

**JOINT MEETING of the SPACE RESOURCES ROUNDTABLE (SRR) and
the PLANETARY & TERRESTRIAL MINING SCIENCES SYMPOSIUM
(PTMSS) JUNE 8-10, 2010 Golden, Colorado**

Lunar Trade Route Costs

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Lunar Transportation Systems, Inc.

NORCAT Space 2010 Conference

Technical Session 2:

Commercial and Logistics ISRU Concepts

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Introduction

- Entrepreneurs **emphasize the Benefits of Cost Reduction and Innovation** in financed startups to pay back investors faster

- Living off the land (LOTL), the Lunar Frontier needs LOTL

- Our American Pioneers carried an Axe & Built Log Cabins

The Lunar Frontier needs Pioneering Financing & Innovation

- Entrepreneurs Need Markets Capable of Sequential Capture
- Twelve Early Markets are proposed with exits for financial rewards
- Markets create revenue & make raising private investment faster
- Oil recovery in the Arctic gives Lessons Learned in an evolved expansion of Commerce and Future Lunar Resource Recovery



Introduction

- Explore the Lunar Trade Route & Commerce
- Entrepreneurs Use Innovation to Raise Private \$
- Raising \$ Needs Markets as Economic Drivers
- Twelve Early Markets are Proposed & Explored
- Oil recovery in the Arctic gives Lessons Learned for an evolved expansion of Commerce and Future Lunar Resource Recovery
- Living off the Land on the Moon is a Goal

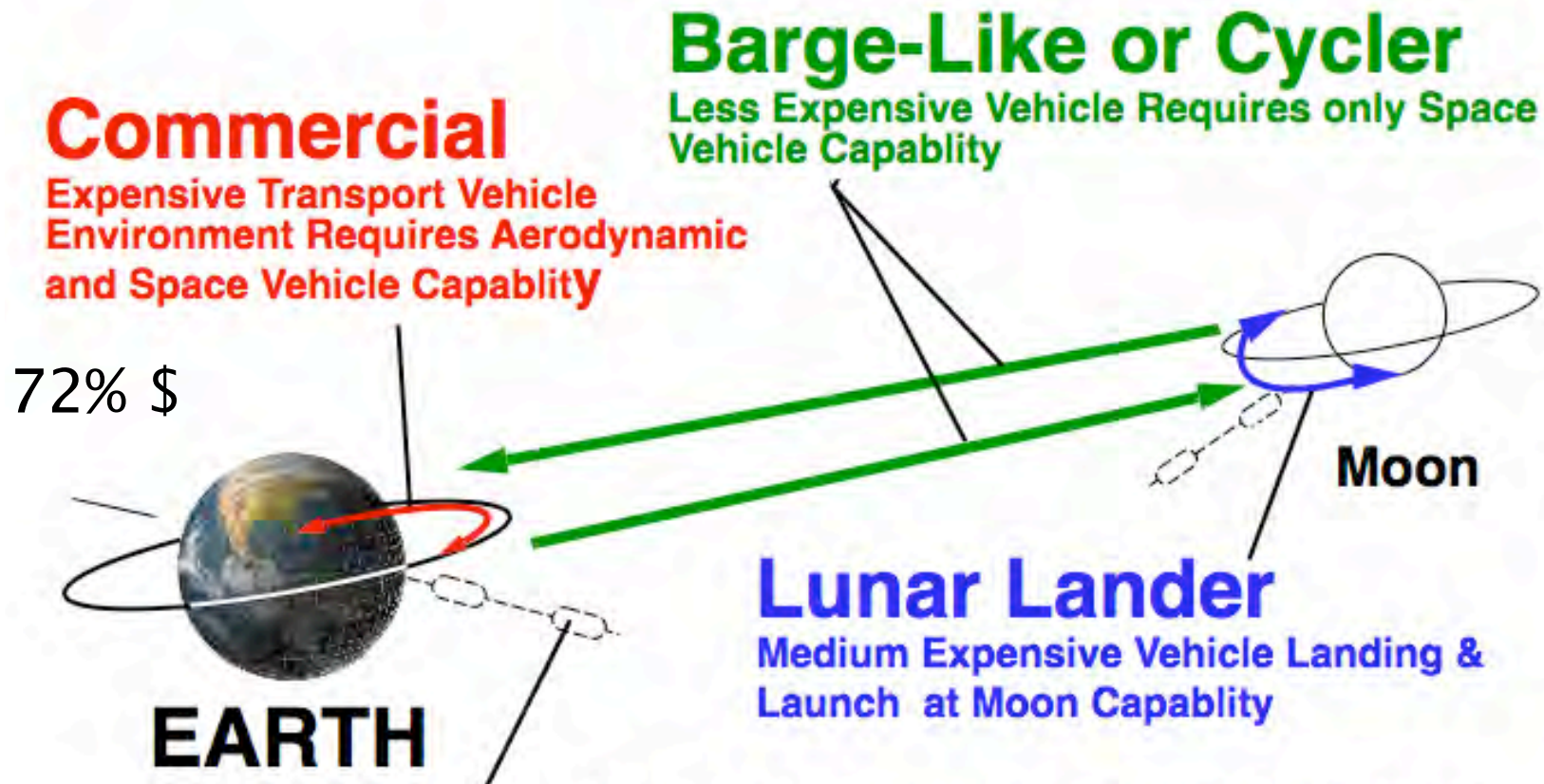
Info on our proposal to buy 3 Shuttles

<http://public.me.com/taylorT>

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Six Separate Transport Cycles



**Transportation Node Platform for Cargo Handling,
Fuel and later Human and Transportation Cycle
Enhancement - The Transportation Node becomes
the Real Estate Market of Space.**



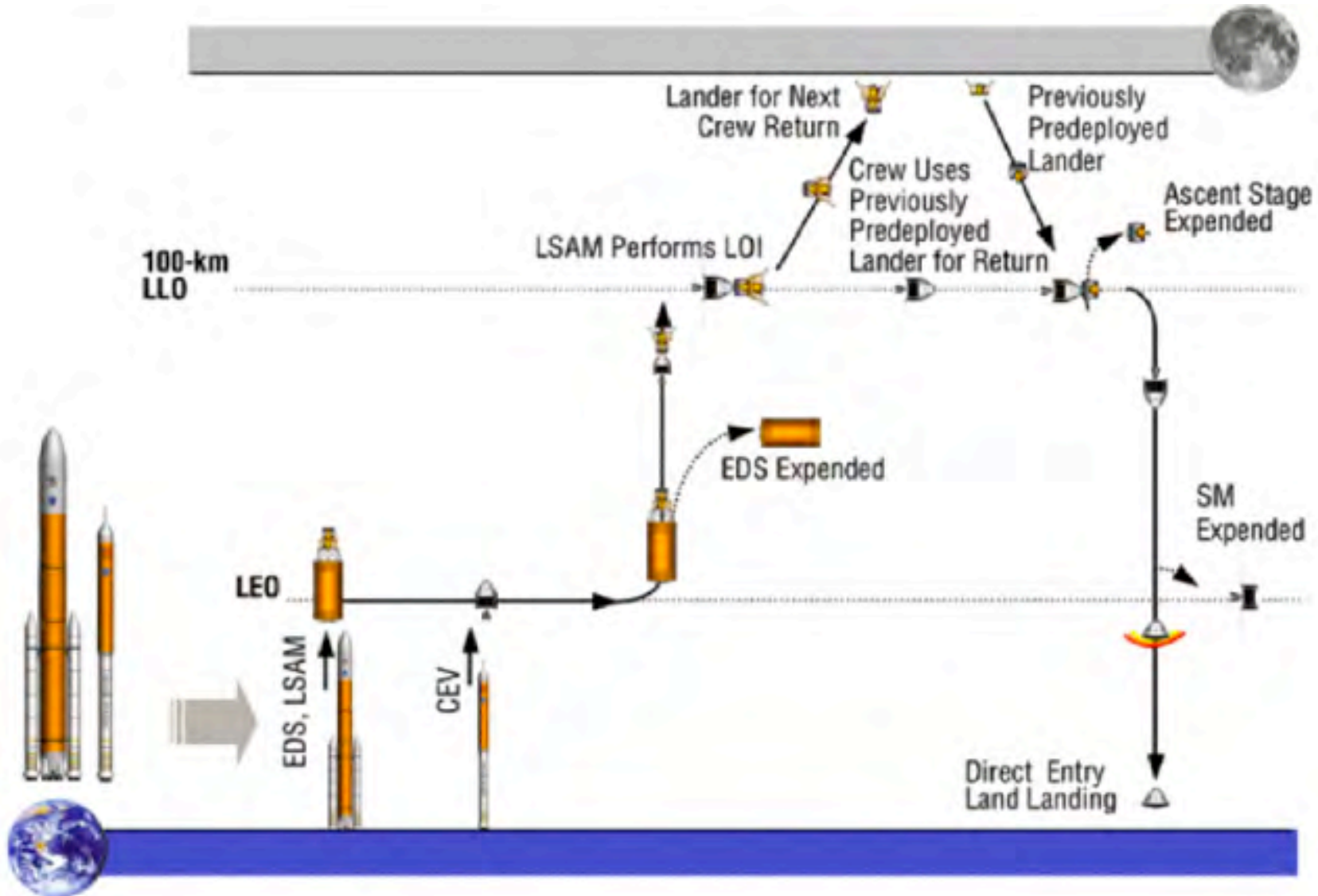
LTS Goal is Lunar Logistics

- Trade Route Transportation must be Affordable
- Unglamorous, Unmanned technology-Innovation
- 12 Early Markets lead to a Commercial SDV
- First Lunar Market is probably Surface Power
- Find most Sunshine on Moon's Surface & Turn it into a Power Util. After you find valuable resources
- Use LOTL Innovation, Reuse LTS Frame
- Create a Logistics Service at profit, & expand
- Raise Private Capital & Assist Commerce
- Trade routes Transport Value both directions

