McKinsey & Company

Off-world Construction

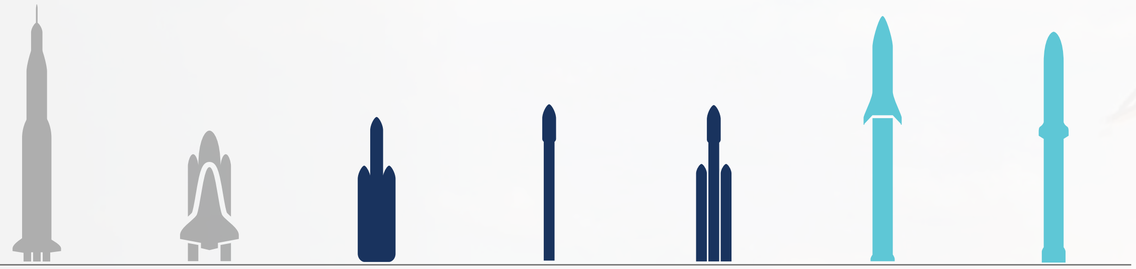
Defining New Opportunities in the Emerging Space Economy.

Updated April 2019


“Remember to look up at the stars and not down at your feet.”
- Stephen Hawking

It’s not science fiction anymore. A new frontier is *now* open for business.

The commercial space industry has seemingly been a hobby for billionaires since the first space tourist paid $20 million to fly to the International Space Station back in April 2001. The fledgling industry has been focused on reducing launch costs for years and has now achieved over a **93.8% costs reduction*** in just 16 years. With more competition rapidly coming online over the next two years, mostly driven by SpaceX’s successful reuse of its rocket boosters, prices are expected to fall dramatically lower still.



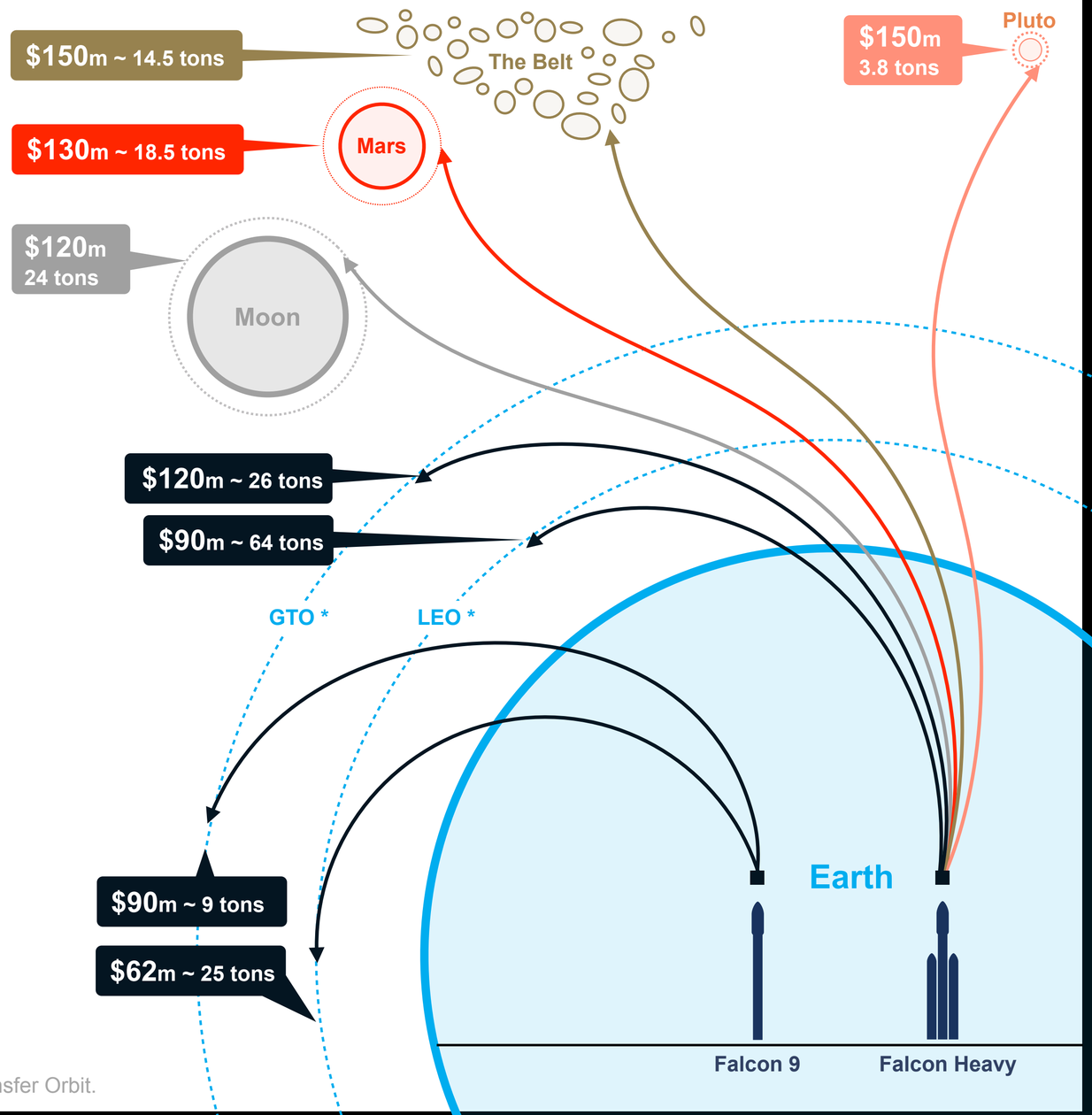
	Saturn 5	Space Shuttle	Delta IV Heavy	Falcon 9	Falcon Heavy	Starship	New Glenn
Launch:	$1.16b	$1b	$350m	$62m	$90m	$40m (est.)	*N/A*
Payload:	130 tons	25 tons	31 tons	25 tons	64 tons	100 tons	47 tons

Previous NASA vehicles Current commercial vehicles Future vehicles currently in development

Falcon Heavy
A pair of SpaceX’s Falcon Heavy boosters landing simultaneously after successful launch to orbit.

Lifting tons and tons into orbit is *no longer* a feat for governments. Even lifting tons into deep space or to other bodies is now a reality.

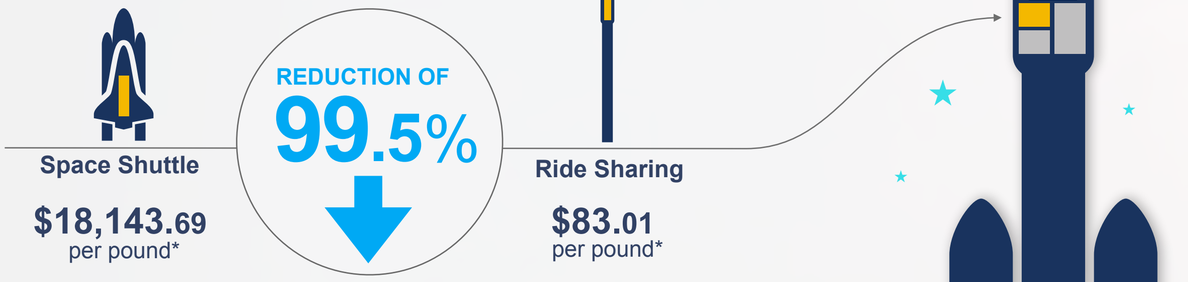
The Falcon Heavy currently has more lift capability than any other operational rocket in the world, with a payload of 140,660 lbs. to low Earth orbit and 37,040 lbs. to a trans-Mars injection. The rocket was designed to meet or exceed all current requirements of human rating. The structural safety margins are 40% above flight loads, higher than the 25% margins of other rockets. Falcon Heavy was designed from the outset to carry humans into space as the Falcon 9 will do this year with NASA astronauts onboard. With launch prices to any destination in the solar systems around 1/10th the price of a Space Shuttle launch just 8 years ago –
access to space is no longer an issue.



Prices are based on publicized pricing by SpaceX. *LEO is Low Earth Orbit. GTO is Geosynchronous Transfer Orbit.

Even with the lowest launch costs in human history, you can *blast into space for even less* with ride sharing services now.

Commercial space companies, such as SpaceX, have driven launch costs dramatically lower in recent years; however, it still presents a large financial commitment for a lot of businesses. If you do not need an entire, dedicated rocket to lift tons and tons into space. New companies in the United States, such as spaceflight.com, offer ride sharing services for companies that would like to launch payloads into space, but do not need the full capacity of modern rockets. Why pay for the entire FedEx plane when you just need to a ship a package?



*Based on NASA Space Shuttle estimated launch costs of $1 billion per flight and its payload capacity of 25 tons versus public pricing from spaceflight.com for containerized 3U payloads.

