

References

- (n.d.). *IJSTMI 2*.
- 1998–1999, M. o. (1999). Case study two: Protein crystallisation. In M. o. 1998–1999, *Open for business* (p. 171).
- 3, S. (2016, March 1). *Newspace TUDelft Alumni Conference* (C. Meerts, Performer).
- Aerospace, B. (2015, July 31). *Bigelow Aerospace and NASA execute NextSTEP contract to study B330 utilization*. Retrieved January 4, 2017, from <http://bigelow-aerospace.com/nextstep-announcement>
- Aldrin, B. (2013). Homesteading to red planet. In B. Aldrin (Ed.), *Mission to Mars* (p. 184).
- Alexandrova, A. B. (2012, February 23). *A bounty system for active space debris removal*.
- America, S. (2016). *About us*. Retrieved June 14, 2016, from Spaceport America: <http://spaceportamerica.com/about-us/>
- Anfimov. (2001). *The MIR experience and commercialisation of the Russian segment of the ISS* (Article 6). Strasbourg.
- Astronautix. (1997). *Astronautix*. Retrieved September 9, 2008, from <http://www.astronautix.com/craft/mirmp1ex.htm>
- Astronautix. (n.d.). *Industrial space facility*. Retrieved February 12, 2017, from <http://www.astronautix.com/i/industrialspacefacility.html>
- Baldesi, A. (2011). Chapter 9, An analysis of two space business opportunities. In S. Tkatchova (Ed.), *Space-based technologies and commercialized development* (pp. 206–249).
- Barnhart, D. (2013, May). (S. Tkatchova, Interviewer).
- BBC. (2009, February 12). *One minute world news*. Retrieved January 6, 2017, from Russian and US satellites collide: <http://news.bbc.co.uk/2/hi/7885051.stm>
- Beggs, J. J. M. (1997). *The International Space Station commercialization study*. Arlington, VA: Potomac Institute for Policy Studies Report.
- Charles Miller, A. W. (2015). *Economic assessment and systems analysis of an evolvable lunar architecture that leverages commercial space capabilities and public private partnerships*. NextGen Space LLC.
- Cluster, L. S. (2016, May 6). *Luxembourg Space Cluster*. Retrieved June 21, 2016, from Exploration and use of space resources: <http://www.spacecluster.lu/News/Exploration-and-use-of-space-resources>
- Commission, E. (2012). *Report of the workshop on Future regulatory framework for sub-orbital flights in Europe*. Brussels: EC.
- Company, S. E. (2013, March). *SEC FAQ*.
- Covault, C. (2013, November). China's bold lunar plan. *Aerospace America*, 51, 24–29.