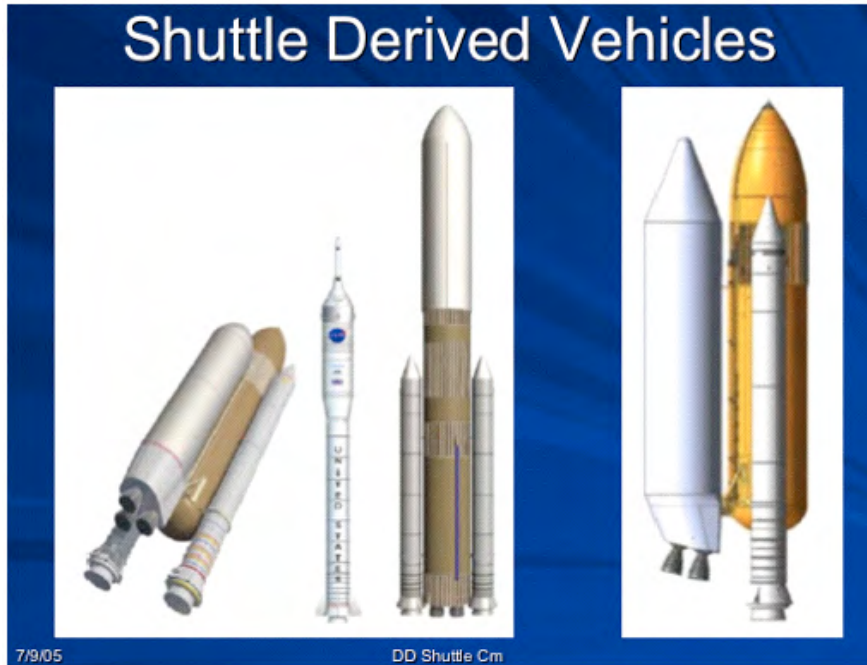
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Bat Chart - Salvage



Current Situation



- Ares I & Ares 5 cancelled
- Space Shuttle to Scrap Heap
- Shuttle Derived is an option

A group of Innovation Companies Offered to Buy the Orbiters with Private Money & Evolve a Commercial SDV launched from KSC to satisfy and stimulate 12 Markets.

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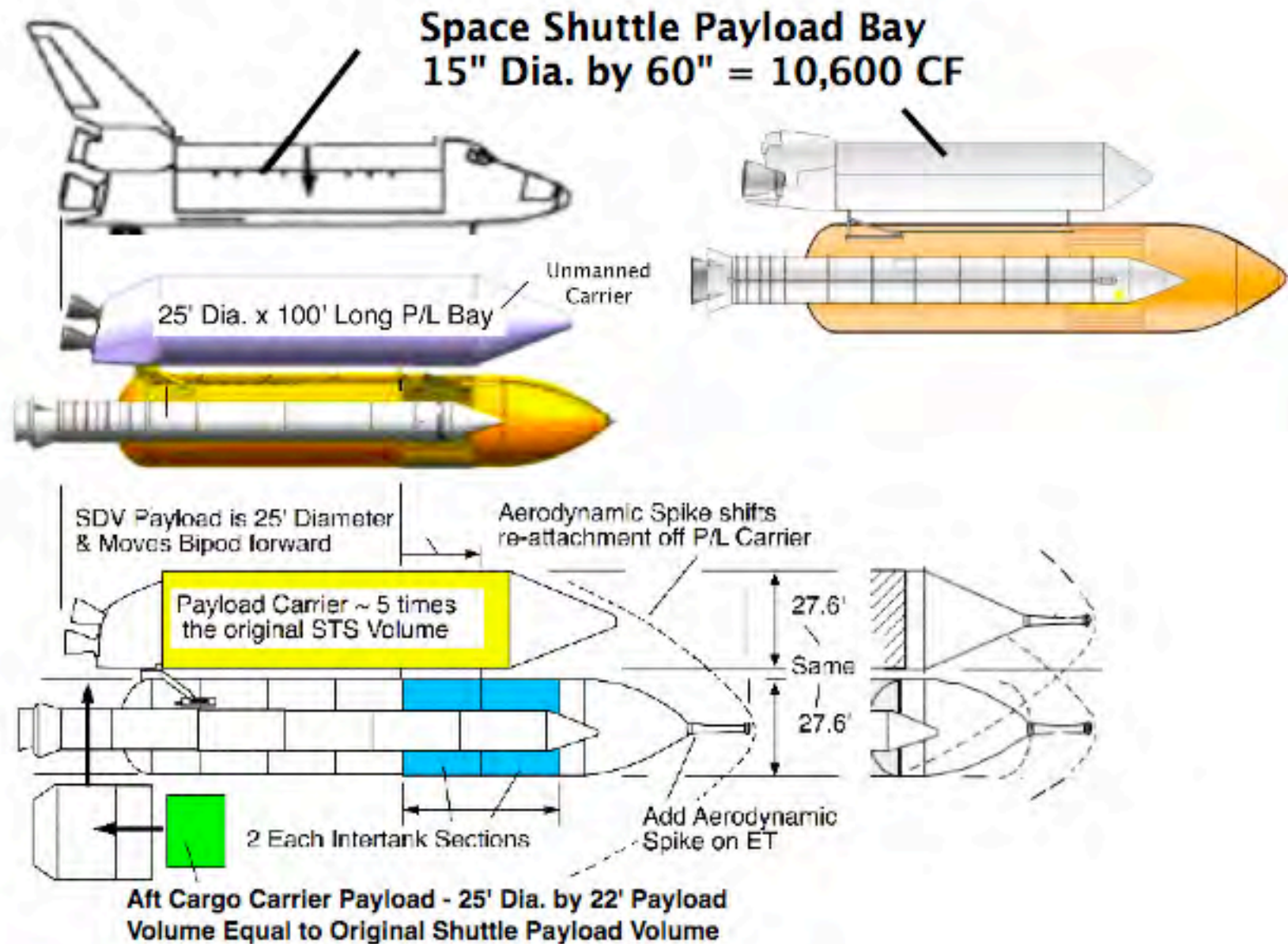


12 Commercial SDV Markets

- NASA operated Launches Mandated by Congress, 3 Bills
- DoD launches by Commercial as required
- Introduce 25' dia. Payload Capability, 15'/25'
- 156 Major Shuttle PLs, some spares, reflight & others
- SDV Cm Carrier focused on Capture of Orbital Industries
 - Lunar Trade Route Logistics & Surface Development
 - Assemble Affordable Orbital Solar Collectors - Materials & Depot Logistics
 - NASA-JSC bigger Solar System Exploration assembly in Orbit
 - NASA-MSFC Exploration Engine Development and Test to Orbit
 - Second Generation Depots on Lunar Trade Route
 - More Robust Orion Life Boat transported unmanned
 - Space Tourist Support and Facilities in Orbit, ET Profit Center
 - Vasimer Engine Testing for Mars Logistics Missions
 - Asteroid Missions and Homesteader Support - Two Way Support Logistics