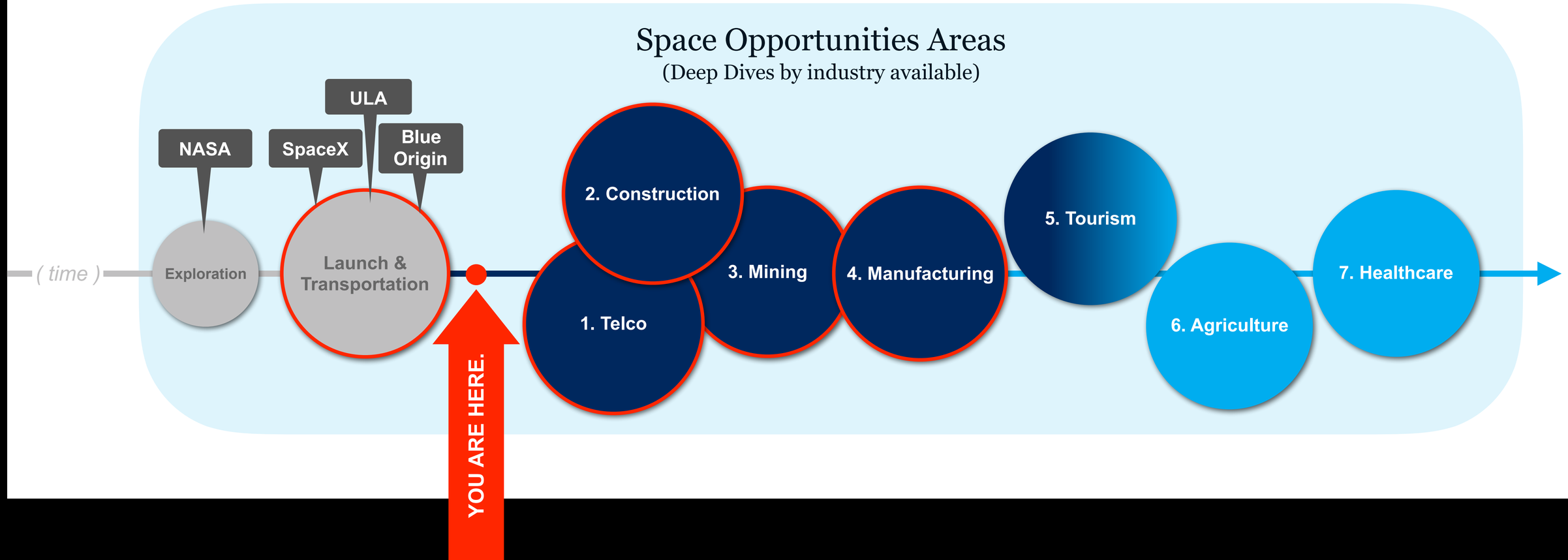
Access to space is within the grasps of startups & corporations alike, so *who will control the new space economy?*

In the past, the risks and extremely high costs of space exploration have often led some to question why humanity should even bother with leaving our own planet. From history we know that every major movement of humanity has tapped entirely new resources, developed new technologies, and created tremendous wealth. Massive “blue chip” corporations, such as Wells Fargo, got their start in the westward expansion of the United States during the 19th century. Now, in the 21st century with the costs of access to space now racing downward; technology is getting physically smaller; natural resources are becoming increasing harder to access; and Earth’s population is growing rapidly – all mean there is a tremendous opportunity for all businesses to harness the infinity of space. The stage has been set for the visionary businesses that will capture the value and control this new economy. The next titans of industry are already writing their name in the stars today.

The New Space Economy.

The universe is a big place and the emerging space economy has endless possibilities for business. As with any new emerging economy, there are enabling or foundational industries that are needed first before the real value in other industries can be fully captured. This does not mean that economies evolve in a linear, waterfall fashion. Rather, the value pools and opportunity areas for some industries only become truly attractive once a large user base or basic capability has been established by another industry. This simply translates into bigger near term opportunities for some industries and bigger long opportunities for other industries. With the new space economy there is also a spatial lens to filter potential opportunities through since the entire solar system is now accessible. The following diagram shows when and where the broadly described industries would likely find the highest ROI of any space focused efforts.

- Opportunity areas w/ established leaders
- Areas/ Industries that enable others
- Near term opportunities
- Future opportunities



“If I'm 80 years old, looking back on my life and the one thing I have done is make it so that there is this ***gigantic entrepreneurial explosion in space*** for the next generation, I will be a happy, happy man.”

- Jeff Bezos

Industry Opportunity:

Construction

Giant space stations, massive ships, fantastic domed cities and massive industrial complexes have always been a staple of science fiction movies serving as amazing backdrops for the characters and their stories. It is not science fiction anymore. Over just the next 5 years alone, a variety of efforts by numerous companies will realistically start moving humanity beyond Earth. Lunar mining company, SpaceIL, launched their lunar lander in February 2019 and another company, Moon Express, plans to land their first rover on the Moon soon. Blue Origins plans to start regular flights to the Moon and SpaceX plans to start launching to the Moon and Mars all within that timeframe. Now that humanity is seriously getting ready to push out into space, *who will actually be building the real structures, machines, and equipment for space, the Moon, Mars, and other destinations in the Solar System?*

Building structures on Earth that have to be stuffed into the rocket fuselage and launched to other locations in the solar system is not economically feasible for business. Even with the historic reduction in launch prices from commercial launch providers, it still costs over **$718 per pound** to lift cargo and large structures into space. With the emerging space economy landing on the Moon and Mars in next 3 to 5 years, the off-world construction industry presents a very large opportunity area for the emerging space economy for the first movers as development needs to begin now. The value is clear:

- Early movers to off world construction can set very defensible positions to box out competitors from these new markets
- Advanced technology development that can move downstream into existing Earth based product lines & service offerings
- High visibility partnerships available with commercial launch companies, various space startups, and agencies like NASA
- Massive uplift of brand visibility and value
- New talent attraction and retention of existing employees

“The future is already here, *it’s just not evenly distributed.*”

- William Gibson

Construction is the gateway industry that allows others to move to space. It will build the actual foundations for a new economy.

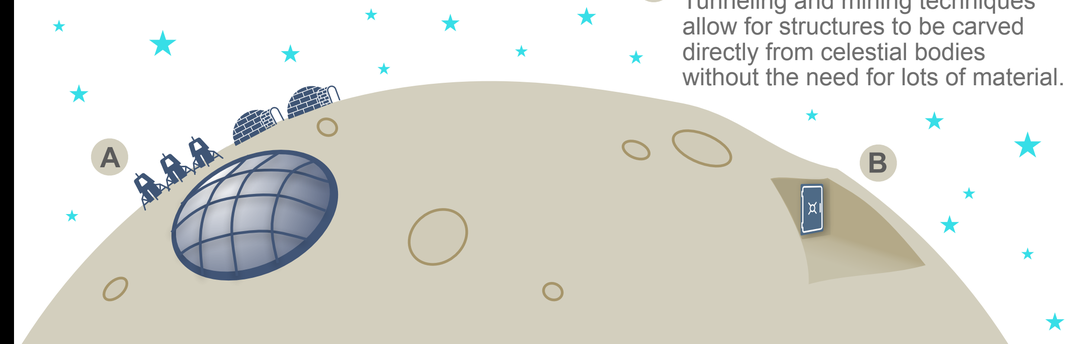
History can show us repeatedly that when vast new lands open up for the first time, so do vast new opportunities for business. From the ship builders to the shipping companies and the wagon makers to the home builders, construction has always one of the first industries transitioning to new lands simply because it enables others. In the 21st century, space will be no different for construction as a whole now that launch costs have dropped to level where new business can take hold. Construction will happen in orbit around Earth, in orbit around the Moon, in orbit around various bodies in the solar system, and also below the surface of various bodies in the solar system. The Mining industry is already seriously looking at mining the Moon and asteroids because of the enormous possible ROI in minerals and raw material, but plans slow when someone asks who can build the facilities and equipment to enable their industry? We are at the beginning of a new era in construction.

CONSTRUCTION ON THE SURFACE

Atmosphere or no atmosphere?
Unlike traditional construction here on Earth, surface construction off world will be in a variety of environments including surfaces of bodies without atmospheres. Construction of these pressurized buildings and structures will be more like ship building than home building on Earth.

A Surface construction
Various methods and materials can be used to build surface structures including 3D printing, sintering, and using preassembled structures.

B Subsurface construction
Tunneling and mining techniques allow for structures to be carved directly from celestial bodies without the need for lots of material.