- Daily, S. (2014, January 19). *Tech Space*. Retrieved 2015, from Space fishing: Japan to test 'magnetic net' for space junk: http://www.spacedaily.com/reports/Space_fishing_Japan_to_test_magnetic_net_for_space_junk_999.html
- Debra, W. (2015, July-August). Upping the station's upmass. *Aerospace America*, 53, 20–24.
- Energy, S. (2016, May). *We are going back to the Moon to get water*. Retrieved June 21, 2016, from Shackleton Energy: <http://www.shackletonenergy.com/overview#goingbacktothemoon>
- ESA. (2005, October 14). Retrieved June 14, 2015, from ESA Health Care Network: http://www.esa.int/Our_Activities/Human_Spaceflight/ESA_Health_Care_Network/From_tubes_and_cubes_to_haute_cuisine_-_the_refinement_of_space_food
- ESA. (2010). *Human Spaceflight Users*. Retrieved March 3, 2010, from ERISTO: <http://www.spaceflight.esa.int/users/index.cfm?act=default.page&level=15&page=845>
- ESA. (2013a, January 31). *Building a lunar base with 3D printing*. Retrieved January 5, 2017, from http://www.esa.int/Our_Activities/Space_Engineering_Technology/Building_a_lunar_base_with_3D_printing
- ESA. (2013b). *Space debris*. Retrieved June 3, 2016, from FAQ: http://www.esa.int/Our_Activities/Operations/Space_Debris/FAQ_Frequently_asked_questions
- ESA. (2015, March 1). *Call for ideas: Space exploration as a driver for growth and competitiveness: Opportunities for the private sector*. Noordwijk: ESA.
- ESA. (2016a, April 12). *Clean space*. Retrieved June 15, 2016, from The Challenge: http://www.esa.int/Our_Activities/Space_Engineering_Technology/Clean_Space/e.Deorbit
- ESA. (2016b, April 12). *E.DEORBIT*. Retrieved June 15, 2016, from Clean Space: http://www.esa.int/Our_Activities/Space_Engineering_Technology/Clean_Space/e.Deorbit
- ESA. (2016c, April 12). *ESA*. Retrieved June 6, 2016, from Clean Space: http://www.esa.int/Our_Activities/Space_Engineering_Technology/Clean_Space/e.Deorbit
- ESA. (2016d). *What is Space 4.0?* http://www.esa.int/About_Us/Ministerial_Council_2016/What_is_space_4.0
- FAA. (2010). *The economic impact of commercial space transportation on the U.S. economy 2010*. FAA.
- FAA. (2016). *The annual compendium of commercial space transportation: 2016*. FAA.
- Federal Aviation Administration, O. o. (2005). *Suborbital reusable launch vehicles and emerging markets*.
- Foust, J. (2004, May 24). *The Space Review*. Retrieved 2013, from A few words with Craig Steidle: <http://www.thespacereview.com/article/148/1>
- Foust, J. (2017). *Lunar cause and effect*. Retrieved from <http://www.thespacereview.com/article/3189/1>
- Galactic, V. (n.d.). *LauncherOne is your satellite's dedicated ride to orbit*. <http://www.virgingalactic.com/satellite-launch/11-performance/>
- Galactic, V. (2016, June 11). *Virgin Galactic*. Retrieved June 11, 2016, from Future Astronauts: <http://www.virgingalactic.com/future-astronauts/>
- Government, L. (2016, June). *Space Resources*. Retrieved June 21, 2016, from Initiative: <http://www.spaceresources.public.lu/en/index.html#initiative>
- Group, T. T. (2013). *Suborbital reusable vehicles: A 10 year forecast of market demand*. Alexandria, VA: The Tauri Group.
- Group, T. T. (2015). *State of the satellite industry report*. Alexandria, VA: The Tauri Group.
- Group, T.T. (2016). *Start-up space raising investment in commercial space ventures*. Alexandria, VA: The Tauri Group.
- Hall, M. (2016). A summary of the Economic Assessment and Systems Analysis of an Evolvable Lunar Architecture that leverages commercial space capabilities and Public-Private Partnerships. *Mary Ann Liebert, Inc., New Space 2016*, (pp. 1–6).
- Henwood, B. N. W. (2014). The "Game" of training humans for commercial sub-orbital space flight. *IAC-13-E6.2.3*, (pp. 1–9).
- Howell, E. (2015, January 9). *Space*. Retrieved June 21, 2016, from <http://www.space.com/28215-elon-musk-spacex-mars-colony-idea.html>

- Hufenbach, B. (2016). International missions to lunar vicinity and surface. In: *66 International Astronautical Congress*, IAC.
- Industries, D. S. (n.d.). 2016. Retrieved from <https://deepspaceindustries.com/mining/>
- I.O.F. (2005). *International Osteoporosis Foundation (IOF)*. Retrieved October 5, 2007, from www.iofbonehealth.org/
- JAXA. (2013). *Cleaning up the space junk*. Retrieved May 13, 2016, from JAXA : http://www.aero.jaxa.jp/eng/publication/magazine/sora/2004_no02/ss2004no02_01.html
- Keravala, J. (2013, January–June). Interview with Jim Keravala from the Shackleton Energy Company. *International Journal of Space Technology Management and Innovation*, 3(1), 68–71.
- Lewis, J. (2009). *Mining the sky: Energy for earth's future* (Presentation).
- Liesbeth Bender, R. W. (2016, December 5). *Green European Journal*. Retrieved December 6, 2016, from Cosmic bonanza-mining in outer space: <http://www.greeneuropeanjournal.eu/cosmic-bonanza-mining-in-outer-space/>
- Lynne, D. M. (2015). *Beyond LEO: The role of ISS exploration*.
- MarsOne. (2012, December). MarsOne Mission: Is it really possible? (S. Tkatchova, Interviewer). *International Journal of Space Technology Management and Innovation*, 2(2).
- MarsOne. (2015, February 16). *MarsOne*. Retrieved June 23, 2016, from The Mars 100: Mars One announces round three astronaut candidates: <http://www.mars-one.com/news/press-releases/the-mars-100-mars-one-announces-round-three-astronaut-candidates>
- MarsOne. (2016a). Retrieved from <http://www.mars-one.com/mission/roadmap>
- MarsOne. (2016b, December 12). *MarsOne now trades publicly and closes €6 million funding*. Retrieved December 26, 2016, from Mars One now trades publicly and closes €6 million funding: <http://www.mars-one.com/news/press-releases/mars-one-now-trades-publicly-and-closes-6-million-funding>
- Matteo Emanuelli, T. L. (2015, February 6). *Risk to aircraft from space vehicles debris*. UN COPUOS Scientific and Technical Subcommittee: 2015 Fifty-second session.
- MCB. (2009). *International Space Station lessons learned as applied to exploration*. Kennedy Space Center.
- MDA. (2009). *NeuroArm*. Retrieved September 20, 2009, from MDA: http://sm.mdacorporation.com/what_we_do/neuroarm.html
- Metals, P. R. (2016, January 7). *Planetary Resources & 3D Systems reveal first ever 3D printed object from asteroid metals*. Retrieved June 30, 2016, from Planetary Resources: <http://www.planetaryresources.com/2016/01/planetary-resources-and-3d-systems-reveal-first-ever-3d-printed-object-from-asteroid-metals/>
- Migeotte, J.-F. (2016). *Belgium Sub-orbital Research Association*.
- Museum, S. (2016). *COSMONAUTS*. Science Museum.
- NanoRacks. (2016, May 20). *NanoRacks*. Retrieved from SmallSat deployment: <http://nanoracks.com/over-100-cubesats-deployed-from-the-iss/>
- NASA. (2010). *On-orbit satellite servicing study*.
- NASA. (2011). *Commercial market assessment for crew and cargo systems*. NASA.
- NASA. (2013, September 27). *Space debris and human spacecraft*. Retrieved June 6, 2016, from http://www.nasa.gov/mission_pages/station/news/orbital_debris.html
- NASA. (2014a). *3D printing in space*. NASA.
- NASA. (2014b, April). *Public-private partnerships for space capability development*.
- NASA. (2015a, October 21). Retrieved June 30, 2016, from Water production in space: Thirsting for a solution: http://www.nasa.gov/mission_pages/station/research/benefits/water_in_space
- NASA. (2015b). *Emerging space, the evolving landscape of 21st Century American Spaceflight*. NASA.
- NASA. (2016a, August 3). ARC Instrument Working Group. NASA.
- NASA. (2016b, May 29). *International Space Station*. Retrieved from Multiple User System for Earth Sensing Facility (MUSES)-06.29.16: http://www.nasa.gov/mission_pages/station/research/experiments/1282.html