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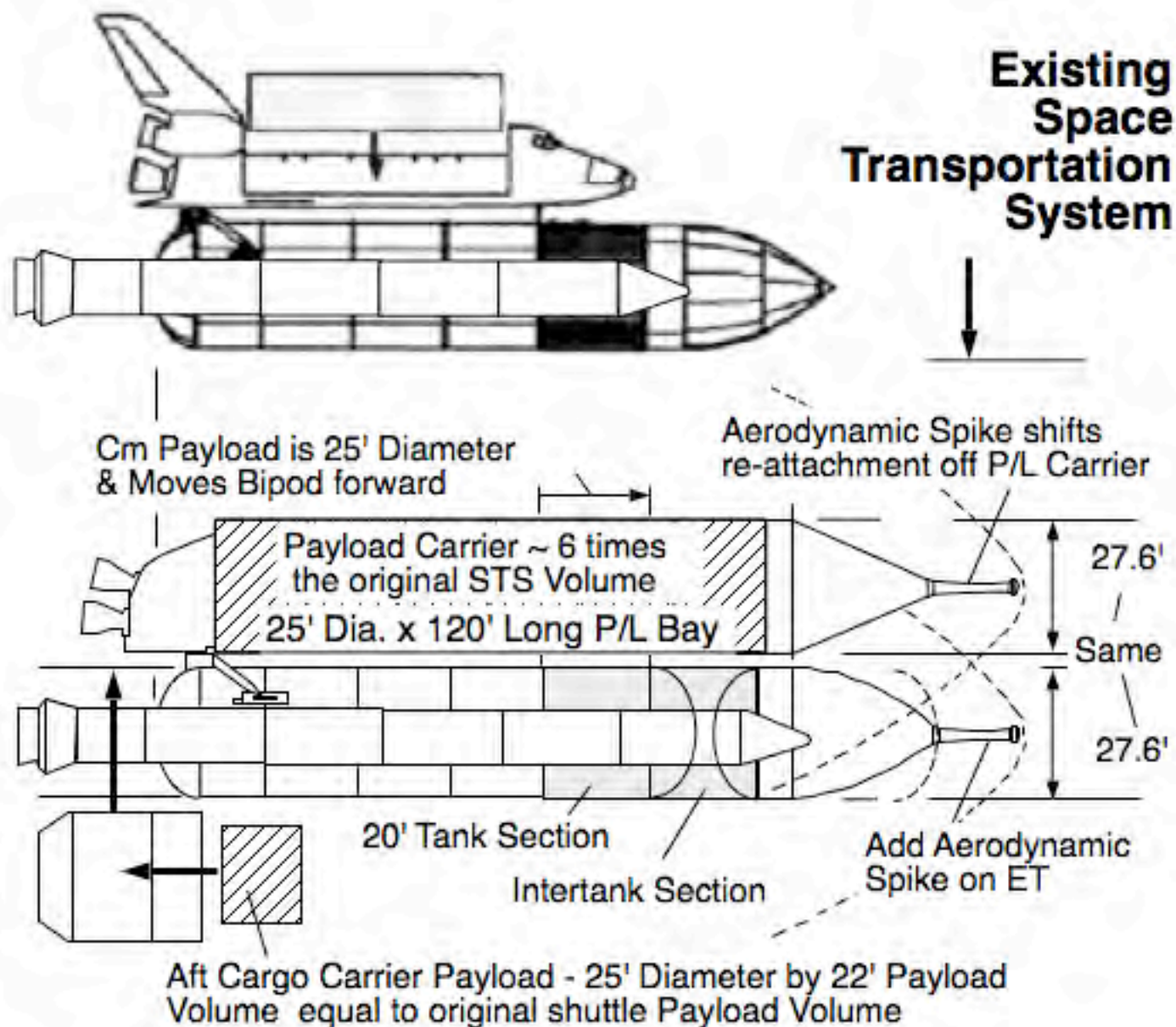
Add 20' Section

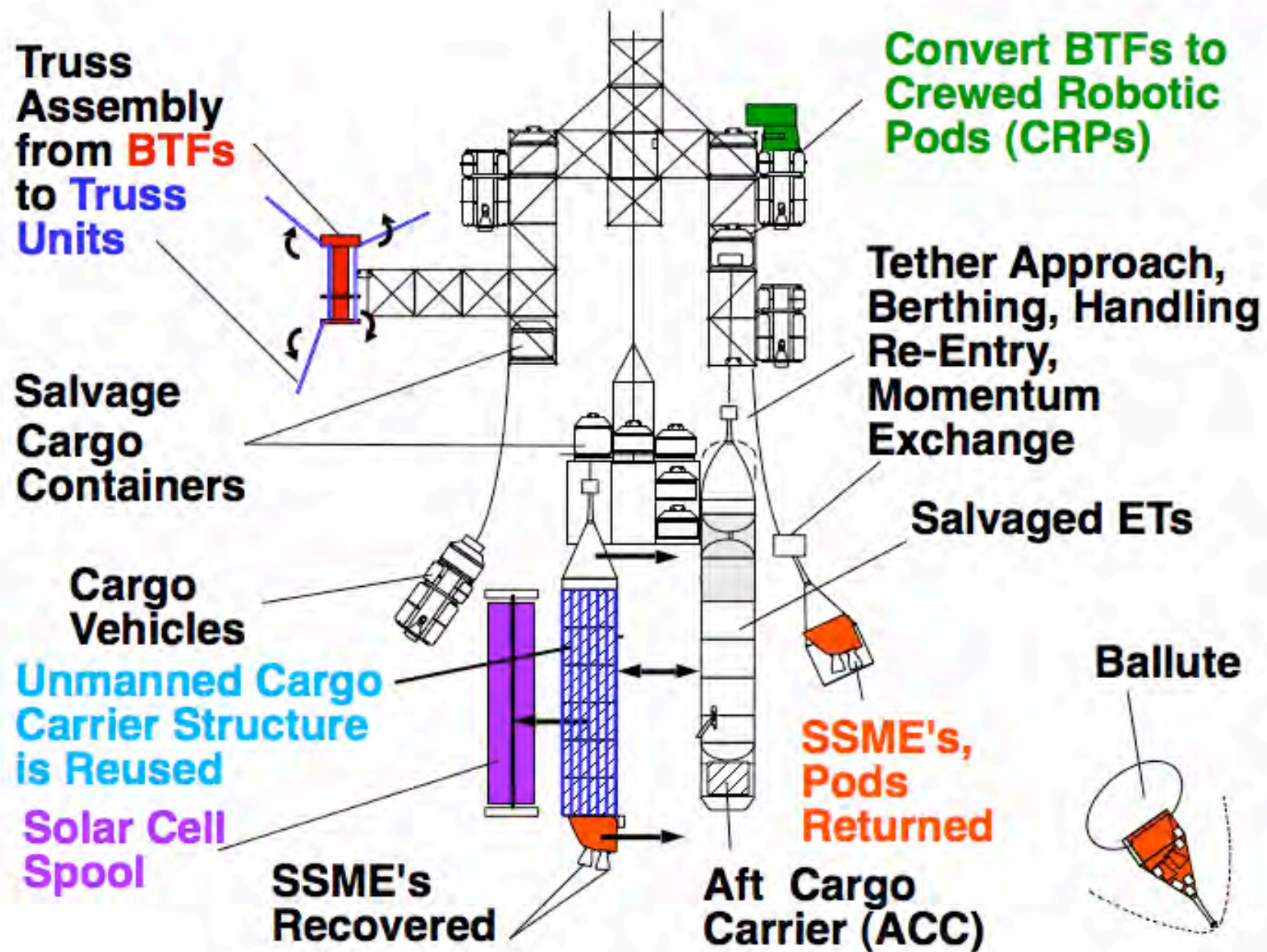
- Lg Diameter ET
- Salvaged in orbit, cash deposit to NASA
- Many uses: **Example SSP**
 - Hotels
 - Military Bases
 - Propellant recovery
 - Gravity gradient stable
 - Mass for tether operations
 - Commercial Innovation
 - Partial gravity solutions
 - Bring the public along
- ET Profit Center



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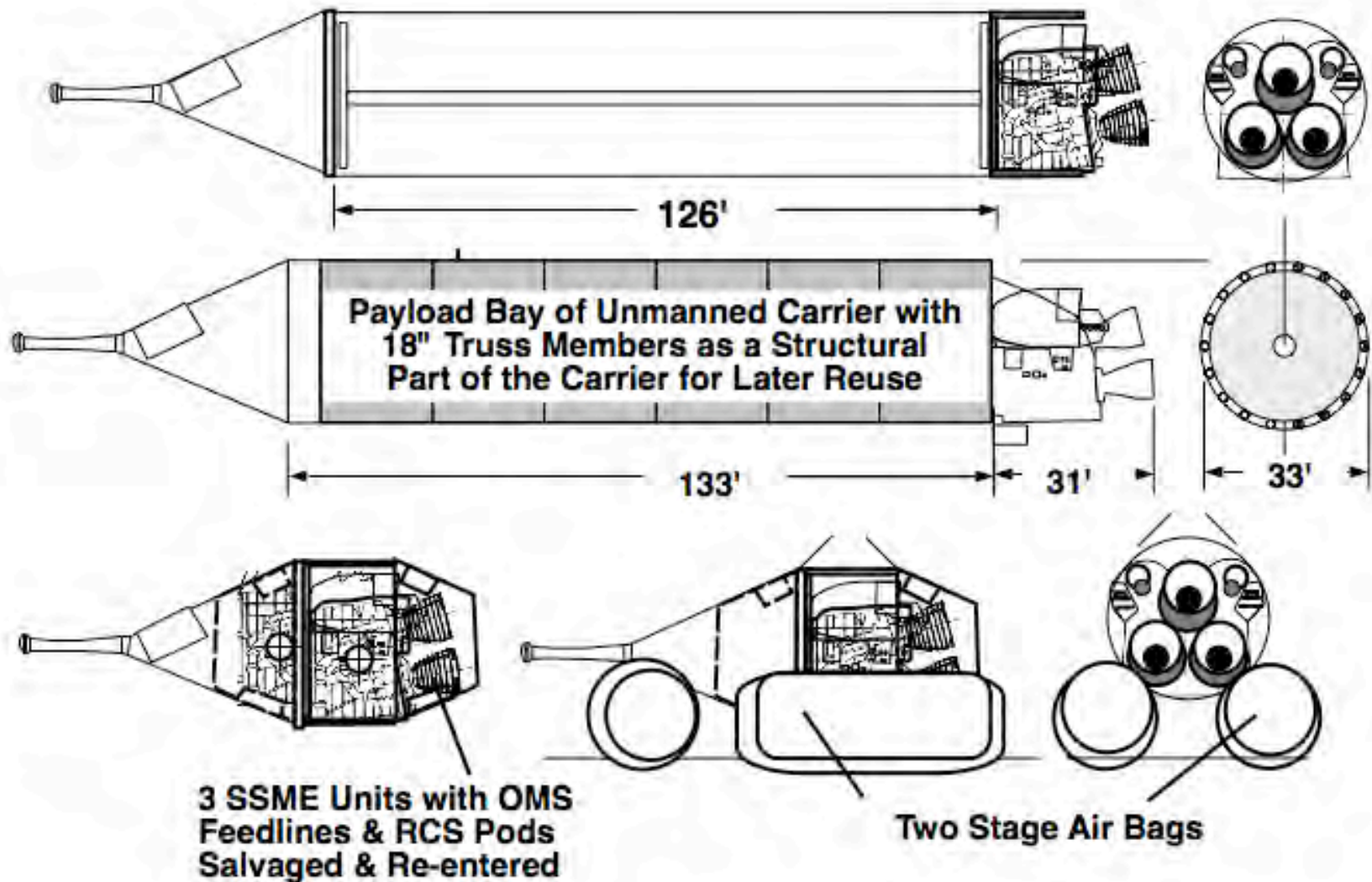




