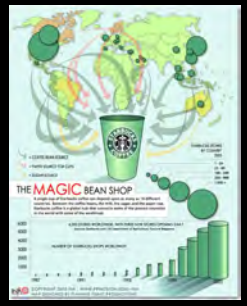
Data source: *Doing Business 2020*, International Bank for Reconstruction and Development / The World Bank

"At its core, Doing Business seeks to provide quantitative measures of business regulation in 1 regulatory areas that are central to how the private sector functions. **A growing body of literature shows that government action to create a sound, predictable regulatory environment is central to whether or not economies perform well and whether that performance is sustainable in the long run.**"
World Bank Doing Business 2017

45

The Global Economy Builds A Plane.. And A Cup of Coffee





The benefits of specialization, mass markets, economies of scale, and free trade

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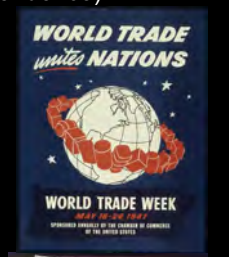
Autarky vs Integration (and interdependence)

- Autarky (self-sufficiency) raises the cost of living and lowers the standard of living
- Autarky ignores the value of comparative advantage, specialization, and economies of scale.
- Do not confuse autarky with non-exporting

Question: If the "Moon" insists on being self-sufficient when it comes to water, metals, etc. , what does that mean for the asteroid mining businesses that view the market for water/metals/etc. as being a key source of revenue?



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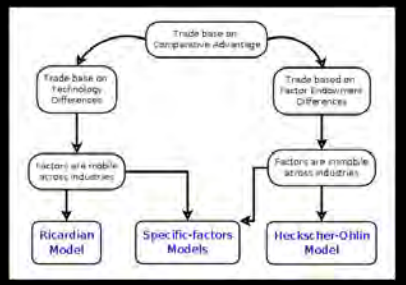
Trade Policy Can Either Help or Hinder

Traditional Trade Models

Ricardian Model:
Measures comparative advantage based on differences in technology

Heckscher-Ohlin Model:
Measures comparative advantage based on factor/natural endowments

Specific Factors Model:
Measures comparative advantage based on endowments that are immobile across industries



QUESTION: What advantages will space have over Earth and are those advantages conducive to the creation of a space resource mining industry to supplement/replace Earth's?

48

Private Property Rights Are Essential

Experts have found out a direct correlation between a nation's wealth and having an adequate property rights system. This is because real estate is a form of capital and capital raises economic productivity and thus creates wealth.
– Loup Brefort, The World Bank

Without property rights, individuals will not have the incentive to invest in physical or human capital or adopt more efficient technologies.
– *Introduction to Modern Economic Growth*, Daron Acemoglu, Massachusetts Institute of Technology Department of Economics

Private property is the foundation of a just social order and the spur to personal industry and national prosperity
– Edmund Burke

Dead capital is an asset that cannot easily be bought, sold, valued, or used for collateral. In short the property is not a fungible asset. This acts as a break on economic growth.
– Hernando de Soto

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Property Rights Key to Settling Frontiers

Land Ordinance of 1785

Land Act of 1804

Donation Land Claim Act of 1850

Homestead Act of 1862

Pacific Railway Act of 1862

Pacific Railway Act of 1864

Desert Land Act of 1877


Westward the Course of Empire Takes Its Way, Emanuel Gottlieb Leutze, 1861

Locke... ownership of something includes the right to use it as one wishes (so long as one does not thereby harm others in ways that violate their rights), to exclude others from its use, to allow another person to use it on any mutually agreed terms, to waive or renounce one's rights in the thing, and to transfer this entire package of rights to another person.
Source: http://philosophyfaculty.ucsd.edu/faculty/rarneson/Courses/166lockeonpropertynotes.pdf