- NASA. (2016c, November 22). *International Space Station*. Retrieved February 26, 2017, from https://www.nasa.gov/mission_pages/station/research/experiments/1157.html
- NASA. (2016d, March 21). *Next Space Technologies for Exploration Partnerships-2 (NextSTEP-2) BAA synopsis*. Retrieved January 4, 2017, from Next Space Technologies for Exploration Partnerships-2 (NextSTEP-2) BAA synopsis: https://www.fbo.gov/index?s=opportunity&mode=form&id=2350bb0e328e814dec4fa385b4dcb17e&tab=core&_cview=0
- National Space Policy of the United States of America*. (2010, June 28). https://www.nasa.gov/sites/default/files/national_space_policy_6-28-10.pdf
- Partners, I. (2015). *International Space Station utilisation statistics expedition 0-40*.
- Pelt, M. v. (2011). Space tourism. In S. Tkatchova (Ed.), *Space-based technologies and commercialized development* (pp. 164–177). Hershey: IGI Global.
- Pittman, B. D. R. (2015). Infrastructure based exploration—An affordable path to sustainable space development. In: *IAC-12, D3,2,4,x14203* (pp. 1–9).
- Policy, N. A. (2011, August). *Falcon 9 Launch Vehicle NAFCOM cost estimates*.
- Rapp, D. (2006, September 5). *The problems with lunar ISRU*. Retrieved July 1, 2016, from The Space Review: <http://thespacereview.com/article/697/1>
- Rasky, D. I. C. (2014, May Space Portal). *Microgravity-based commercialization opportunities for material sciences and life sciences: A Silicon Valley perspective*. Level 2 Emerging Space Office, NASA Ames Research Centre.
- Resources, P. (2016a). *Harvesting water from asteroids*. Retrieved from Planetary Resources: <http://www.planetaryresources.com/asteroids/#harvesting-water>
- Resources, P. (2016b, November 3). *Planetary Resources*. Retrieved May 20, 2017, from Planetary Resources and the Government of Luxembourg announce €25 million investment and cooperation agreement: <http://www.planetaryresources.com/2016/11/planetary-resources-and-the-government-of-luxembourg-announce-e25-million-investment-and-cooperation-agreement/>
- Resources, S. (2016). *Space resourced initiative*. Retrieved from Initiative: <http://www.spaceresources.public.lu/en/index.html#initiative>
- Rumpf, C. (2015). The right motives for Ariane 6. *Ruimtevaart*, 39.
- Sanders, J. (2016, November). *L-8: In-situ resource utilization capabilities*. Johnson Space Center Engineering Directorate.
- Seedhouse, E. (2014). Spaceports. In E. Seedhouse (Ed.), *Suborbital industry on the edge of space* (pp. 113–124). Springer Praxis Books in Space Exploration.
- Sgobba, T. (2013). *Space debris re-entries and aviation safety*.
- Simberg, R. (2009). *ATLANTIS A Journal of Technology and Society*. Retrieved June 30, 2016, from A space program for the rest of us: <http://www.thenewatlantis.com/publications/a-space-program-for-the-rest-of-us>
- Smith, S. (2007, August 26). *Space junk*. Retrieved 2009, from USA Weekend Magazine: http://www.usaweekend.com/07_issues/070826/070826space.html#junk
- Smith, S. (2013). *I'm a doctor, not an astronaut*. Space KSC.
- Smith, S. (n.d.). *Space KCS*. Retrieved February 22, 2017, from <http://spaceksc.blogspot.be/2013/07/im-doctor-not-astronaut.html>
- Space, M. i. (2015). *Zero gravity 3D printer*. Retrieved December 26, 2016, from Zero gravity 3D printer: <http://www.madeinspace.us/projects/3dp/>
- Space Resource Exploration and Utilization Act of 2015. (2015, June 6). *Summary: H.R.1508—114th Congress (2015-2016)*.
- Spacehab. (2015, January 4). *Spacehab*. (E. Astronautica, Ed.)
- Space-X. (2015, September). *About*. Retrieved February 19, 2017, from <http://www.spacex.com/about>
- Star Technology and Research Inc. (2013). *EDDE vehicle*. Retrieved January 16, 2017, from <http://www.star-tech-inc.com/id121.html>
- Studies, K. I. (2012). *Asteroid retrieval feasibility study*. KISS.