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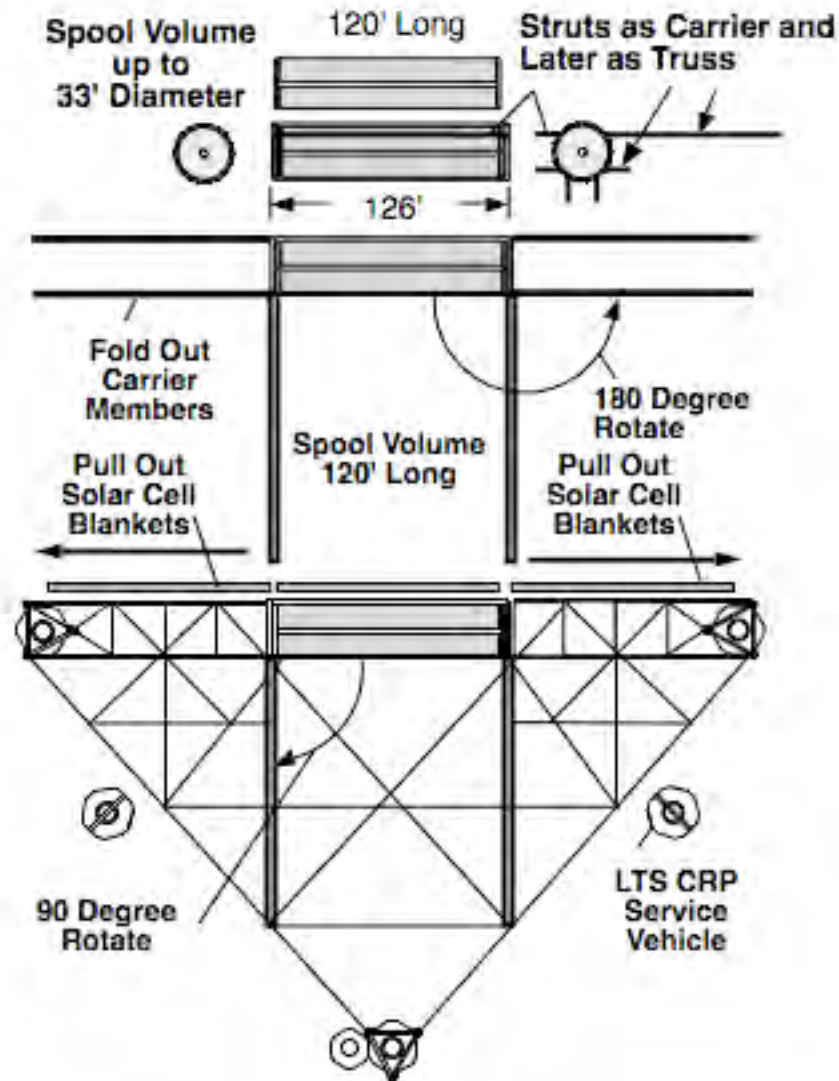
Recover Cm Components



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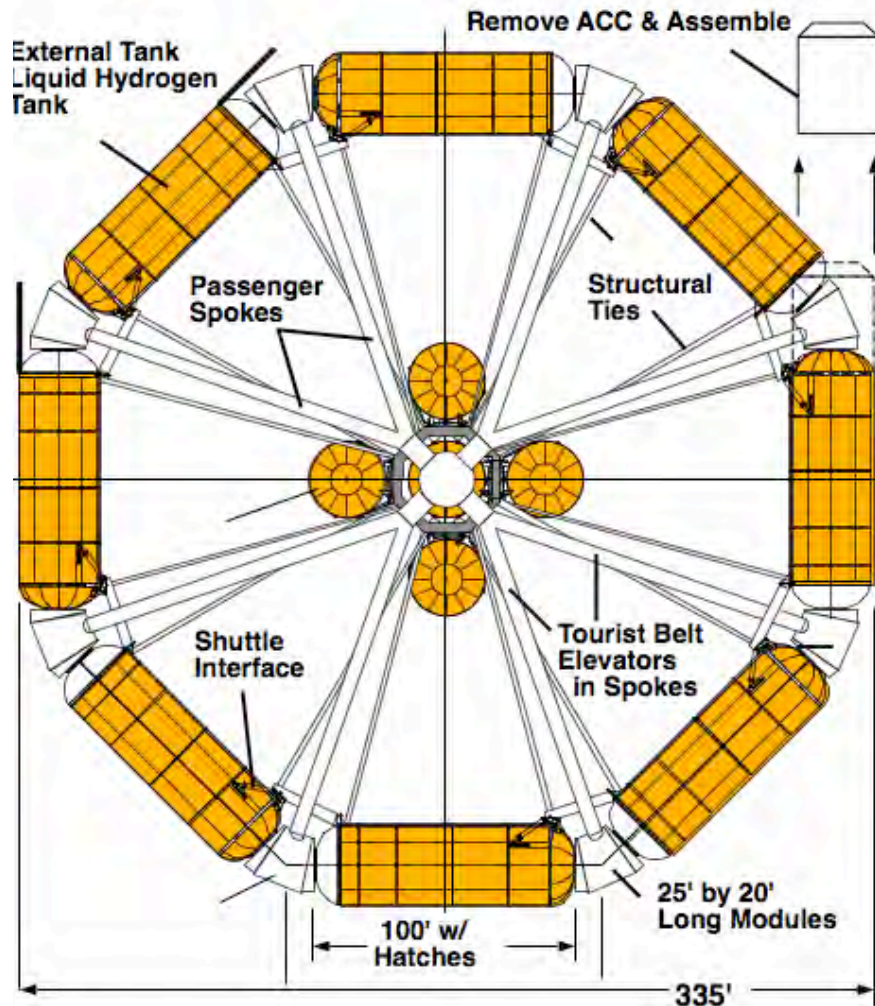
Reuse Cm Carrier in Orbit