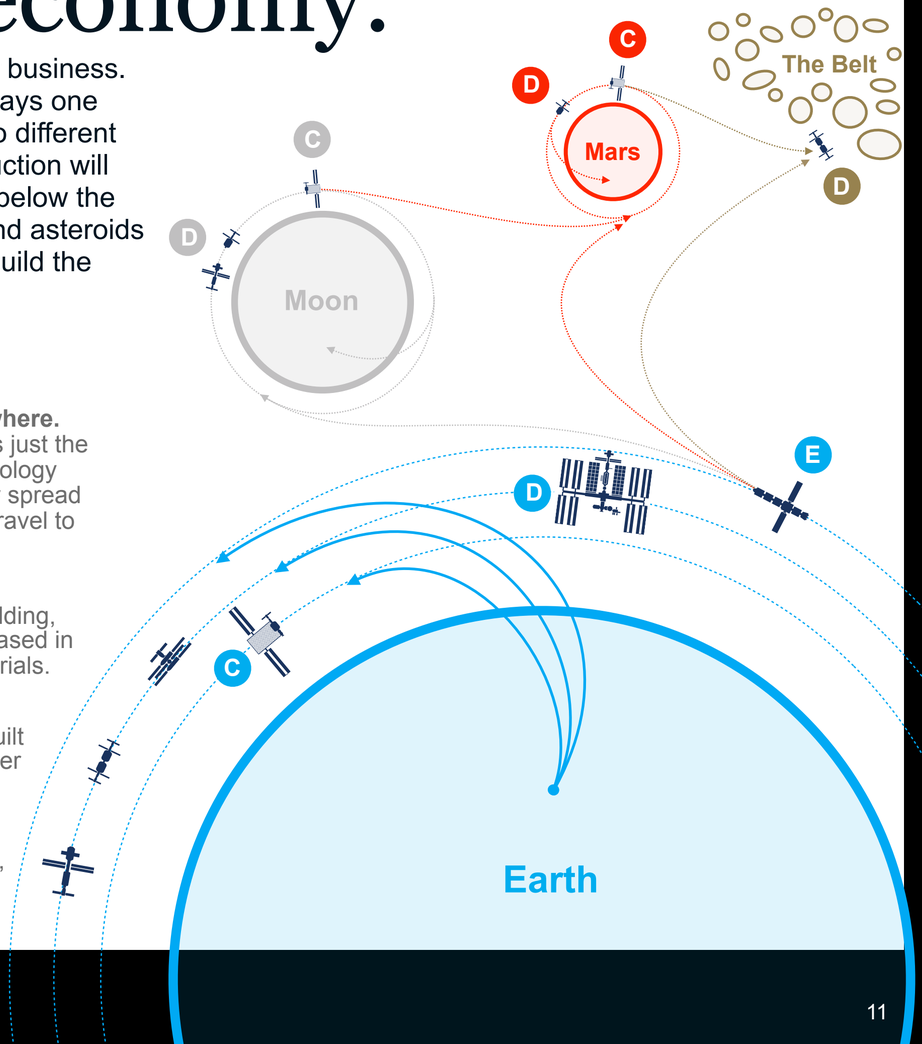
CONSTRUCTION IN ORBIT

Construction will happen everywhere.
Orbital construction around Earth is just the beginning. Techniques and methodology developed in Earth orbit will quickly spread to other destinations that humans travel to within the Solar System.

C Orbiting dry docks
Floating ship yards for ship building, station building, and repairs. Based in LEO* for easier supply of materials.

D Space Stations
Large space stations can be built using the orbital dry docks rather lifting preassembled modules.

E Large spacecraft & ships
Assembled in orbital dry docks, towed to and launched from MEO* and HEO*.



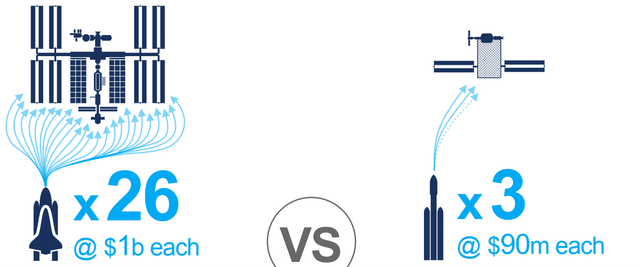
*LEO = Low Earth Orbit. MEO = Medium Earth Orbit. HEO = High Earth Orbit.

Orbital dry docks will be floating construction & work sites for space based construction.

Space stations and massive space ships have remained on drawing boards and, at best, relegated to science fiction due to the enormous price tag historically associated with rocket launches. Orbital construction facilities are now feasible with dramatically lower launch cost via commercial launch providers. With even more powerful launch vehicles coming online over the next few years, plus the International Space Station being scheduled for decommissioning, there is already rapidly growing demand for commercial space facilities. Several space based startups such as Bigelow, Axoim, and Orion Span are already working to provide space station design, construction, and operations using their own modular systems to meet the coming commercial business needs in space. The approach used by these companies are centered around launching pre-fabricated modules from Earth, which are then assembled/connected in space similar to the International Space Station (ISS). Given the rate current launch costs are dropping, there is now a substantial opportunity to build and operate the first orbital ship yard in space to meet the demands from research, manufacturing, mining, and tourism.

CONSTRUCTION LAUNCHES

The International Space Station (ISS) was constructed by flying pre-assembled parts and modules from Earth into orbit. This process required **26 NASA Space Shuttle flights *plus* 9 other rocket flights** to lift the parts to the orbital construction site. This was extremely expensive endeavor costing over **$150 billion**.



*All values shown in Millions (m) and Billions (b). Estimated values based on pricing from SpaceX and Bigelow.

ANATOMY OF AN ORBITAL CONSTRUCTION SITE

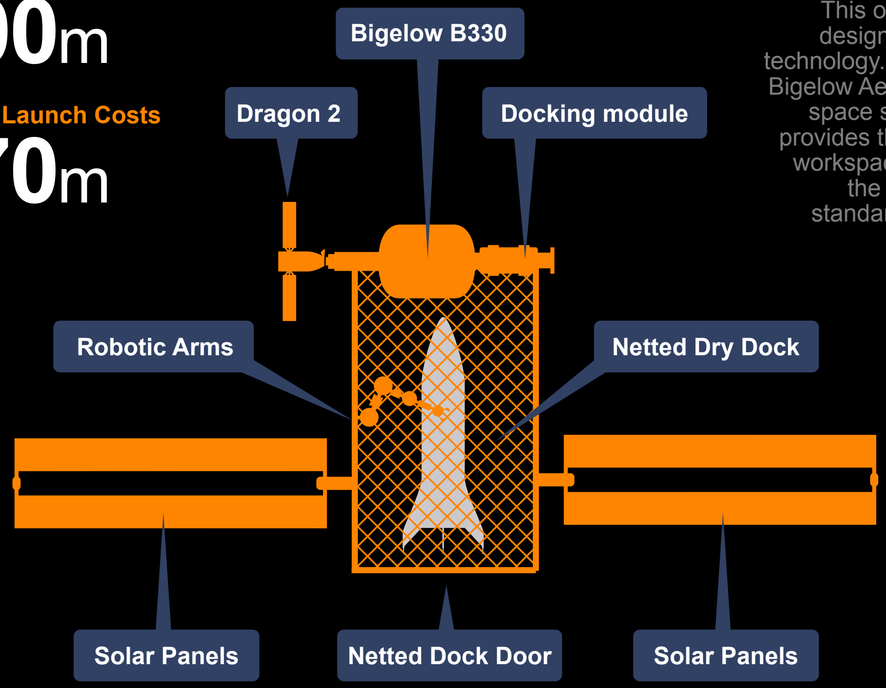
An orbital dry dock is a space station that has a large enclosed dock / hanger area used for the construction of large ships or space station components. This orbital dry dock design is based on NASA's "Roof" space station concept from the 1980's, but updated with an large enclosed central hanger area for work. The large, enclosed hanger is built from a simple truss system with safety netting attached to prevent workers, tools and parts from floating away to become space junk. At one end of the hanger, a motorized vertical section of truss opens and closes the large netted end of the hanger to allow hanger access for materials, space ships, and space station blocks constructed in the hanger. The habitat and pressurized work area form one section of the space station's frame.

Estimated Build Costs

$700m

Estimated Launch Costs

$270m



Existing Equipment

This orbital dry dock design uses existing technology. The inflatable Bigelow Aerospace B330 space station module provides the habitat and workspace. The rest of the dry dock uses standard trusses and solar panels.

APPLICATIONS

An orbital dry dock can be used for more than just construction in orbit. The safe work space provided by the netted hanger allows for multiple other uses.

Ship/Station Construction | **Ship Repair** | **Asteroid Processing**

The race has begun to build space tugs, welders and other needed orbital construction equipment.