- Studies, P. I. (1997). *The International Space Station Commercialisation (ISSC) study*. Arlington, VA: Potomac Institute for Policy Studies.
- Team, C. S. (2016). *Cleansat*. ESA.
- Team, E. C. (2016). *Cleansat*. ESA.
- Thomas, L. (2017, April 6). *ETCNBC.com*. Retrieved April 7, 2017, from In a new space age. Goldman suggests investors make it big in asteroids.
- Tkatchova, S. (2006). *From space exploration to commercialisation*.
- Tkatchova, S. (2011a). Emerging markets and space applications. In S. Tkatchova (Ed.), *Space-based technologies and commercialized development* (pp. 132–133). Hershey: IGI Global.
- Tkatchova, S. (2011b). FAA role in encouraging the development of the U.S. commercial space transportation industry: Interview with Ken Davidian. *International Journal of Space Technology Management and Innovation, 1*, 56–60.
- Tkatchova, S. (2011c). JAXA ISS commercialisation strategy. In S. Tkatchova (Ed.), *Space-based technologies and commercialized development* (pp. 67–69). Hershey: IGI Global.
- Tkatchova, S. (2011d). Space station lessons learned. In S. Tkatchova (Ed.), *Space-based technologies and commercialized development* (pp. 70–73). Hershey: IGI Global.
- Tkatchova, S. (2011e). Space station commercialisation. In S. Tkatchova (Ed.), *Space-based technologies and commercialized development* (pp. 59–79). Hershey: IGI Global.
- Tkatchova, S. (2012). Interview: Mars One Mission: Is it really possible? Interview with the Mars One Team. *International Journal of Space Technology Management and Innovation, 2*, 80–84.
- Tkatchova, S. (2013, October 30). *Future trends in space commercialization*. ISC Summit Presentation. London.
- Universe, F. (n.d.). Retrieved February 19, 2017, from <http://www.fundinguniverse.com/company-histories/spacehab-inc-history/>
- Wall, M. (2012, February 23). *Space.com*. Retrieved May 20, 2017, from Japanese company aims for space elevator by 2050: <http://www.space.com/14656-japanese-space-elevator-2050-proposal.html>
- Werner, D. (2016, September 21). *Space News*. Retrieved January 11, 2017, from Congress gets report on giving FAA space traffic role: <http://spacenews.com/congress-gets-report-on-giving-faa-space-traffic-role/>
- Wiegel, D. (2015). The evolving ISS Lab: Improvements to enable new research utilization. In: *ISS R&D Conference*.
- Woerner, J. (2016, March 1). ESA Director General. *Moon Village: Humans and robots together on the Moon* (ESA, Interviewer). ESA.
- Writers, S. (2016, August 19). *Moon Daily*. Retrieved August 22, 2016, from Roscosmos to spend \$7.5 M in studying issues of manned lunar missions: http://www.moondaily.com/reports/Roscosmos_to_spend_7_5Mln_studying_issues_of_manned_lunar_missions_999.html
- Young, A. (2015, April 27). Commercial lunar transportation services: A speculation. *The Space Review*.
- Zak, A. (2013). Chapter IV: Vision into the future. In A. Zak (Ed.), *Russia in space* (p. 190). Griffin Media.
- Zak, A. (2016, June 27). *Russia's plan to spin of a new space station from the ISS*. Retrieved February 26, 2017, from Popular Mechanics: <http://www.popularmechanics.com/space/a21543/russian-plan-new-space-station-iss/>
- Zubrin, R. (2011, July–December). Future Mars missions in trans-orbital railroad plan: Interview with Dr. Robert Zubrin (S. Tkatchova, Interviewer). *International Journal of Space Technology Management and Innovation, 1*(2).