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ET Salvage Profit Center

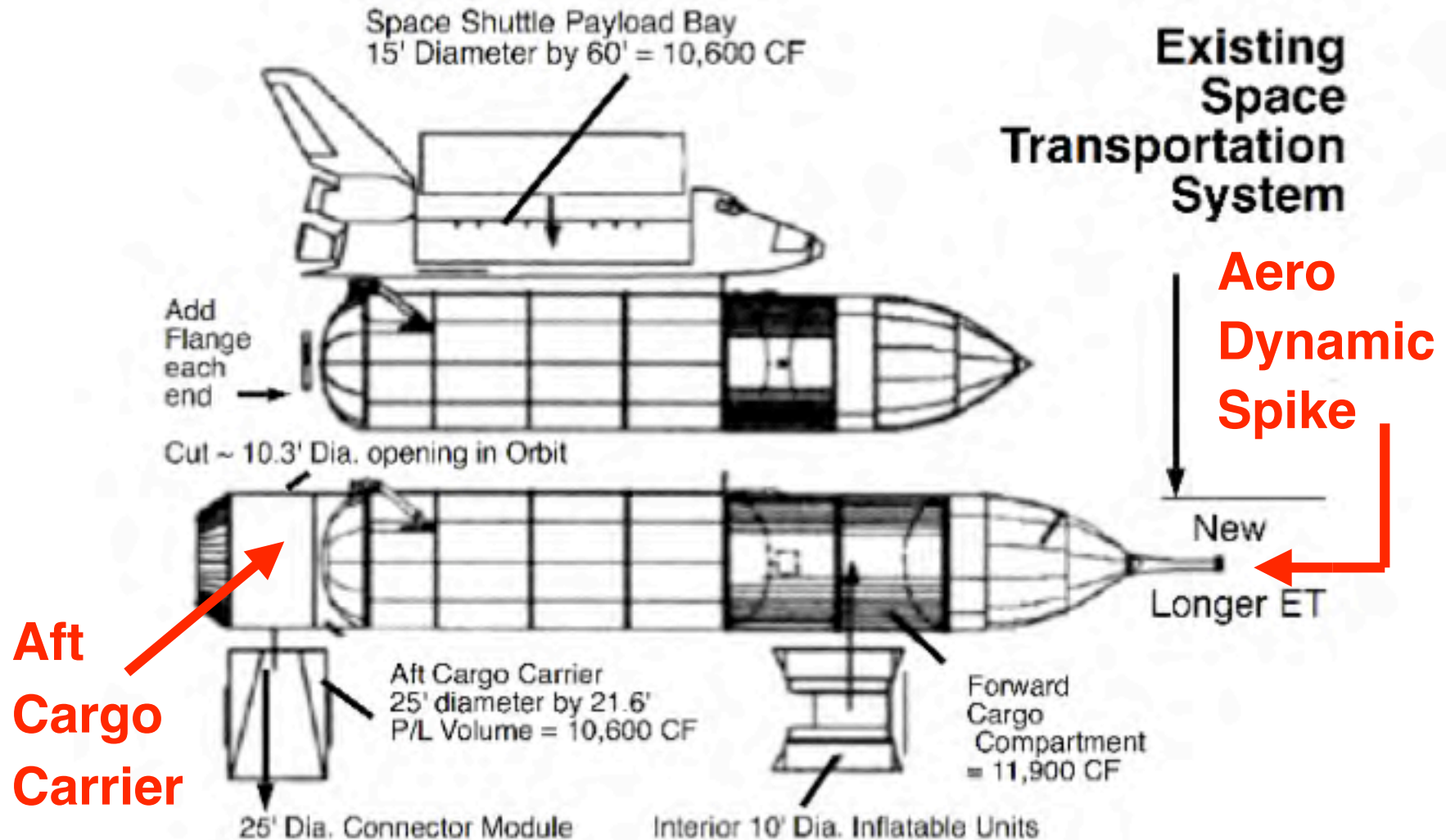


- 18 ETs into Hotel
- Partial Gravity, 2-3 rpm
- ET invested transportation energy value = \$ 500m/ET
- 10 ea 100' Free Fly Zone with Trampolines
- Earth Viewing Support
- Vertical Belt Elevators
- Microgravity Habitats also available for SSP Assembly Facility Crew

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ET Options Proposed



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**Converted Unmanned Shuttle Cm Carrier
Converted to Cross Truss**

**Solar Cell Spool Line
Replacable Unit (LRU)
for Technology Upgrade
Later**

**Orbital Tug
Positions Truss
Sub-Assembly**

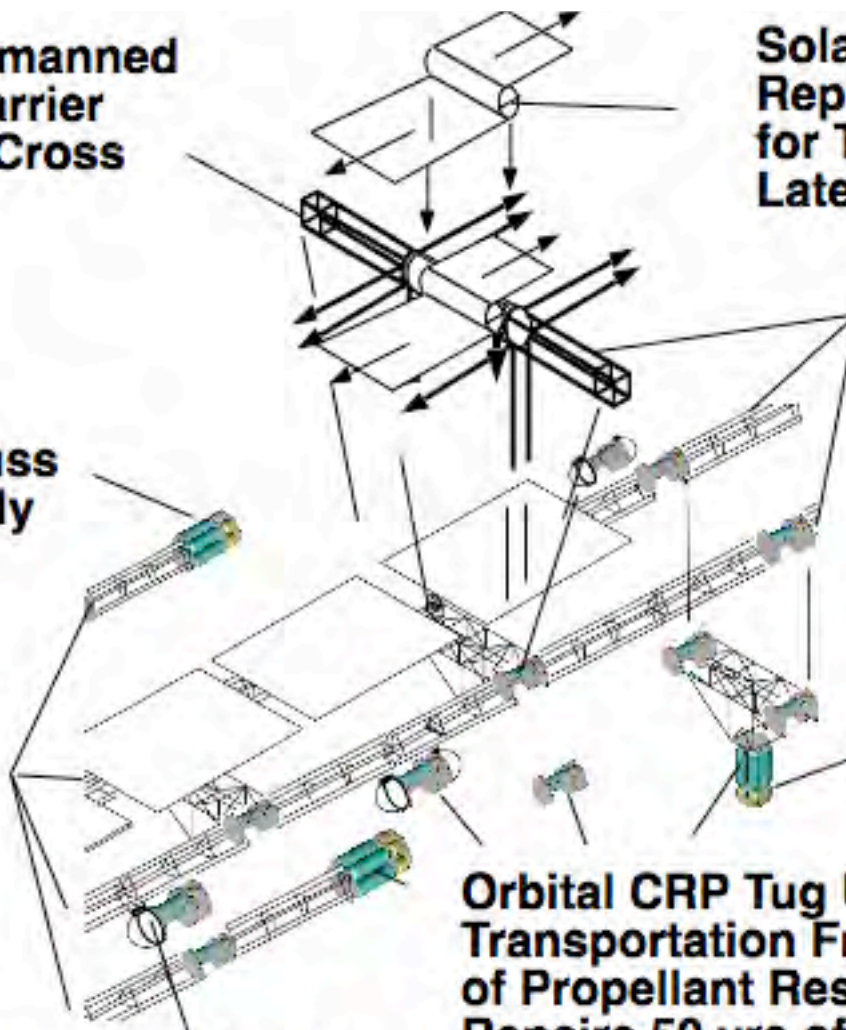
**Concentric Tubes
Rotated to Convert
into Cross Truss &
mate with BTF Truss
Units using Orbital
CRP Tugs**

**Discarded
LTS (BTF)
Hardware
Becomes
Truss Unit**

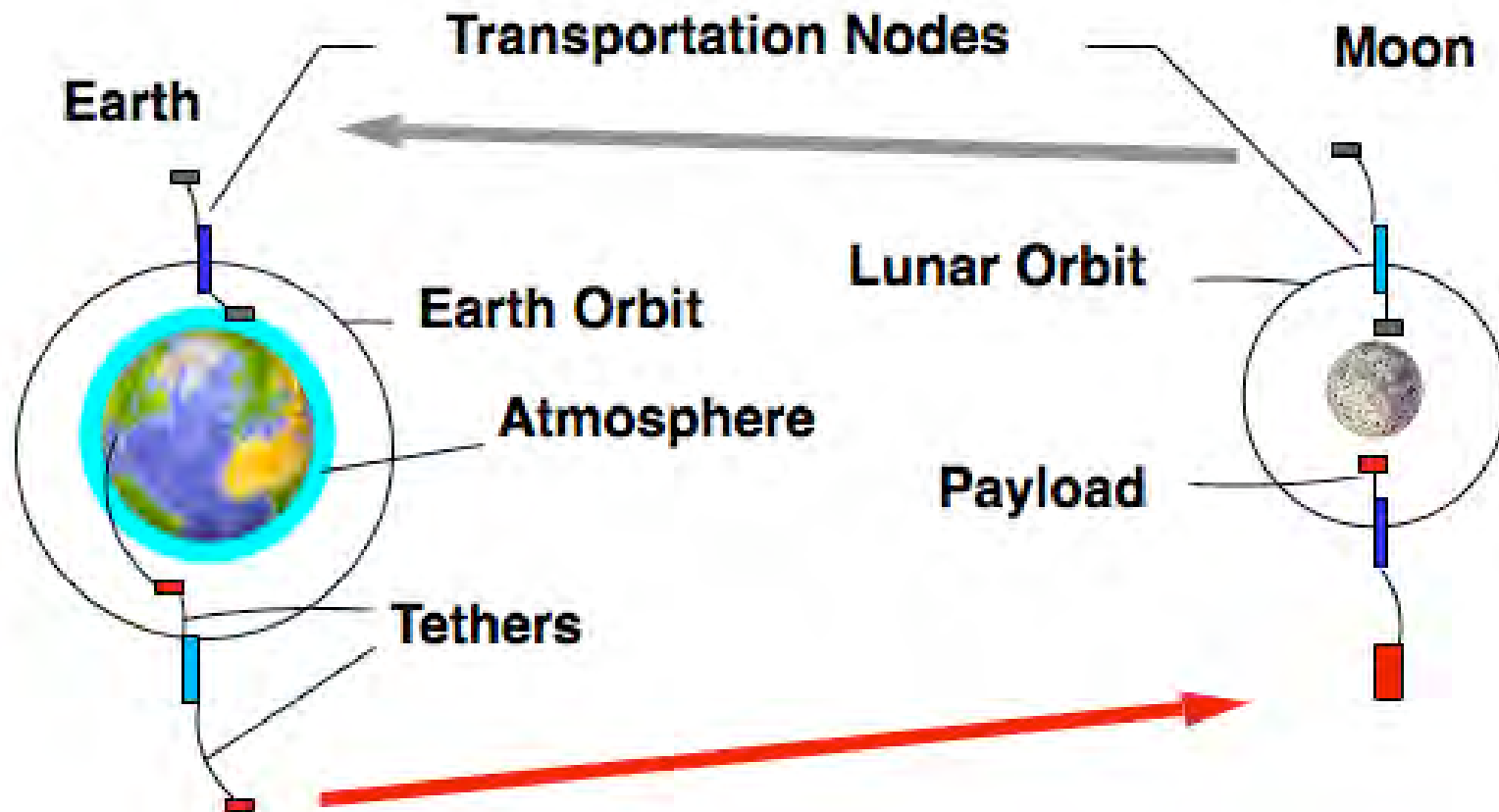
**Orbital Crewed
Robotic Pod
(CRP) Tug operates
on cables or free
flying RCS**