Traditionally, designs for space based ships, stations, and satellites have been severely constrained by rocket size and extremely high launch costs that only governmental actors could afford. This has prevented construction and manufacturing from taking hold in space as the only customers were governments with their own space agencies. Today, launch prices have dropped to historic lows; new heavy lift rockets are now operational; massive new rockets will be coming online over the next 16 - 24 months; and a plethora of private companies are making ambitious planning. This all indicates that construction in space is about to finally take off. The only near term hinderance will be if the construction industry is ready for the new space economy with the equipment and services that are required. The early movers here will set highly defensible positions for decades to come.

CONSTRUCTION EQUIPMENT

A number of companies and new space startups are racing ahead with plans to start building the tools, equipment and businesses that will be needed for space based construction. This isn't science fiction or wishful thinking. California based startup, Made In Space, has had two zero gravity 3D printers operating aboard the ISS since 2016. Time will tell if the traditional brand names in construction move upwards to space.

Space Tugs

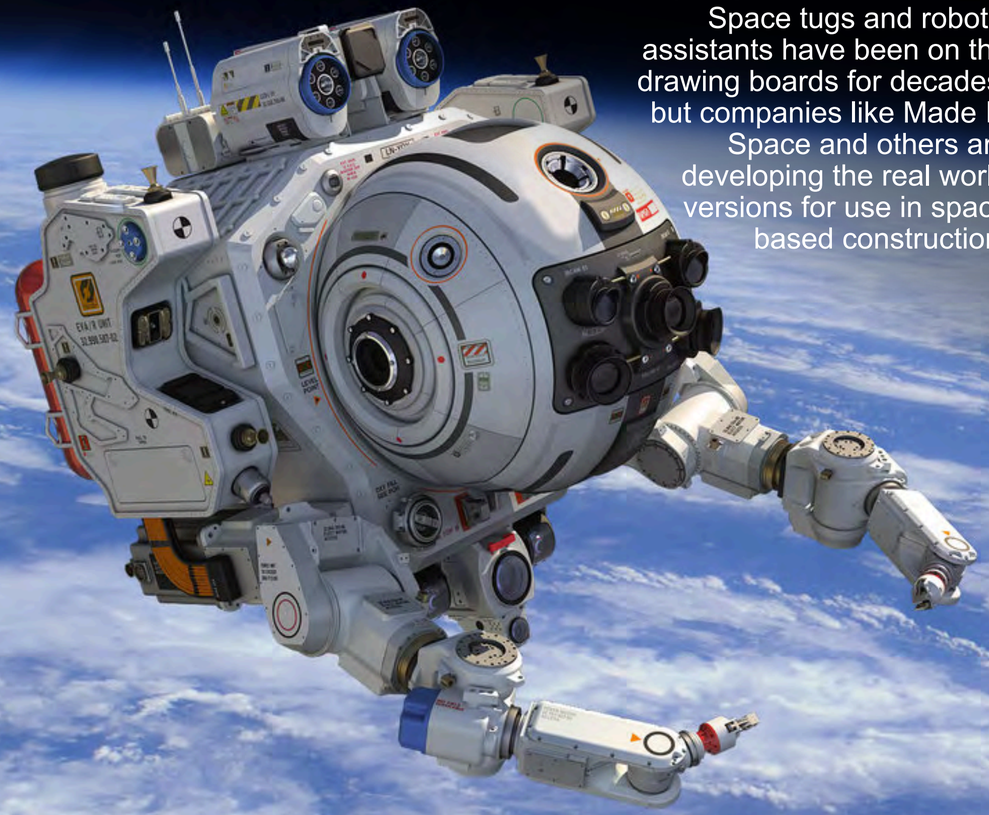
Material Handlers

Drone Printers

Composite Welding

Work Suits

Drone Welders



Flying Space Drones

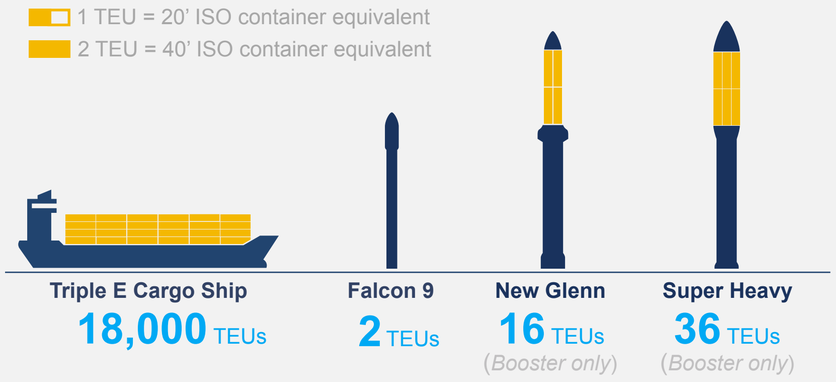
Space tugs and robotic assistants have been on the drawing boards for decades, but companies like Made In Space and others are developing the real world versions for use in space based construction.

Shipping cargo & materials efficiently into space requires a new version of the intermodal container.

Mature transportation and logistics companies on Earth rapidly moved to standardized international shipping containers back in the 1960s. By creating a standardized intermodal container that is reusable versus loading loose bulk cargo, *bilateral trade between countries increased by over 700% in just 20 years* while *shipping costs reduced dramatically worldwide**. In the same way that reusable rockets have dropped launch costs, reusable cargo containers will further drive down launch costs. Currently, every unmanned rocket launched uses a protective shell around its payload through the atmosphere and into space called fairings. Once out of the atmosphere, the fairings are discarded and left as either orbital space junk or to burn up on reentry in the atmosphere. For cargo missions to the International Space Station (ISS), small spacecraft designed originally for human space flight are stripped down for cargo missions with much less capacity than the cargo area inside fairings atop rockets. These fairings costs the cheapest launch provider, SpaceX, $6 million each which is why they have been trying to capture the discarded fairings for reuse.

CARGO COMPARISON

Lifting weight is not a big problem compared to efficiently shipping cargo into space. ISO shipping containers on Earth are optimized in size for ground transportation via roadways. If ground transportation requirements are needed for shipping space cargo, the following diagram shows how many TEUs can be moved with vehicles based only on lift capacity and rocket body diameter (center of gravity/load balancing was not accounted for here).

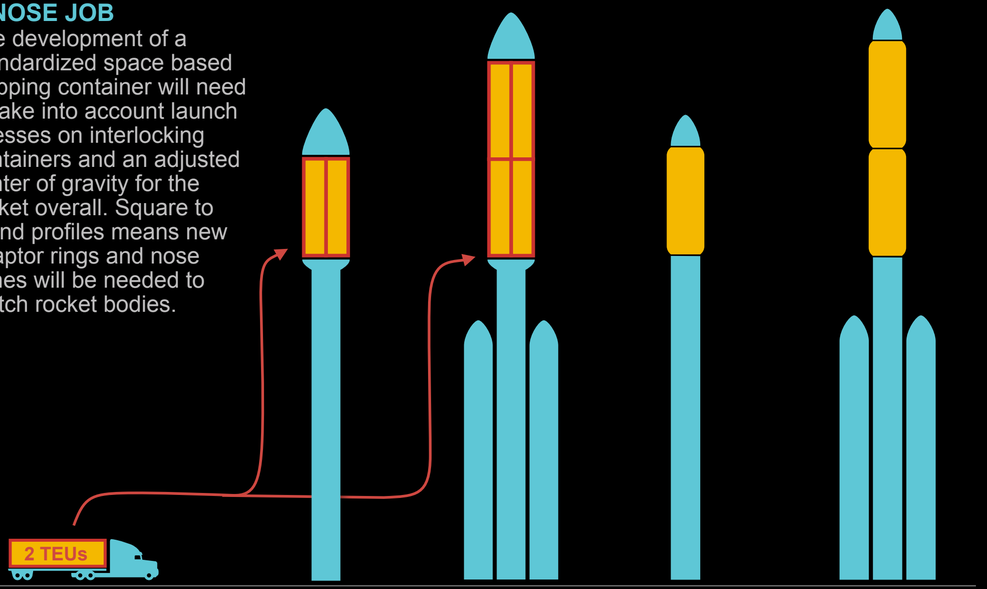


OPPORTUNITY: THE CONTAINERIZATION OF SPACE

Modern shipping containers were invented by American trucking magnate, Malcom McLean, in 1956. The standardized metal box were sized to the max widths allowed on U.S. highways and later set into standard lengths of 20', 40', and 53' long. Your typical dry freight container is 8' wide X 8' tall X 20' or 40' in length. Standardizing containers for space cargo means either standardizing around highway widths or rocket body diameters. Truck based shipping of cargo directly to a launch site could be done for cargo missions where planetary protection is not a concern such as to Earth orbit or the Moon. If truck based shipping is not needed or allowed, then a full rocket body sized container would have a substantially higher cargo capacity and offer more stable flights. These rocket sized, large shipping containers are not transportable over highways without using heavily curated routes that involve road closures, and require escorts. This means a larger rocket sized shipping container would need to be loaded with cargo at the rocket assembly building for the launch provider, cutting down efficiencies in loading and unloading cargo.