Index

A

Abu Dhabi, 6
Additive manufacturing, 69
Advertising, 83
Airbus A340, 99
Air-launch, 77
Air Revitalization System (ARS), 11
Air traffic, 98
Alloys, 82
AlphaSparks, 32, 77
Aluminium, 49
Angel investors, xii
Ansari X Prize, 7, 107
Antares, ix, 74
Antares launch vehicle, 9
Anti-satellite weapon (ASAT), 93
Ares 1/Ares V rockets, 2
Ariane 5, 12, 18
Ariane 6, ix
Arianespace, 18
Arkyd telescopes, 68
Armadillo Aerospace, 21, 114
ASICS, x
Asteroid, 67
Asteroid mining, 68
Asteroid Redirect Mission (ARM), viii, 16
Astrobotic Technology, 15
Astronauts, 5
Astroscale, 97
Atlas 5, 74
ATV, 10
Automation, 63
Aviation, 98
Aviation safety, 98–99

Avoidance, 96

Axe/Lynx, 111

Axiom, 77, 88

B

Baikonur Cosmodrome, 122
Basic and applied research, 7
BEAM module, xi, 5, 58, 85
Benefits, 43, 80
B612 Foundation, 32
Bigelow Aerospace, 32
Bigelow space stations, 4, 85–86
Biochemistry, 88
Bio-engineering, 70
Biolab, 44
Bio-materials, 82
Bioreactor, 82
BioServe, 77
Biotechnology, 83
Blood measurement instruments (BMI), x
Blue Origin, 8, 11, 18, 21, 32, 110, 114
Blue Origin Orbital, 32
Blue Origin West Texas Rocket Flight Facility,
121
Boeing, 8, 11, 32
Bone density, 44
Bone loss, 44
Booster Industries, 32, 107, 110
Bottom-up research, 57
Budgetary reductions, 46
Bulgaria, 40
Business case, 26
Business models, 18, 72

C

Canadarm2, 85
 Cancer research, 82
 Capital, 80
 Caribbean Spaceport, 32, 107, 110
 CCDev, viii, ix, xi
 CCDev 1, 10
 CCDev 3, 12
 CCiCAP, 10
 CCP, 12
 CCSC programme, 15
 Cell/tissue engineering and medical device testing, 6
 Center for the Advancement of Science in Space (CASIS), 76
 Centrifuges, 121
 Cerise, 94
 Challenges, 71
 Chandrayaan-2 mission, 56
 Chang landers, 56
 China, 56
 Cis-lunar space (CLS), 25
 Citizens in Space, 32
 CleanSat, 100
 Clean Space initiative, 99
 CNES, 99
 CO₂, 64
 Cobalt, 49, 64
 Columbus module, 76
 Commercial cargo, 5
 Commercial Crew Development (CCDev), 8
 Commercial Crew Development 2 (CCDev2), 10
 Commercial Crew Transportation Capability (CCtCap), 13
 Commercialization, vii, 23, 24, 77
 Commercial Products Contract (CPC), 13
 Commercial Space Federation, 32
 Commercial space markets, x, 21, 24
 Commercial space transportation markets, 18
 Commercial space transportation services, 18
 Commercial Transportation System (CTS), 11
 Commercial ventures, 46
 Competition, 24, 61
 Composite pressure vessel, 11
 Constellations, 95
 Copenhagen Suborbital Dassault Aviation Vector Space Systems, 32
 Copenhagen Suborbitals, 107, 110
 Cosmica airplanes, 32
 Cosmonauts, 40

Cost, 39

 overruns, 71
 recovery, 46, 78
 Cost savings, 18
 COTS, ix
 Craters, 64
 Crew/cargo management, 122
 Crew Exploration Vehicle (CEV), 1
 CRS, 1, 87
 CrystalCards™, 88
 CSA, 77
 CST-100, 11
 CST-100 Starliner, viii
 CST-100 vehicle, 74
 CTS-100, 5
 C-type asteroids, 66
 Cuba, 40
 CubeSats, 22
 Cultural projects, 78
 Customers, 24, 26, 33, 91
 Cygnus, viii
 Cygnus spacecraft, 9
 Cygnus vehicle, x, 5, 74