**Crewed Robotic Pod (CRP)
Rides Truss Cables**

**Orbital CRP Tug Using LTS Basic
Transportation Frame (BTF) is Capable
of Propellant Resupply, Assembly,
Repairs, 50 yrs of Maintenance, Habitation
and Equipment LRU Changeout**



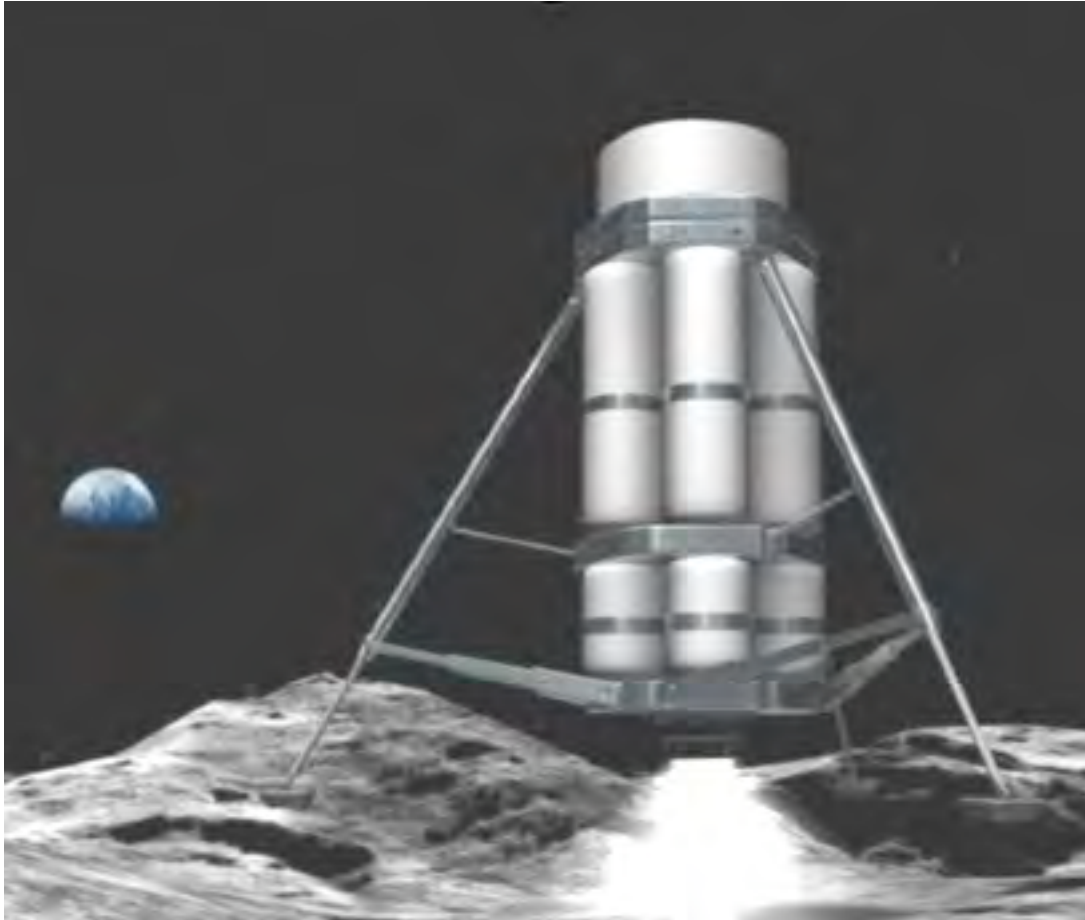
One Future Node System



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Commercial Lunar Transport



- 800 kgs to 10 Tons
- Non-Critical Lunar Cargo Business
- Commercial
- Could be a PPP Privately Funded
- Same Startup team as SPACEHAB and Kistler, Aerospace with a Cost Reduction Record
- Innovation - **\$1.2B Private Equity**
- Cost Reduction
- Other Financing Sources
- Color Video

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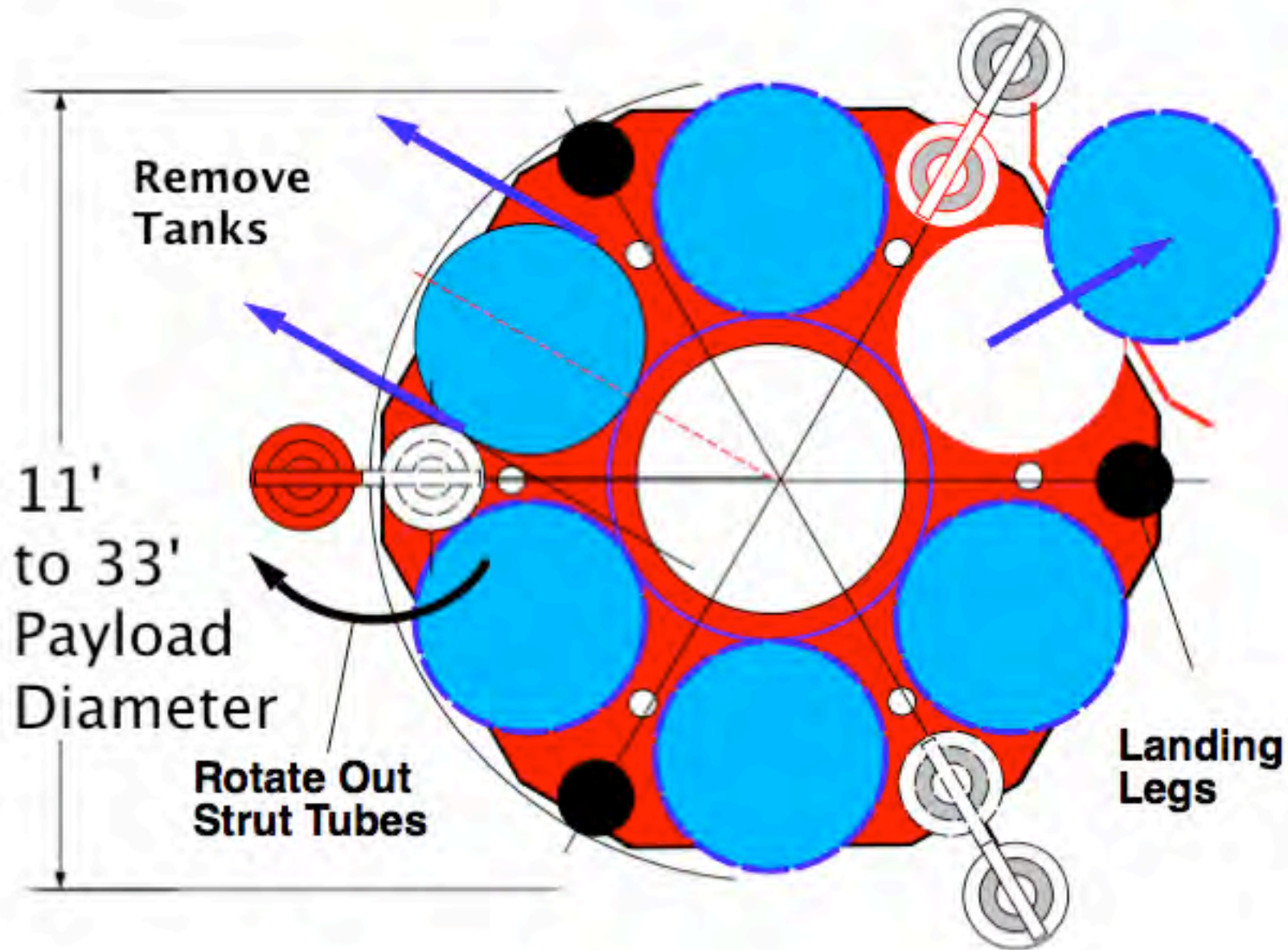
Early Lunar Surface Markets

Commercial Priority (#)