A NOSE JOB

The development of a standardized space based shipping container will need to take into account launch stresses on interlocking containers and an adjusted center of gravity for the rocket overall. Square to round profiles means new adaptor rings and nose cones will be needed to match rocket bodies.



Launch Vehicle:	Falcon 9	Falcon Heavy	Falcon 9	Falcon Heavy
Configuration:	4 TEUs	16 TEUs	22 TEUs	44 TEUs
Highway Transport:	YES	YES	NO	NO
Cargo Volume:	132 m^3	531 m^3	732 m^3	1,464 m^3

Truck sized cargo containers (road safe) Rocket sized cargo containers (too big for roads)

* From 'Estimating the effects of the container revolution on world trade' by Daniel M. Bernhofen, Zouheir El-Sahli , & Richard Kneller https://economics.fiu.edu/events/2013/seminar-daniel-bernhofen/bek_container_feb-3-2013.pdf

“That's the wonderful and terrible thing about technology – it changes everything.”

- Solomon Epstein

Surface construction on the Moon and Mars will happen within the next decade and require new types of equipment and a variety of new techniques.

While building bases on the Moon and Mars has been a dream for two generations that the Apollo Moon landings of the 1960's and early 70's inspired, it is about to become reality within the next 5 years. NASA, Blue Origins, SpaceX, plus a plethora of private space startups are all eyeing a return to the Moon by 2021. The commercial space race has been on a steady trajectory to return to the Moon and Mars for over a decade now. Mining, manufacturing, and tourism will be industries that put economic incentive in these locations for businesses initially; however, construction will be the industry that enables business to occur in these off-world locations. Building in extreme environments such as other planets, moons and asteroids will force the creation of new construction methods & techniques that will have immediate impact back on Earth. Solar power, cordless power tools, microwave ovens, and new advanced materials all are the commercial byproducts of the space exploration over the past 60 years. The owners of the new technology developed for off-world surface construction will revolutionize construction back on Earth as well as open new market opportunities for themselves. The value of construction in space goes far beyond contracts to build the equipment and structures required by others - it will establish the dominant corporate players for the 21st century.

BUILDING ON THE SURFACE

Robotic site work

Robotic construction drones arrive before any humans to start site work and prepping the area for infrastructure to arrive.

Camping

The first arrivals to the Moon or Mars will be camping out using their landers as an operating base until new habitats are built.

Domes

Large domes for farming and life support are constructed from 3D printed structural spans or constructed from inflatable, high pressure structural elements like AirBeams. By capping a crater with a dome, a large habitat could be quickly erected with minimal materials.

3D Printing

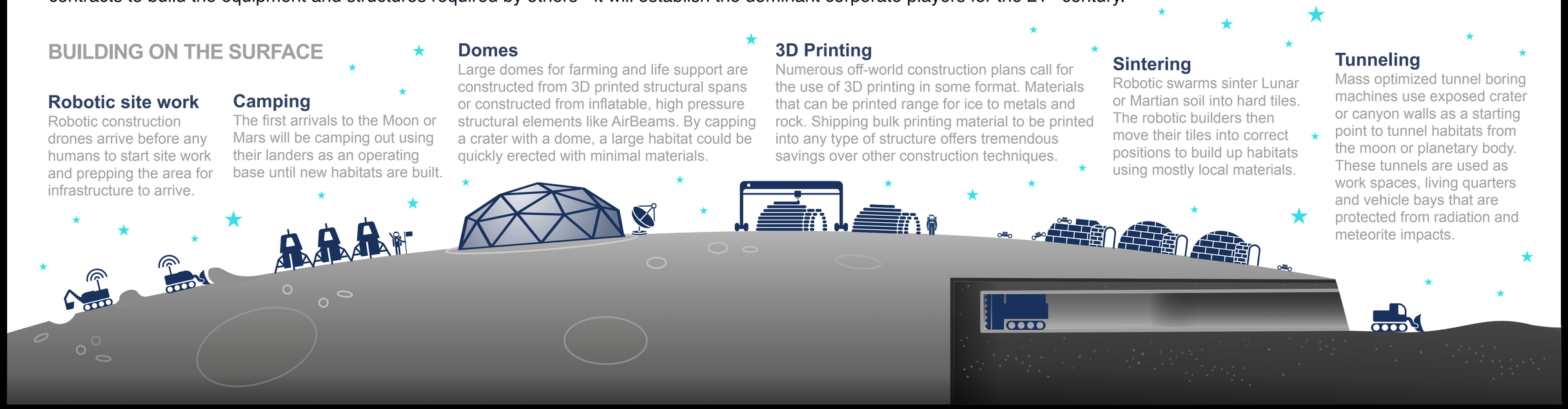
Numerous off-world construction plans call for the use of 3D printing in some format. Materials that can be printed range for ice to metals and rock. Shipping bulk printing material to be printed into any type of structure offers tremendous savings over other construction techniques.

Sintering

Robotic swarms sinter Lunar or Martian soil into hard tiles. The robotic builders then move their tiles into correct positions to build up habitats using mostly local materials.

Tunneling

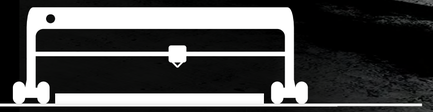
Mass optimized tunnel boring machines use exposed crater or canyon walls as a starting point to tunnel habitats from the moon or planetary body. These tunnels are used as work spaces, living quarters and vehicle bays that are protected from radiation and meteorite impacts.



The off-world construction industry will get started with **Landing Pads.**

The first major piece of off-world infrastructure needed within the next 5 years are landing pads on the Moon and for Mars. Landing pads will be the docks on new worlds that will ease travel and logistics, de-risking flights for capital intensive travel to destinations. Not only do they keep dust and debris from sand blasting nearby equipment, they provide stable platforms for cargo transfer. By starting with foundational construction projects like landing pads, the technical knowledge to expand quickly into roadways, foundations, and habitat construction will be developed rapidly.

LANDING PAD CONSTRUCTION



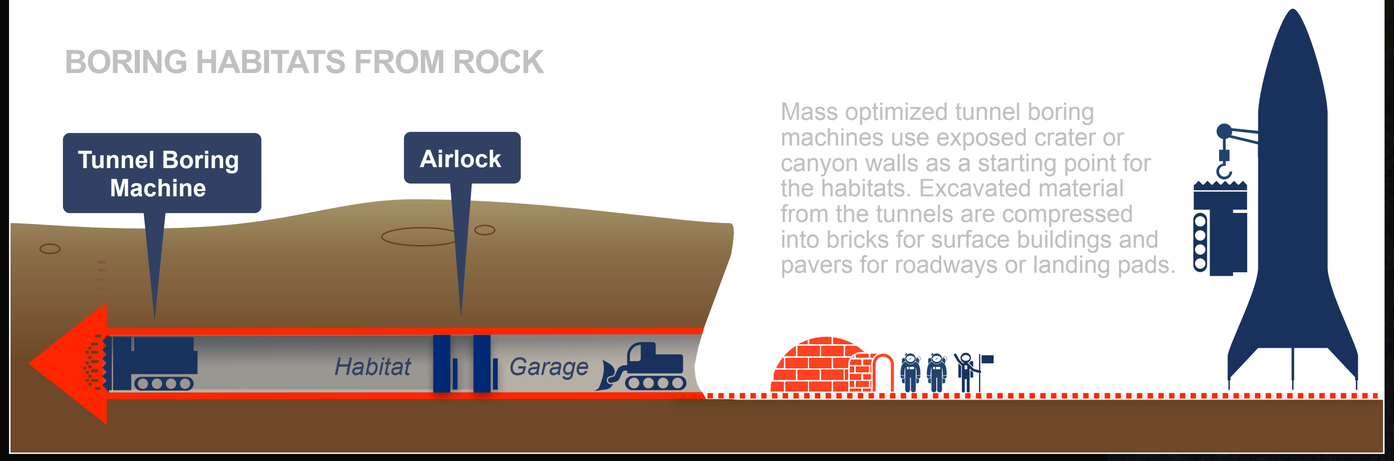
Printing with melted rock

Since the 1950's, companies in Eastern Europe have been melting and casting basalt rock like metal. Basalt is the most common form of volcanic rock on Earth and the Moon. By heating the rock to 1800˚C it becomes molten and can be 3D printed to produce a landing pad that is lighter than steel and stronger than carbon fiber. This means no materials need to be transported to a construction site, because they are already there.