D

DARPA, 5, 102
 Deep Space Industries, 32, 66, 68
 Deimos, 69
 Deimos Imaging, xii
 Demand, xi, 4–5, 71, 80
 Denis Tito, x
 De-orbiting technologies, 96
 DigitalGlobe, xii, 3
 Direct benefits, 18
 Disruptive technology innovation, xi, xii
 Diversify, 38
 Dombarovsky, 122
 Dragon, viii, x, 74, 85
 Dragon capsule, 10
 Dream Chaser, 11, 74
 Drug development, 82
 Dynetics, 7

E

Earth, 49
 EcoDesign, 100
 Economic benefits, 17
 Economic impacts, 18
 Economic incentives, 100

Economics, viii
 Economies of scale, 14
 eDeorbit, 100
 EDT systems, 100
 Education, 83
 Edutainment, 70
 Electrodynamics tethers, 100
 ELIPS programmes, 76
 Emergency Detection System (EDS), 11
 Emerging commercial space markets, xi
 Emerging markets, 83
 Employment, 18
 End-users, 80
 Entertainment, 27, 83, 122
 Environment, 83
 Environmental Control and Life Support System (ECLSS), 11
 EO systems, xii
 ERISTO, 83
 ESA, x, 16
 ESA Columbus, x
 EU, 18
 Europe, ix, x
 European Drawer Rack (EDR), 44
 European SME, 109
 European space, xi
 EU Space Strategy, 18, 110
 Eutelsat, 18
 Evolvable Lunar Architecture (ELA), 56
 exactEarth, xii
 Excalibur Almaz, xi
 Exoliner, 74
 ExoMars, 16
 EXOS Aerospace, 121
 Expandable Bigelow Advanced Station Enhancement (XBASE), 85

F
 FAA, 4
 Falcon launchers, ix
 Falcon 9 rocket, xi, 74
 Ferrous metals, 63
 Financing, 68
 Flight licences, 109
 Flight opportunities programme, 13–14
 Fluid Science Laboratory (FSL), 44
 Fragments, 93
 Free market economy, 40
 Frenzier, 22
 Fuel handling, 119
 Funded Cargo SAA, 8
 Funded Crew SAA, 8

G

Game theory, 108
 Gap, 33
 Generation Orbit Launch Services, 7
 GEO satellites, 3
 Global cooperation, viii
 Golden Spike, 32
 Google Lunar X Prize, 5, 51
 Governmental customer, 38
 Governments, 17, 119
 Grand Challenge, ix

H

H2020, 98
 Habitation, 63
 Hamilton Sundstrand, 89
 Hangers, 119
 Health, 83
 Helium 3, 15
 Hepatitis C, 84
 High-intensity discharge (HID), x
 H-II, 10
 Honeywell, 77
 Hubble telescope, 36
 Hungary, 40
 Hydrocarbons, 72
 Hydrogen, 64
 Hypobaric chambers, 121

I

IIASL, 110
 India, 56
 Indirect benefits, 18
 Industrial applications, 84
 Industrial Space Facility (ISF), 35
 Industry dependence, xi
 Inflatable modules, xi, 73
 Innovative Lunar Demonstration Data (ILDD) programmes, 10, 20
 In-orbit satellite servicing, x, 28, 102–104
 In situ resource exploitation, 24
 In situ resource extraction, 28
 In situ resource utilization (ISRU), 2
 Inspirational dimension, viii
 Inspiration to Mars, 32
 Interdependencies, 31
 Interkosmos programme, 40
 International Space Exploration Coordination Group (ISECG), 65
 International Space Station (ISS), vii, xi, 4, 74
 brand, 45