50

Capital is One Key to Economic Growth

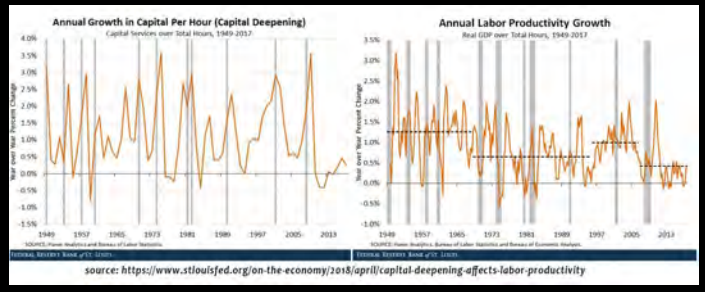
"...growth in net fixed capital accounted for about 69% of Australia's GVA (Gross Value Added) growth... the average annual contribution of labor to GVA growth was 18%... Multifactor productivity accounted for the residual growth in GVA, making a contribution of 12%."

Source: The role of capital and labour in driving economic growth in Australia, KPMG Research Paper, 2016

The ability to attract capital investment will depend on both the perceived risks and rewards and the "rules of the game"

51

Capital to Labor Ratio and Capital Deepening



Increases in the Capital to Labor ratio (k/l) leads to Capital Deepening

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Robotic Labor vs Human Labor

Class	Category	Robots/Automation	Human Labor
Availability	Max Work Hours per Year	8760	2000
Availability	Mean Time Between Failure	High & Predictable	Unpredictable
Productivity	Quantity of Output Predictability	High	Medium
Labor	Workplace Safety Costs	Low	High
Labor	Injury Liability	None	High
Labor	Cost per Hour	Fixed/Declining	Variable, Rising
Labor	Management Required	Minimal	Variable
Labor	Training Time/Costs	N/A	Variable
Labor	Human Resources (HR)	No	Yes
Environment	Environmental Support Systems	None	High
Environment	Environmental Support Mass	None	High
Environment	Living Space Requirements	0	1,740 m³/person
Environment	Radiation Shielding Requirements	0	450 g/cm²

"The diffusion of automation is believed to be one of the fundamental drivers of both the decline in employment, and the increase in output and productivity in U.S. manufacturing over the past decades, during which labor's share of output has also diminished."

Automation, Labor Share, and Productivity: Plant-Level Evidence from U.S. Manufacturing, Emin Dinlersoz and Zoltan Wolf, U.S. Census Bureau, 2018

53

An Economic Critique of a Martian State System

The Martian "Soviet" economic system flaws:

- High system costs lead to high product costs
- Dominance of government-owned monopolies will stifle innovation
- Dominance of government-owned monopolies will stifle productivity growth
- Lack of property rights will greatly deter investment and hinder capital formation
- A rigid labor market will increase product costs and hinder productivity growth
- Wage and price controls will increase bureaucracy and decrease flexibility and efficient resource allocation
- Requirement for equity stake in all businesses will deter business formation and investment
- Government business approval process will foster corruption
- Limited work week and high UBI will raise labor costs and system costs
- System assumes access to unlimited capital
- Lack of system drivers for improving system efficiency

In the coming era of manned space exploration by the private sector, market forces will spur development and yield new, low-cost space technologies. If the history of private aviation is any guide, private development efforts will be safer, too.

- Burt Rutan, Wired Magazine interview

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Space As An Economic Growth Future

I think by the middle of this century we're going to see human settlements on the Moon and Mars; we're going to see an interplanetary Internet; we're going to see a true space economy.

And my prediction is that by 2050 it's going to be the economic engine that drives this planet.

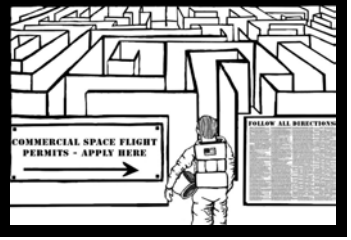
Simon P. Worden,
Director, NASA Ames Center,
at Pioneers Festival 2014

It only makes sense to invest in space if by doing so we improve humanity's future prospects. - JP

55

It Can Happen If...