Tunnel boring machines will be the *all-in-one, mobile city builders* of 21st century construction.

Mass optimized, tunnel boring machines will be one of the most valuable pieces of heavy equipment to own and operate as an off-world construction company. For the price of just one launch to its destination, a tunnel boring machine will be capable of boring miles and miles of radiation resistant, pressurized habitats with minimal materials. Any exposed cliff side or crater wall in a structural sound rock body could have habitats, equipment garages, or mechanical shelters burrowed into it. Prefabricated airlock panels can be installed into sealed or unsealed tunnels that have been excavated to create pressurized sections of a tunnel. Excavated material (muck) from the tunnel boring process can be compressed into small bricks and pavers for surface construction needs. Craters and canyons could be sealed via roof glazing and connected by habitable tunnels to quickly build out cities.

BORING HABITATS FROM ROCK



Mass optimized tunnel boring machines use exposed crater or canyon walls as a starting point for the habitats. Excavated material from the tunnels are compressed into bricks for surface buildings and pavers for roadways or landing pads.

The Boring Company

Recently, Elon Musk's The Boring Company completed this demonstration tunnel under L.A. to test transportation schemes. The company also recently announced that they will be selling bricks compressed from excavated material from their tunnel building for construction purposes as a price competitive material.

A Bored Habitat

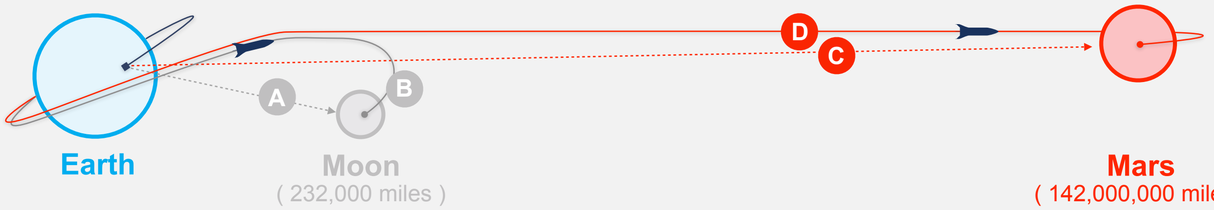
Currently, The Boring Company is using 14' (4.26m) diameter tunnel boring machines. A 14' diameter tunnel would create a single level pressurized habitat that could run for miles and interconnect with other tunnels to form larger settlements. The cross section of a tunnel habitat (at right) shows how public right of ways and private living areas could be divided from the same 14' bored tunnel habitat.

14' Diameter Bored Habitat (Typical cross section)

Digital supply chains will power the 3D printing enabled construction sites far beyond Earth.

3D printing is a buzzword often used as a magic bullet type of solution to lots of manufacturing or construction problems; however, the technology is well proven and very real. For example, the Austin, Texas based startup ICON builds extremely large 3D printers that can print an 800sq. ft. home in less 24 hours from concrete for under $10,000 each. Large scale 3D printing of structures is nothing new, but as humanity seriously prepares to move business into space now, the technology makes even more sense for construction sites that are millions of miles away. A single shipment of filament or resin for 3D printing to a destination in the Solar System can produce not only structures, but tools, fasteners, replacement parts, vehicle bodies, and an infinite type of structural elements. Using 3D printers that can be fed with local materials such as ice, top soil, or other easily acquired natural materials, means construction costs essentially drop to costs of ownership for the printers themselves. This type of digital fabrication creates economies of scale that are impossible to match with a supply chain that spans 142 million miles of hard vacuum to Mars. Even the Moon, at a much closer distance of 232,000 miles from Earth, would be the longest supply chain in human history. Transmitting only files to printed locally, millions of miles away, will create the longest and fastest supply chain in human history.

JUMPING TO LIGHT SPEED



Mars Ice House*

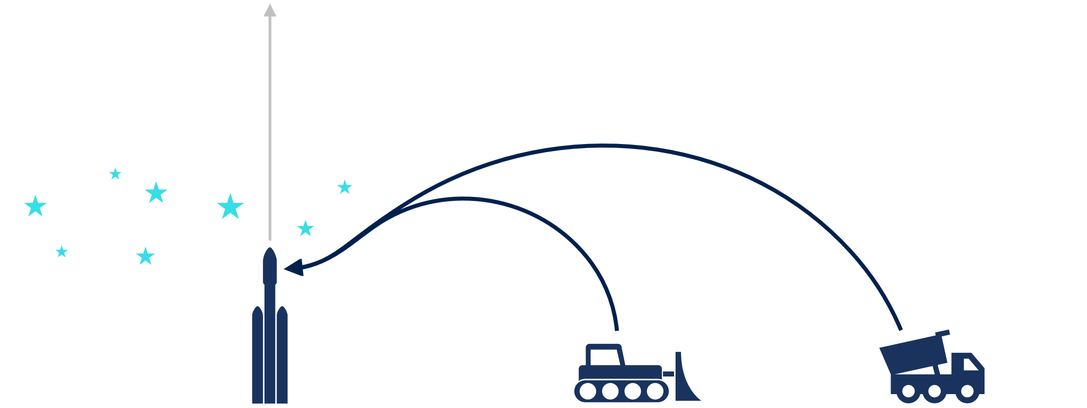
SEArch and Clouds AO's joint team recently won the NASA sponsored *3D Printed Habitat Challenge for Mars* with their design which uses 3D printing with water to create a ice enclosure for the habitat. Ice shields from radiation while still allowing natural light to pass through. Mars is extremely cold making natural materials such as ice a viable building material.

	A	B	C	D
Destination	Moon	Moon	Mars	Mars
Type (.Digital / Physical)	Transmission	Chemical Rocket	Transmission	Chemical Rocket
Distance (MILES)	232,000	232,000	142,000,000	142,000,000
Travel Time (DD:HH:MM:SS)	00:00:00:01	03:12:51:21	00:00:24:00	162:00:00:00
Costs (USD)	**$0.12**	**$125,000,000**	**$0.12**	**$150,000,000**

* SEArch / Cloud AO Mars Ice House design: https://vimeo.com/142099027

What if a bulldozer had launched on the Falcon Heavy instead of an electric sports car?

After offering multiple free rides to various parties on the maiden test flight of the Falcon Heavy in 2018 *and getting no takers*, SpaceX was forced to go with their backup plan. The backup plan was just to have some fun by launching Elon Musk's personal Tesla roadster into space towards Mars. Imagine the headlines when someone lands the first bulldozer prototype on the Moon or Mars? Serious science and innovation make good business.



	SpaceX Falcon Heavy	Caterpillar D9	Caterpillar 785D
Launch Costs:	$90 - 150m	Fits onboard	Fits onboard
Payload / Mass:	64 tons	54 tons	24 tons each

Off-world construction presents several major opportunity areas:

1. ORBITAL CONSTRUCTION SERVICES
Space stations and large space ships are now possible with orbital construction services. Orbiting ship yards with dry docks for construction and repair will yield ongoing cash flow for their operators with the coming space boom.

2. SHIPPING & LOGISTICS SERVICES
The containerization of space will have a tremendous effect on businesses expanding into space. The owners of space based shipping lines stand to be early winners.