- International Space Station (ISS) (*cont.*)
 commercialization, viii, 23
 markets, 75
 partners, viii, 73, 79, 80
 prices, 45
 products and services, 45
 programme, 80
 resources, 44
 utilization, xiii, 25
 water recycling, 82
- Interorbital systems, 7
- Interplanetary missions, 57
- Interplanetary settlement, 49–72
- IPR rights, 43
- Iridium, 3
- Iridium 33, 94
- Iron, 49, 64
- J**
- Japan, 56
- JAXA Cosmode Project, x
- JAXA Open Space Lab, x
- Jiuquan Satellite Launch Center, 122
- K**
- Ka-band frequencies, 95
- Kentucky Space, 77
- Kessler syndrome, 28, 95
- KIBO module, 78
- Kiruna, Sweden, 125
- KocmoKypc, 110
- Kosmos-2251, 94
- Ku frequencies, 95
- L**
- Laggers, 14
- Launch abort system, 11
- LauncherOne, 19
- Lease, 119
- Lessons learnt, 47
- Lilly, 77
- Low Earth orbit (LEO), xi, 7
- Low-G biology, 70
- Luna, 56
- Lunar Atmosphere and Dust Environment Explorer (LADEE), 16
- Lunar Catalyst programme, viii, 15, 40, 62
- Lunar ice, 61
- Lunar resources, 52
- Lunar sand, 61
- Lunar surface, 62
- Lunar-with a capital L, xiii
- Luxembourg, 28
- LuxImpulse, 55
- M**
- Made in Space, 65
- Made in Space Stratolaunch Systems, 32
- Manganese, 49
- Manufacturers/operators, 109
- Market creation, 79
- Market evolution, 23
- Market opportunities, 78
- Markets, 33
- Market segmentation, 24–25
- Market structures, 17
- Mars Atmosphere and Volatile Evolution (MAVEN), 16
- Mars Colonial Transporter, 51
- Mars One, 32, 69, 70
- Mars One mission, 5
- Mars Society, 69
- Mass, 93
- Masten Space Systems, 13, 15, 32, 110, 121
- Material Science Laboratory (MSL), 44
- mCLV-RSR, 13
- MDA, 32
- Medical devices, 47
- Medical services, 122
- Mediet food tray, x
- Merck, 77
- METRON project, 82
- Microcosm, 7
- Microgravity platforms, 5
- Micrometeorites, 64
- Microsatellite market, 7
- Mid-deck lockers, 77
- Military, 5
- MIRCorp, 42
- MIR space station, x
- Mission control services, 122
- Mojave Aerospace Ventures, 107
- Mojave Air and Space Port, 121, 124
- Moon Express, 15, 32, 56
- Moon village, 58
- Multidisciplinary, 24, 43
- Multilateral Coordination Board (MCB), 79
- MUSES, 89
- N**
- NanoRacks, 22, 32, 77, 88–89
- NanoRacks CubeSat Deployer (NRCSD), 22
- NanoRacks NanoLab™, 89

- NASA, viii, x
 Asteroid mission, 10
 COTS programme, viii, xi
 Lunar Catalyst, 5
 STEM community, 13
 Nascent stage of development, 21, 27
 National interests market, 81
 Near-Earth Objects (NEOs), 28
 Near Space Corporation, 13
 Net present value (NPV) model, 18, 77
 Neurosurgery, 82
 New Glenn, 18
 New materials, 83
 NewSpace, vii, x, xi
 NextStep Programme, 59, 63
 Nickel, 49, 64
 Nitrogen, 64
 Nitto Seimo Co, 100
 Non-EU technologies, xii
 Northern Lights, 120
 Novartis, 77
- O**
 Open Space Lab, 78
 Orbital ATK, 121
 Orbital launch services, 3, 77
 Orion vehicle, 2
 OSTEO facility, x, 44
 Osteoporosis, 6, 45, 82
 Osteoprotegerin, 45
 Oxides, 64
 Oxygen, 63
- P**
 Parabolic flights, 121
 Paragon Space Development Corporation, 8,
 10, 11
 Payload, 119
 Pepsi, x
 P&G, 77
 Phobos, 69
 Phoenix project, 103
 Phosphorous, 66
 Pioneers, 40
 Pizza Hut, x
 Planetary defence, 52
 Planetary Resources, 32, 65, 66
 Planet Labs CubeSats, 3
 Platinum group metals (PGMs), 67
 Plesetsk Cosmodrome, 122
 Poland, 40
 Prevention, 96
 Price, 68
 Pricing policies, 79
 Primary market sectors, 30
 Private financing, 53
 Private investor, 71
 Profitability, 14
 Profits, xi, 68
 Progress 23 ship, 99
 Propellant facilities, 119
 Propellants, 28, 63
 Property rights, 96
 Prospector-X, 55, 68
 Protection, 96
 Protein crystal growth-1, 88
 Protein crystal growth (PCG), 89
 Protein crystallization, 6, 24
 Protein growth, 79
 Proton M, 18
 Publications, 83
 Public investors, xii
 Public-private partnership (PPP), 59, 119
 Pyroxene, 64
- R**
 RadarSat, xii
 Radiation, 64
 Rate of return, 18
 R&D
 customers, 13
 markets, 6, 13, 27, 83
 microgravity markets, 14
 needs, 14
 payloads, 24, 27
 solutions, 46
 Reaction Engines, 32, 110
 Red, 77
 Re-entry Direct Broadcasting Alert System
 (R-DBAS), 99
 Refuel LEO, 28
 Regolith, 64
 Removal, 96
 Repair LEO, 28
 Reusable vehicles, xi
 Revenues, 18
 Risks, xii, 40
 Robonaut (R2), 102
 Robotics, 50, 63, 69
 Rocket, xi
 Rocket Development and Test Facility, 121
 Rocketplane, xi
 Rocket plan Kistler, 9