- High-power, high efficiency non-chemical propulsion systems are developed
- Affordable life and hardware radiation protection systems are developed
- Affordable mining & manufacturing processes are created
- Affordable and reliable fault tolerant life support and energy systems are developed
- A supportive and stable social and political environment exists
- Economic policies that reward investment, capital accumulation, and competition in a market environment are put in effect
- Government is a customer-of and not a competitor-to space industry



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Delusions of Space Enthusiasts

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The Economics of Space Settlement
Jim Plaxco – JimPlaxco@chicagospace.org
Chicago Society for Space Studies
https://www.chicagospace.org
National Space Society Space Ambassador
https://space.nss.org/space-ambassador-jim-plaxco/

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SUSTAINABLE DEVELOPMENT IN SPACE LAW: ETHICAL AND ECONOMIC CONSIDERATIONS OF SETTLEMENT IN OUTER SPACE

April 8, 2022 – A Hybrid Event
Altgeld Hall & Zoom

ALYSON DECKER
Owner, Alyson Claire Law

WORKING IN SPACE: THE FINAL FRONTIER OF REMOTE WORK

Working in Space:
The Final Frontier of Remote Work

Presenter: Alyson C. Decker

Alyson Claire Law

1

Jurisdictional Confusion

- Employment laws in America vary from state to state and even from county to county and city to city.
- Jurisdiction determines what employment laws apply to a worker.
  - But what happens when the employer and the employee "reside" in different jurisdictions?
  - Can we solve this confusion with contract law?

Alyson Claire Law

2

Taxes & Workers' Compensation

- Employers must pay payroll taxes in both the state an employee is a citizen of and the state where the work is generally being performed.
- Employers must have workers' compensation insurance in every state they have employees in.
- Therefore, an employer must have a legal presence in every state they have employees in or use a Professional Employer Organization.

Alyson Claire Law

3

Space Is for Nations Only

Question: Do private actors exist in space?

Answer:

However, the activities in outer space are of a special character, and are different from other activities of an economic and technical character carried out on the territories of individual States. The launching of satellites, scientific programmes and preparation of cosmonauts are of such a responsible and also, expensive, character that these undertakings concern the security and interests of all other States. It is an activity which is typically one of public interest and it should never be submitted to profit-making, private interests and purposes. It was not by chance that all activities, planning and making of the research related to outer space has been carried out exclusively by Governments and by their organs. How else could the principle of the liability of States for space-vehicle accidents be effectively applied, as proposed even by the United States? Is there not a contradiction here? It is time to put an end to attempts to pull private-property categories and profit-making interests into new, immense cosmic space, which mankind has begun to penetrate only through the joint efforts of States.

Alyson Claire Law

4

The Foundations of Space Jurisdiction

- The Outer Space Treaty
  - Nations have to authorize and supervise their non-governmental space actors.
- The Liability Convention
  - Jurisdiction is determined by the original launch site of a space object.
- The Moon Agreement
  - Reinforcing an "international waters" view of space grounded in the Outer Space Treaty.

5

Exporting Maritime Law to Space

Registration Convention  Convention on the Law of the Seas

- Expand the Registration Convention to allow it to be used by private entities and formally link space registration, liability, and jurisdiction.
- Treat private space employees like sailors and apply default federal employment laws.

6

Space & Human Capital

- Keeping humans alive in space is not cheap, so who foots the bill?
- How will HR work in space?
  - Is anyone really an at-will employee in space?
  - How do you ensure a harassment free workplace in space?
  - What happens if there is a "space mutiny"?
- Time by any other name.

7

Any Questions?