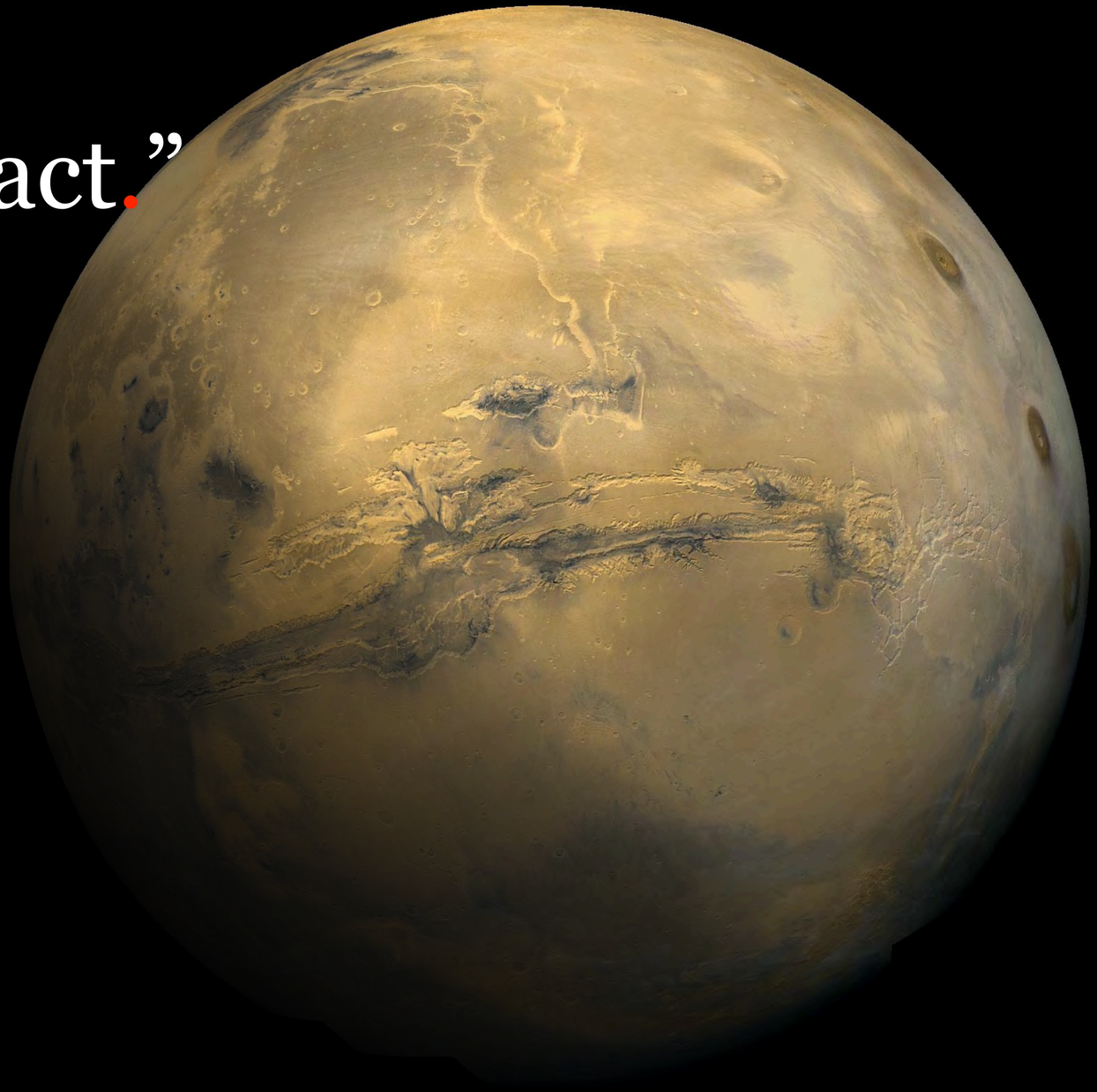
3. NEW EQUIPMENT & TECHNOLOGY DEVELOPMENT
The demanding work environments of space require new types of tools and equipment. These opportunities have to be acted upon now to order to keep new disruptors at bay.

4. SURFACE CONSTRUCTION BUILDERS
Like the orbital construction services, off-world surface construction currently presents historic opportunities for commercial developers.

5. NEW LABOUR FORCE
Like the mining industry on earth, or every industrial revolution, construction in space requires re-skilling and the creation of new roles and responsibilities.

“I would like to die on Mars. Just not on impact.”

- Elon Musk



Holistic solutions: The magic of McKinsey

There is significant upside for specific industries, especially those that specialize in creating the infrastructure and physical foundations for the new space economy. But there is also a need for a systems based approach that facilitates connected opportunities and the development of new ecosystems.

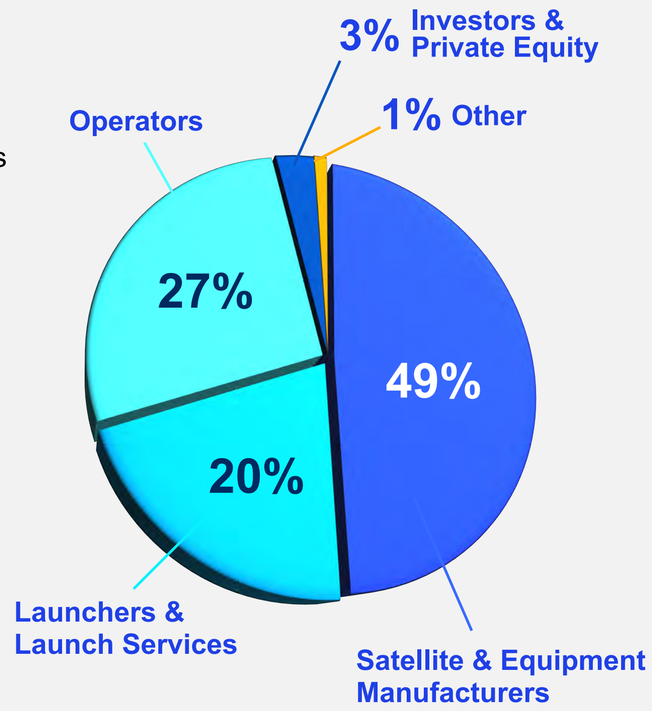
Our magic lies in creating new economies, products and services across planetary boundaries, creating new industries or extensions of existing ones. These problems are human, industrial and perhaps extra-terrestrial which require us to think across sectors.

McKinsey already serves clients across the space value chain globally,

ranging from satellite manufacturing to launch to operations & services provisioning.

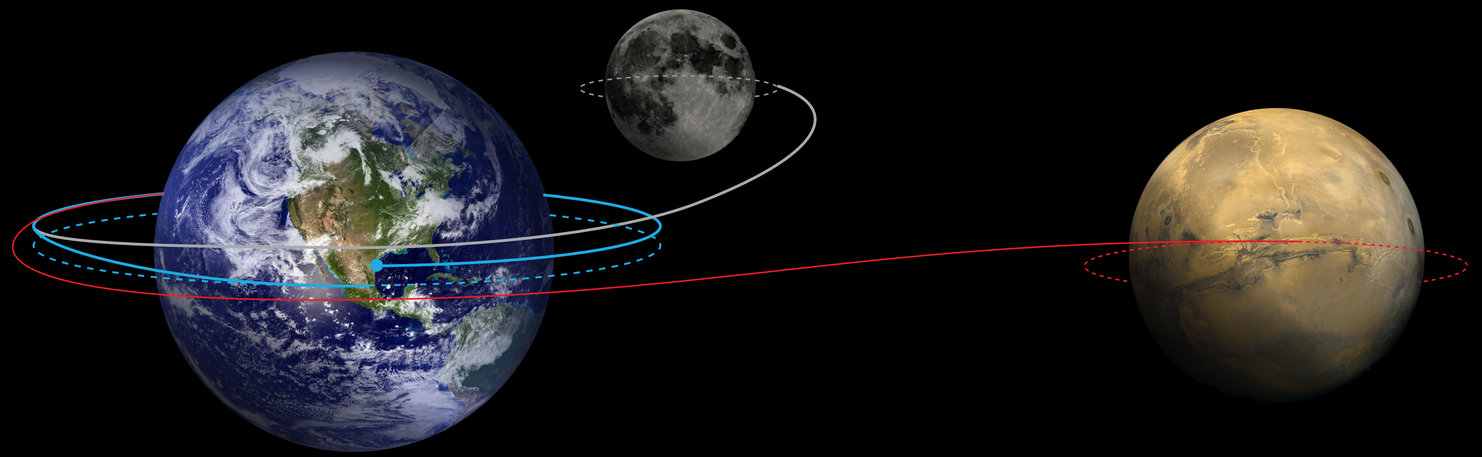
Aerospace expertise runs deep at the firm. We didn't just jump into space recently following the buzz and hype from VC and billionaire funded "new space" enterprises. The firm has been there in the background from the Apollo moon landings in the 1960s to helping modern aerospace businesses adapt to the quicken pace of disruption in the 21st century.

AT RIGHT »
McKinsey's activity in space by sector over the past seven years (2012 - 2019).



McKinsey combines financial, legal, policy, design, engineering, and technology capabilities together for clients who want to *be proactive*, rather than *reactive* to coming disruptions & market shifts.

From former NASA engineers to former Presidential administrations to some of the most creative minds in the world, no other organization is better positioned to help industry envision the future and then actually build it. Change is happening faster and faster now in the 21st century. Technology is driving massive disruptions across every industry, country, and organization in the world. At McKinsey, we know this all too well given our unique global perspective. The businesses and industries that are not disrupting through innovation today, will be left attempting to react to competition's disruptions until the velocity of change simply overwhelms them. Defensive postures for even the healthiest organizations can only be held as long as they have the stamina. In the end, defensive postures reacting only to change is a zero sum game. McKinsey is uniquely positioned to teach organizations how to be proactive and disrupt not only their competitors, but their entire industry.



The New Space Economy is ***waiting*** for the first movers & McKinsey can help you explore your options.

There is a reason why Venture Capitalists are pouring money into space based ventures. It is early and the value pools that can be captured are truly mind boggling. The first companies to move business into space will set a highly defensible position for decades to come in a market with few (if any) existing competitors.