- Roscosmos, viii, 3
 Runway, 121
 Russia, 56
- S**
- Scaled Composites, 32, 107, 110
 Science, viii
 Secondary market sectors, 30
 Security management, 122
 Selene-2 mission, 56
 Self-sustainable, 69
 7 meter asteroid, 2
 Shackleton Energy Company (SEC), 32, 64
 Shuttle Bay, x
 Sierra Nevada Corporation, 8, 11, 32
 Silicon, 64
 Simulators, 121
 Skybox, xii
 Skylab, 94
 SLIM mission, 56
 Smallsats, 96
 SME and R&D companies, 88
 Société Nationale de Crédit et d'Investissement (SNCI), 55, 67
 Solar-powered satellites, 27
 Space, 50
 - agencies, 50, 75
 - applications, 69
 - cosmetics, 83
 - debris, 26, 28, 93–105
 - industry, xi
 - laboratory, 73
 - tourism, x
 - tourist, 7
 - traffic management, 95, 99
 - transportation services, 8
 Space 4.0, ix
 Space Act Agreement (SAA), 8
 Space Activity Law, 9
 Space Adventures, 32, 77, 110
 Space-based products, xi
 Space-based resource exploitation, xii
 Spacecraft, 63
 Space debris mitigation (SDM), 99
 Space Exploration, 83
 Spacehab, x, 35
 Space Launch System (SLS), 2
 SpaceLoft tm XL, 13
 Spaceport America, 123
 Spaceports, 119–125
 Space-related product, 111
 SpaceShipOne, 5, 107
 SpaceShipTwo, 13
 Space Shuttle, xii, 35–38
 Space Situational Awareness, 95
 SpaceX, xi, 3, 32, 85–88
 SpaceX Falcon Heavy launch vehicle, 5
 SpaceX McGregor, 121
 Spektr, 42
 Spillovers, 18
 Spin-in, 59
 SRV, 7
 SS2, 13
 Stakeholders, xi, 75–78
 Starfighters, 7
 Starliner, 12
 STEM, 79
 STIG, 13
 Stratolaunch, 110
 Sulfur, 66
 Sweden, 8
 Swedish Space Port, 32, 110, 120, 125
 SWOT analysis, 18
 SXC, 110
- T**
- Taiyuan Satellite Launch Center, 122
 Tanegashima Space Center, 122
 Targeted markets, 33
 Tauri Group, 6
 Taxpayers, 119
 Technology innovation, 18
 Technology platform, 100
 Techshot, 77
 Tele-communications, 5
 Teledyne Brown Engineering, 77, 89
 Tele-medicine, 82
 Tele-operations, 63, 71
 Terrestrial competition, 71
 Terrestrial mining, 55
 Terrestrial technologies, 24
 Tether, 100
 Tether Applications, 97
 Threat, 98
 3D printing, 24, 58, 65
 Time to market, 79
 Titanium, 49
 Tito, Dennis, 42
 Top-down market analysis, 79
 Transfer vehicles, 77
 Transversal market segments, 26, 27
 TRL, 29

U

Uchinoura Space Center, 122
ULA, 3, 32
Uncontrolled re-entry, 98
Unfair competition, 14
Unfunded Crew SAA, 8
United Launch Alliance (ULA), 8, 11
Unknown R&D customers, 79
UP Aerospace, 13, 32, 110
USA, 8
US Constellation programme, 1
US DoD, 5
User-driven, 90
User-friendly conditions, 45
UTC, 77
Utilization, xii

V

Value chains, 24
Vehicle integration/checkout and others, 119
Venture capitalists, xi
Vicetris, 84
Virgin Galactic, 6, 13, 32, 110, 114
Vision for Space Exploration (VSE), 1

Volvo, 111
Vostochny Cosmodrome, 122

W

Waste management, 82
Water, 64
White Knight, 107
Willis Inspace, 110
World View, 13

X

Xaero sub-orbital vehicles, 13
Xbase station, 88
XCOR Aerospace, 7, 21, 32, 110, 114, 121
XCOR Lynx, viii
Xichang one, 122

Z

Zero Gravity, 32, 83, 110
Zero2Infinity, 32
Zubrin, 69