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SUSTAINABLE DEVELOPMENT IN SPACE LAW: ETHICAL AND ECONOMIC CONSIDERATIONS OF SETTLEMENT IN OUTER SPACE

April 8, 2022 – A Hybrid Event
Altgeld Hall & Zoom

ADAM GREENSTONE
Agency Counsel for Ethics, NASA

ETHICAL CONSIDERATIONS FOR GOVERNMENTS

National Aeronautics and Space Administration

Government Ethics and Sustainable Space Exploration

Northern Illinois University Law Review
Symposium on Space Law
April 8, 2022

1

National Aeronautics and Space Administration

Disclaimer

The views expressed in this Article are personal to the author and do not necessarily represent either the views of NASA or the United States government.

2

National Aeronautics and Space Administration

Introduction and Theme

Government ethics law is important to humanity's efforts to sustain our exploration of outer space. For this, we review

- Concepts of space sustainability as they relate to ascertaining conditions for sustainable space exploration.
- The practice of U.S. government ethics law at NASA, as it relates to the agency's mission, and related U.S. administrative law.
- Government ethics law in the context of international anti-corruption norms and good governance policies.

3

National Aeronautics and Space Administration

Space Sustainability and Sustainable Space Exploration

What is Space Sustainability?:

- A Broad View: All factors supporting humanity's steady expansion of activity into space.
- A Specific View: Ensuring space is used consistent with conserving natural resources (e.g., implications of orbital debris, radio frequency spectrum use).
- Sustainable Space Exploration, in U.S. policy requires plans maintaining long-term support.

Best space outcomes will cover all these bases.

4

National Aeronautics and Space Administration

Government Ethics Law at NASA: How Does Ethics Law Advance NASA's Mission

- Areas: Gifts, conflicting financial interests, appearance of impartiality, misuse of position, personal activities during government service, restrictions after leaving.
- Key U.S. Government Ethics Pillars:
  - Ethics advice to employees
  - Financial Disclosure
  - Ethics Training

National Aeronautics and Space Administration

Government Ethics Law at NASA (Cont'd): How Does Ethics Law Advance NASA's Mission

NASA's ethics practice supports recruitment from to diverse public/private/academic sector experience bases:

- Presidential nominations practice for Senate confirmed positions, including coordination with the U.S. Office of Government Ethics (OGE).
- Technical and professional talent management objectives, including use of the Intergovernmental Personal Act (IPA) codified at 5 U.S.C. §§ 3371-3375.

NASA's ethics practice also supports talent transfer to private sector national infrastructure advancing NASA and U.S. policy objectives through post-employment ethics opinions and advice.

National Aeronautics and Space Administration

Government Ethics Law at NASA (Cont'd): How Does Ethics Law Advance NASA's Mission

- Public Information dissemination on NASA activities required by 51 U.S.C. § 20112(a)(3).
  - Participating in and attending widely attended events.
  - Partnering with commercial parties without endorsing the partner, or its products or services.
- Commercial and marketing activities on the International Space Station (ISS). See NASA Interim Directive (NID 8600.121): Use of International Space Station (ISS) for Commercial and Marketing Activities.
  - Ensuring NASA or its personnel do not endorse any product or service, or appear to.

National Aeronautics and Space Administration

Government Ethics Law and International Anti-Corruption

- UN Convention Against Corruption (UNCAC), entered into force December 14, 2005, with public sector obligations:
  - Public employee codes of conduct.
  - Financial interest reporting & procurement conflicts screening.
  - Anti-corruption training.
  - Also, transparency, bribery, embezzlement, influence trading & abuse of office restrictions.
  - Counters resource diversion & poverty, crime & violence; advances rule of law, trust in institutions, international peace & security.
  - Also includes private sector anti-corruption obligations including against money laundering, bribery, and embezzlement.
- UN, IMF, & World Bank now have ethics offices.