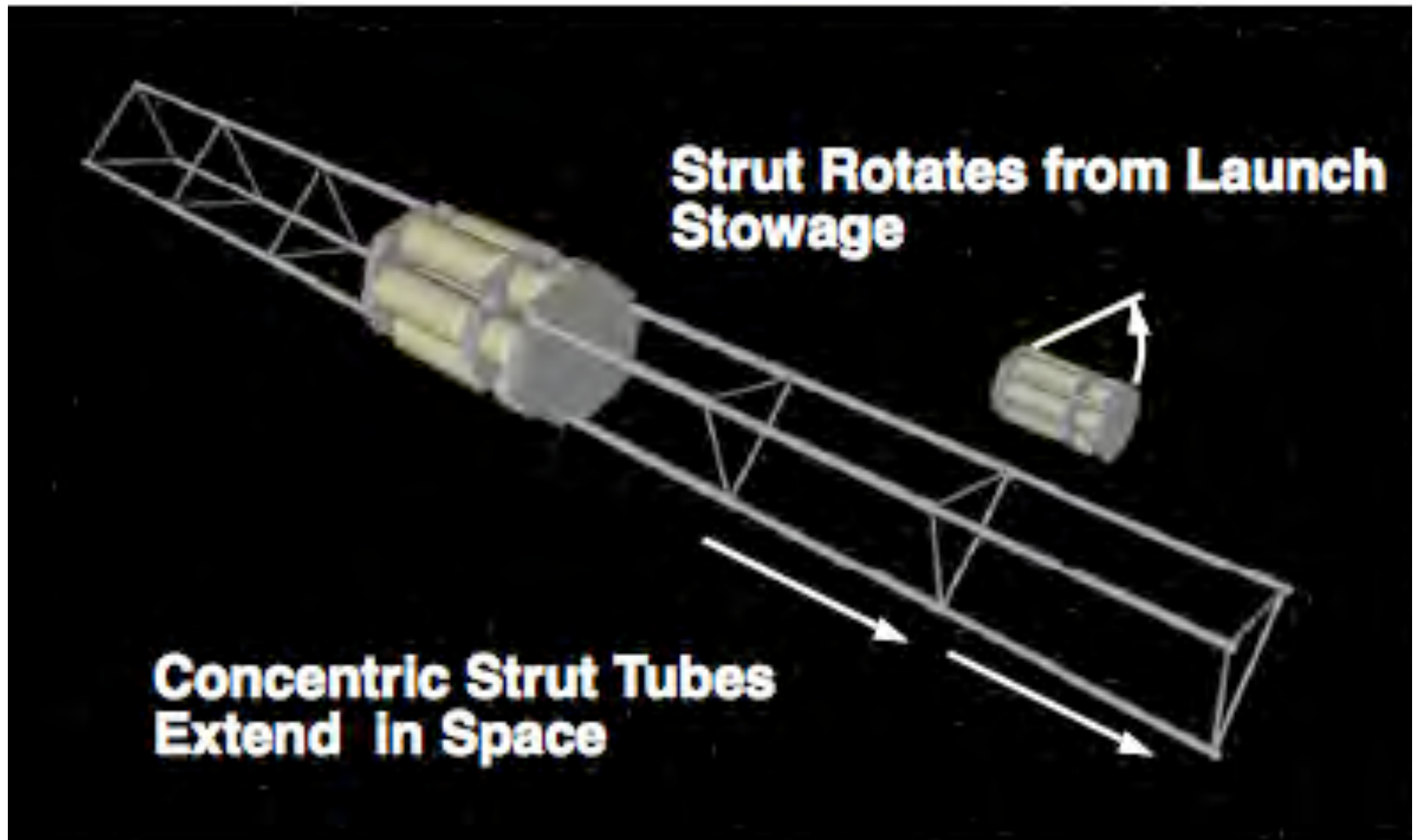
1. Water (2)
2. Air- Breathable (6)
3. Sunlight for Power (1)
4. Reusing Lunar Hardware (7)
5. Parts Salvage (5)
6. Multi-Function/Longer Life Facilities/Structures (8)
7. Mining (3)
8. Tourist Services
9. Habitation Services (9)
10. Lunar Logistics-Space Transportation/Surface (4)

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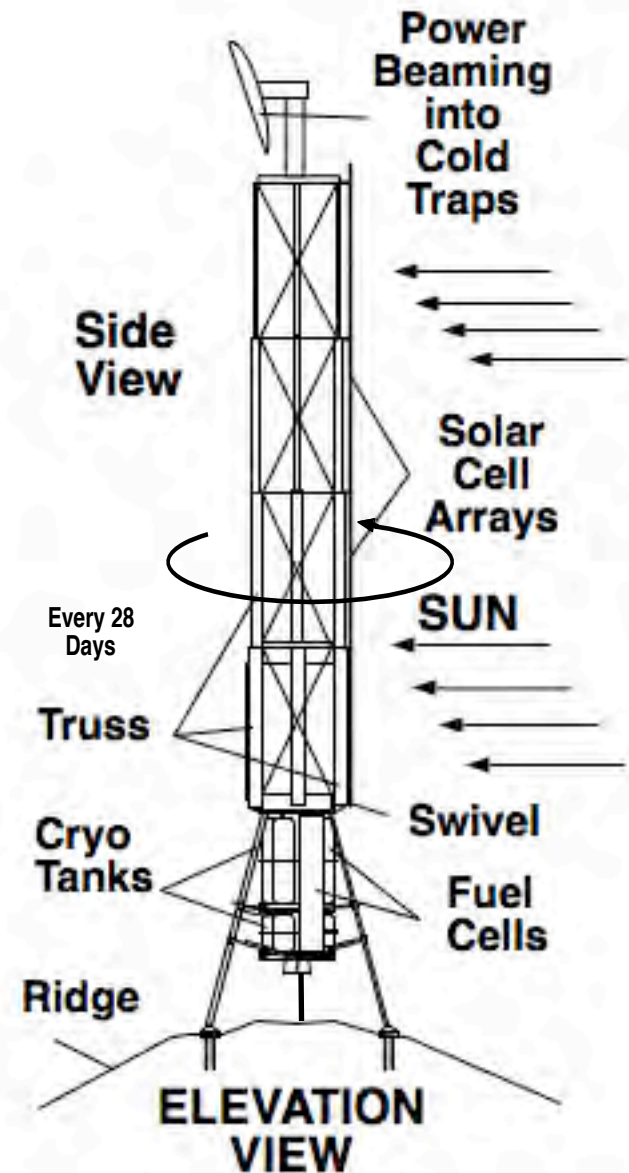
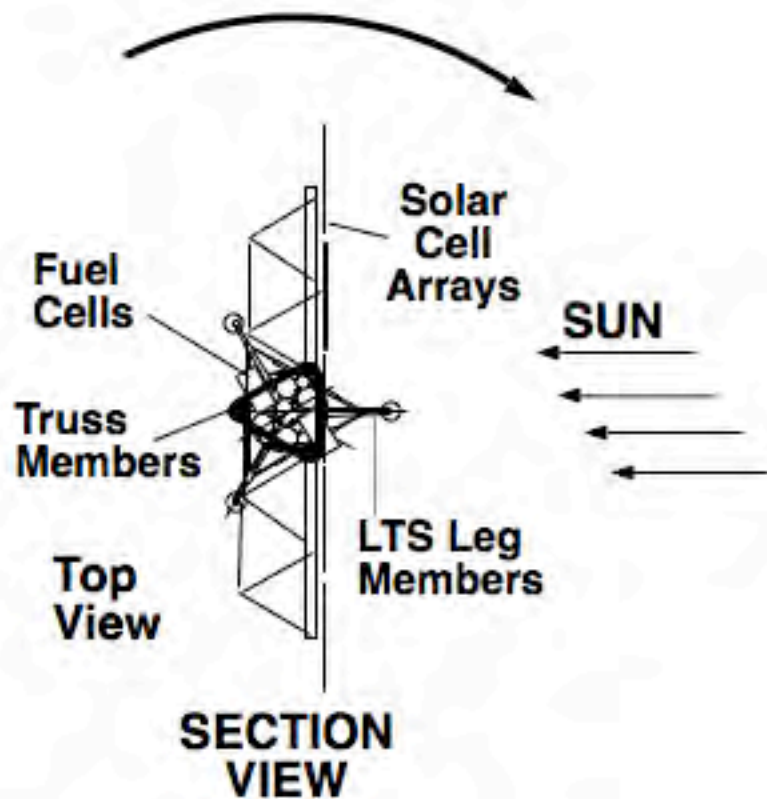