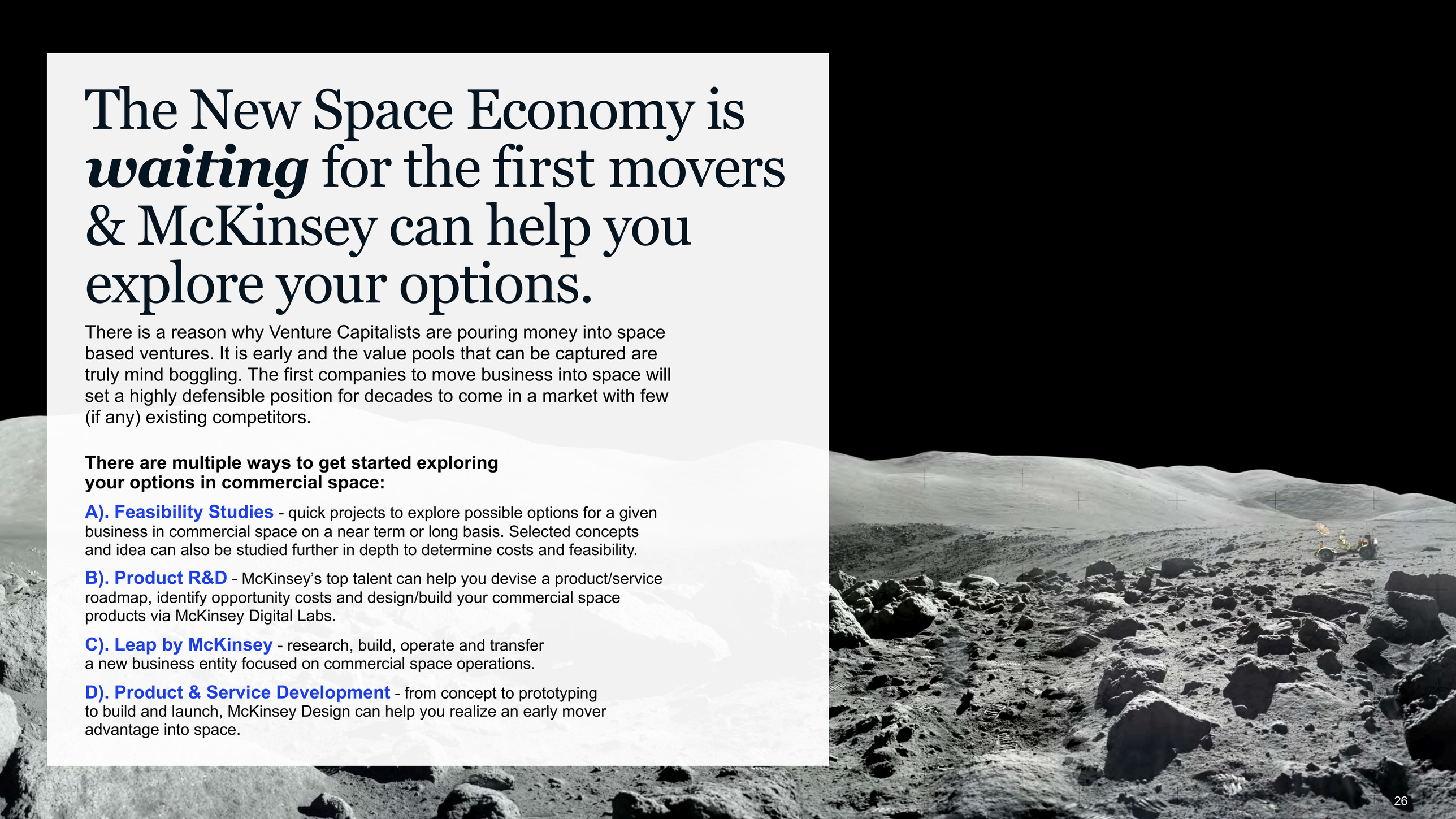
There are multiple ways to get started exploring your options in commercial space:

A). Feasibility Studies - quick projects to explore possible options for a given business in commercial space on a near term or long basis. Selected concepts and idea can also be studied further in depth to determine costs and feasibility.

B). Product R&D - McKinsey's top talent can help you devise a product/service roadmap, identify opportunity costs and design/build your commercial space products via McKinsey Digital Labs.

C). Leap by McKinsey - research, build, operate and transfer a new business entity focused on commercial space operations.

D). Product & Service Development - from concept to prototyping to build and launch, McKinsey Design can help you realize an early mover advantage into space.



Commercial Space Ventures

The commercial space ventures program is based in McKinsey Digital Labs' design studios in Austin + London to serve both North American and European clients.

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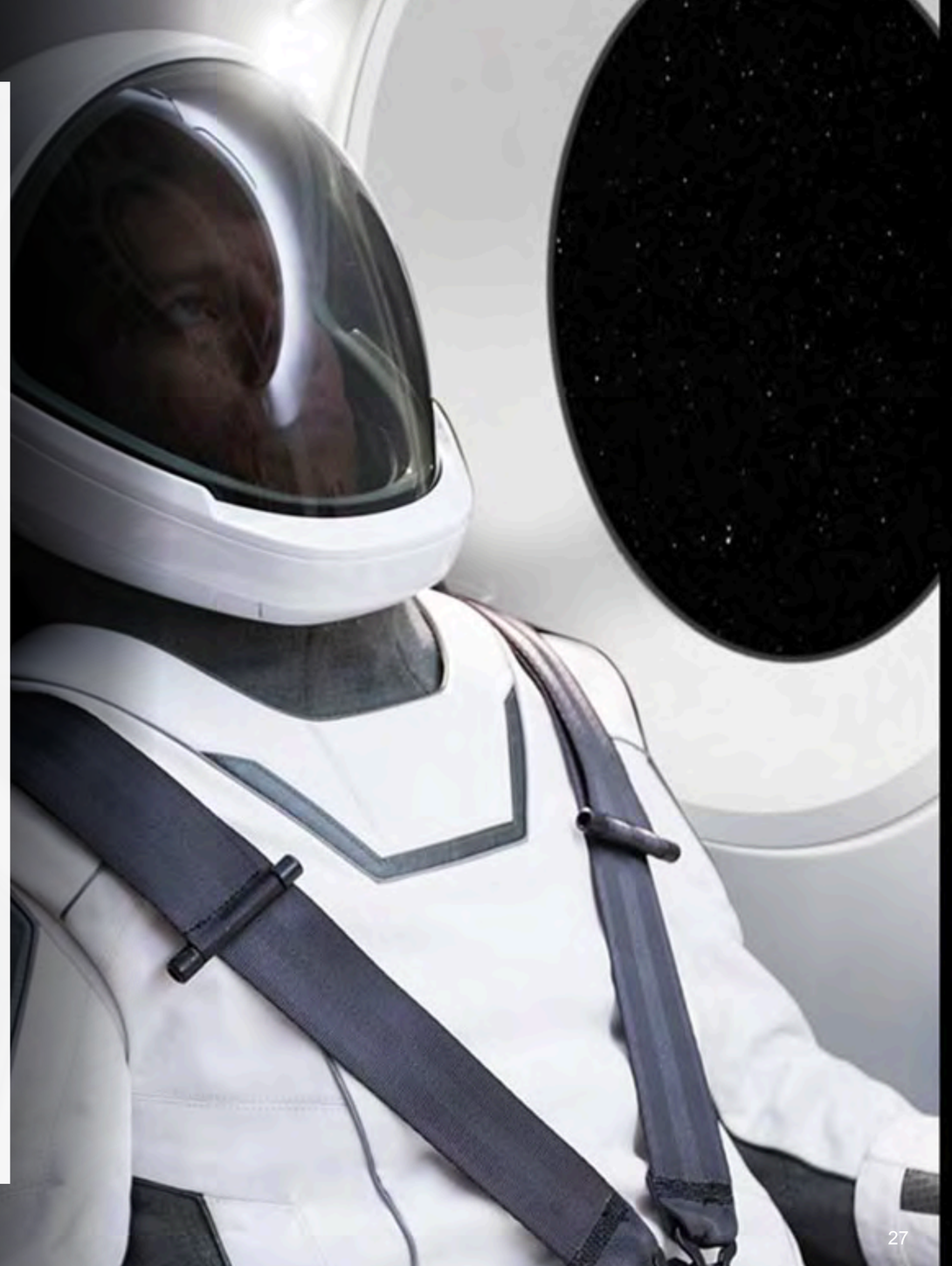

McKinsey & Company

Off-World Construction By the Project Skywalker Team

Updated April 2019

Designed by McKinsey Design

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