National Aeronautics and Space Administration

Government Ethics Law and International Anti-Corruption (Cont'd)

- Current U.S. Government ethics law developed in tandem with U.S. space program, prior to global anti-corruption coordination:
  - Executive Order 11,222 (1965), Prescribing Standards of Ethical Conduct for Government Officers and Employees.
  - Ethics in Government Act enters into force and NASA memento regulation issued on October 26, 1978.
  - Intergovernmental Agreement (IGA) for the International Space Station (1998) resulting in ISS Crew Code of Conduct.
- UNCAC entered into force more recently in 2004
  - Information on UNCAC developments is disseminated through UNCAC's Conference of State Parties (COSP).

9

National Aeronautics and Space Administration

Government Ethics Law and Sustainable Space Exploration

- Messaging power of space exploration
  - Nations, cities, institutions, individuals
  - Actors in space are vastly increasing
  - Artemis Accords
  - Private suborbital and orbital vehicles
  - ISS commercial partners
- A reputationally adverse event in space, however isolated, can damage the aggregate message of spacefaring actors, including with regard for anti-corruption norms.

10

National Aeronautics and Space Administration

Conclusion

- With emergence of global anti-corruption norms, government ethics has become part of a larger value ecosystem.
- Given the extraordinary messaging power of space, this is particularly true for government ethics practice related to space exploration.
- Space faring actors and collective space efforts should each consider how government ethics implicates the path to humanity's best space outcomes, and respond accordingly.

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SUSTAINABLE DEVELOPMENT IN SPACE LAW: ETHICAL AND ECONOMIC CONSIDERATIONS OF SETTLEMENT IN OUTER SPACE

April 8, 2022 – A Hybrid Event
Altgeld Hall & Zoom

AJ LINK
Research Director, Jus Ad Astra

GALACTIC ACCESSIBILITY: INTERPLANETARY HUMAN RIGHTS LAW THROUGH CRIP LEGAL THEORY

Galactic Accessibility

An Introduction to Interplanetary Human Rights Law
Through Crip Legal Theory

By AJ Link

1

Prologue

- Please Don't Be Afraid to Stop Me
  - If I go too fast
  - If we need time to reflect
  - Asking for clarification
- Things To Think About
  - ASL, CART, Accessibility
- Tips from Mat
  - Don't be monotone
  - Don't be boring

2

Introduction

- Space should be accessible inclusive for those who wish to go
- The benefits of space should be shared equitably amongst all stakeholders
- Current International Human Rights Law (IHRL) is not properly situated to fully address the unique environments and circumstances presented by human activity in outer space
- International Space Law (ISL) has not developed an explicit human rights from long-term space activities

3

Interplanetary Human Rights

- The intersection between IHRL and ISL should be filled by the new field of Interplanetary Human Rights Law (IPHRL)
- IPHRL should be viewed as part of the evolution of the current International Human Rights regime, not a totally different body of law (yet…)

4

Historical Perspective

- Natural Law
- Positivist Law
- Legal Realism/Post-Realism

5

Legal Realism/Post-Realism

- Critical Race Theory
- Feminist Legal Theory
- TWAIL and CAIL
- Crip Legal Theory

6

Crip Legal Theory - A Unifying Perspective for Space

- Intersectional/Inclusive
  - Disability intersects with every other identity
  - CRPD mentions the intersection with other treaties
- Space is Harsh
  - Space is likely a disabling environment
  - Models of Disability are a guide to navigating these environs
- Accessibility Framework
  - Lessons from Disability Justice on Accessibility
  - The Right of Access

7

Disability in Space, Right Now

- UNOOSA Space for Persons with Disabilities
- NASA/ESA Parastronaut Programs
  - Gallaudet Eleven
- Mission:AstroAccess

8

Conclusion

- Outer space is a realm of possibility, one that can potentially be developed in a way that is inclusive and accessible for everyone who wants to go
- A new interplanetary human rights framework built upon a post-realist disability perspective focused on galactic accessibility is best suited to protect human rights in outer space

9

Q&A

10

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- Email: jlink@olemiss.edu

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End.

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