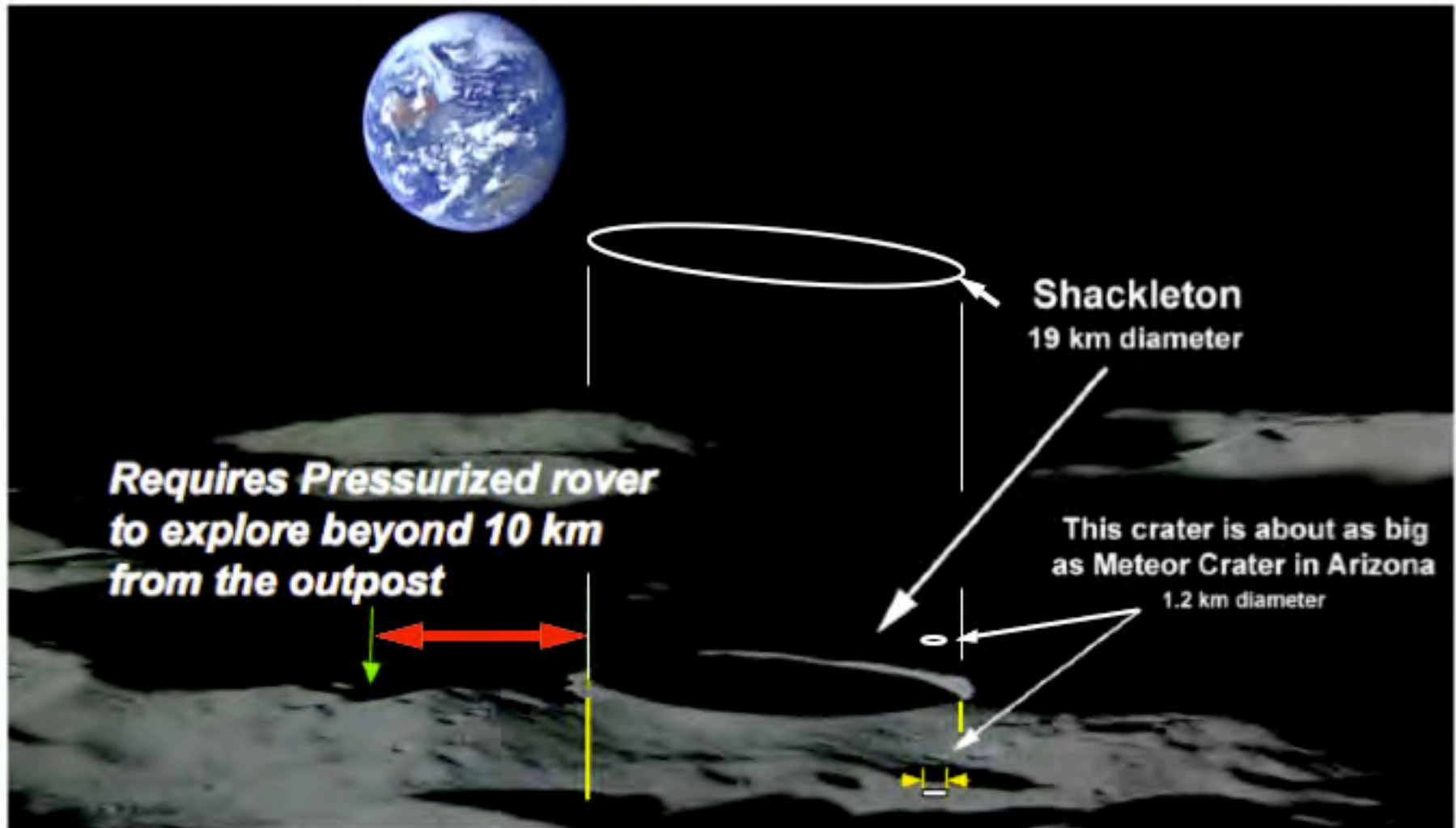
Truss Unit from Salvaged BTF



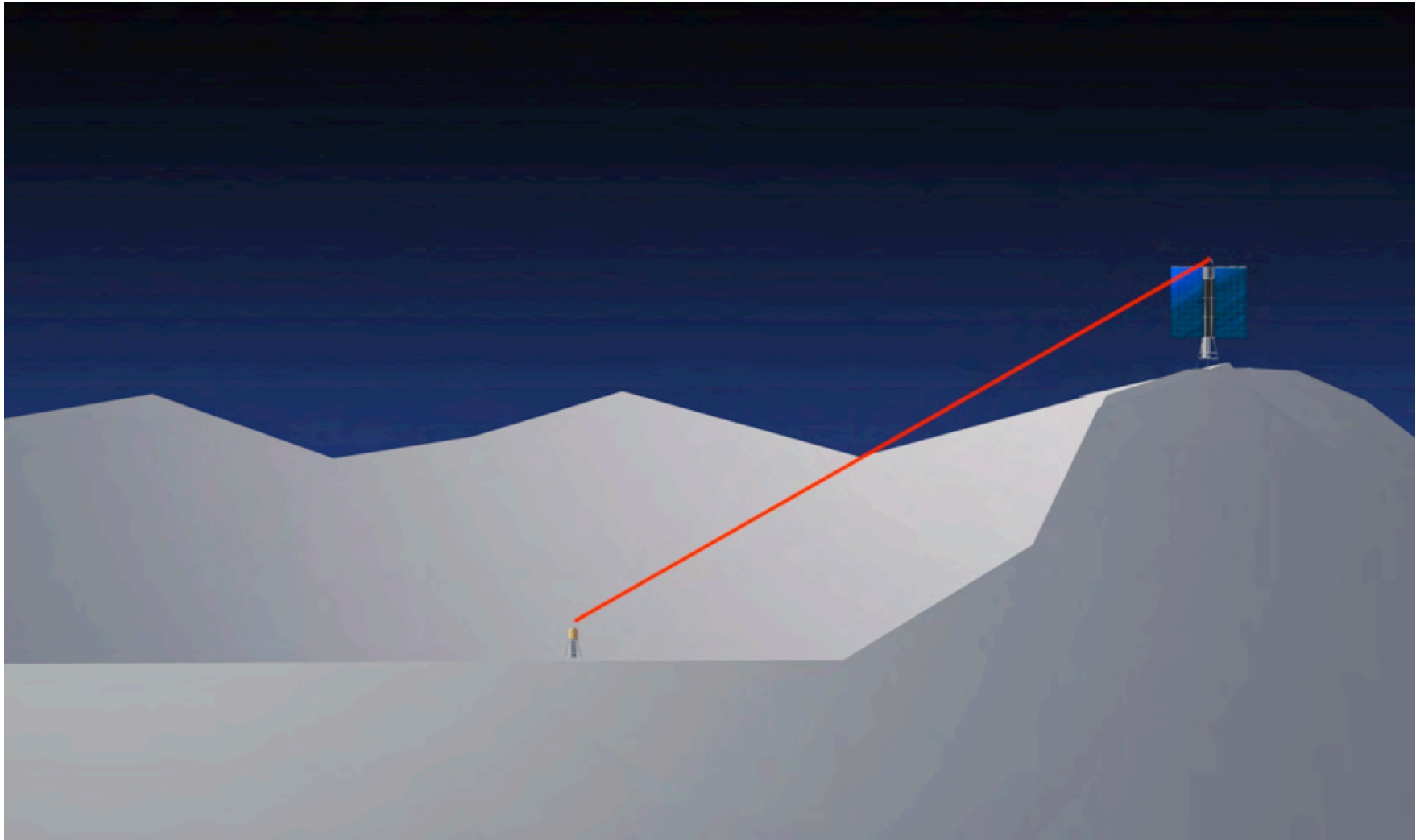
Energy Tower Utility (1)



The Moon is Vast



Mining Cold Traps

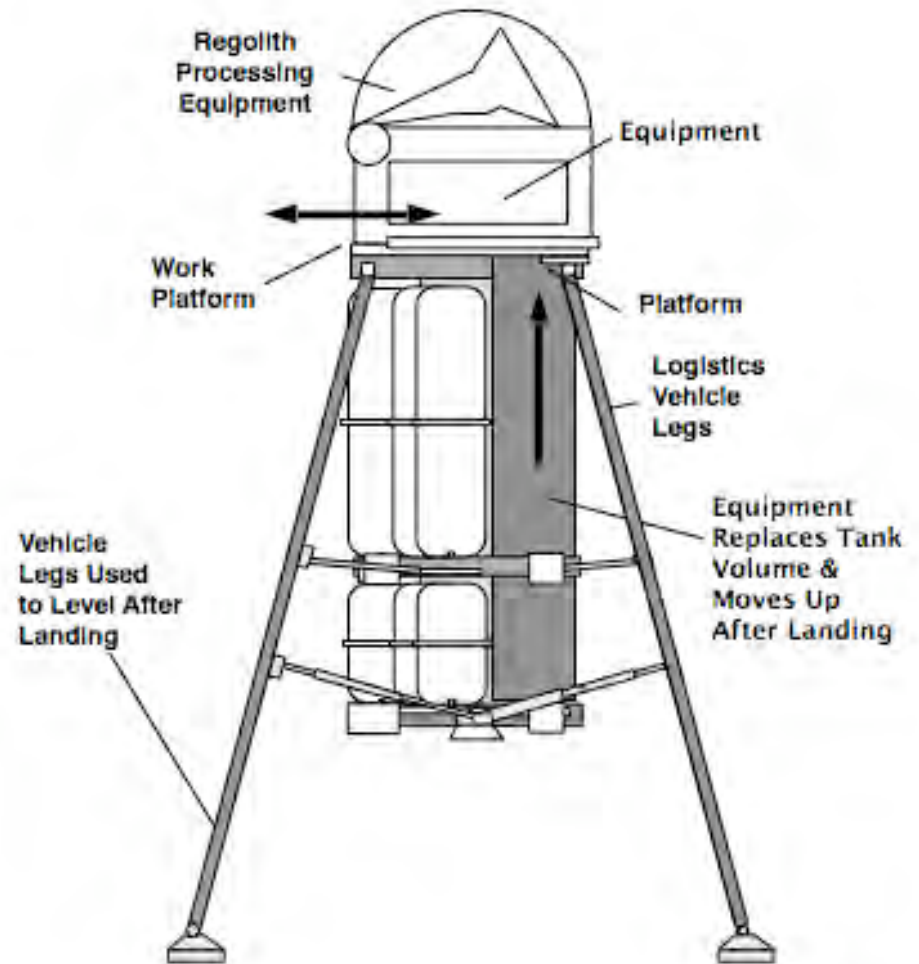


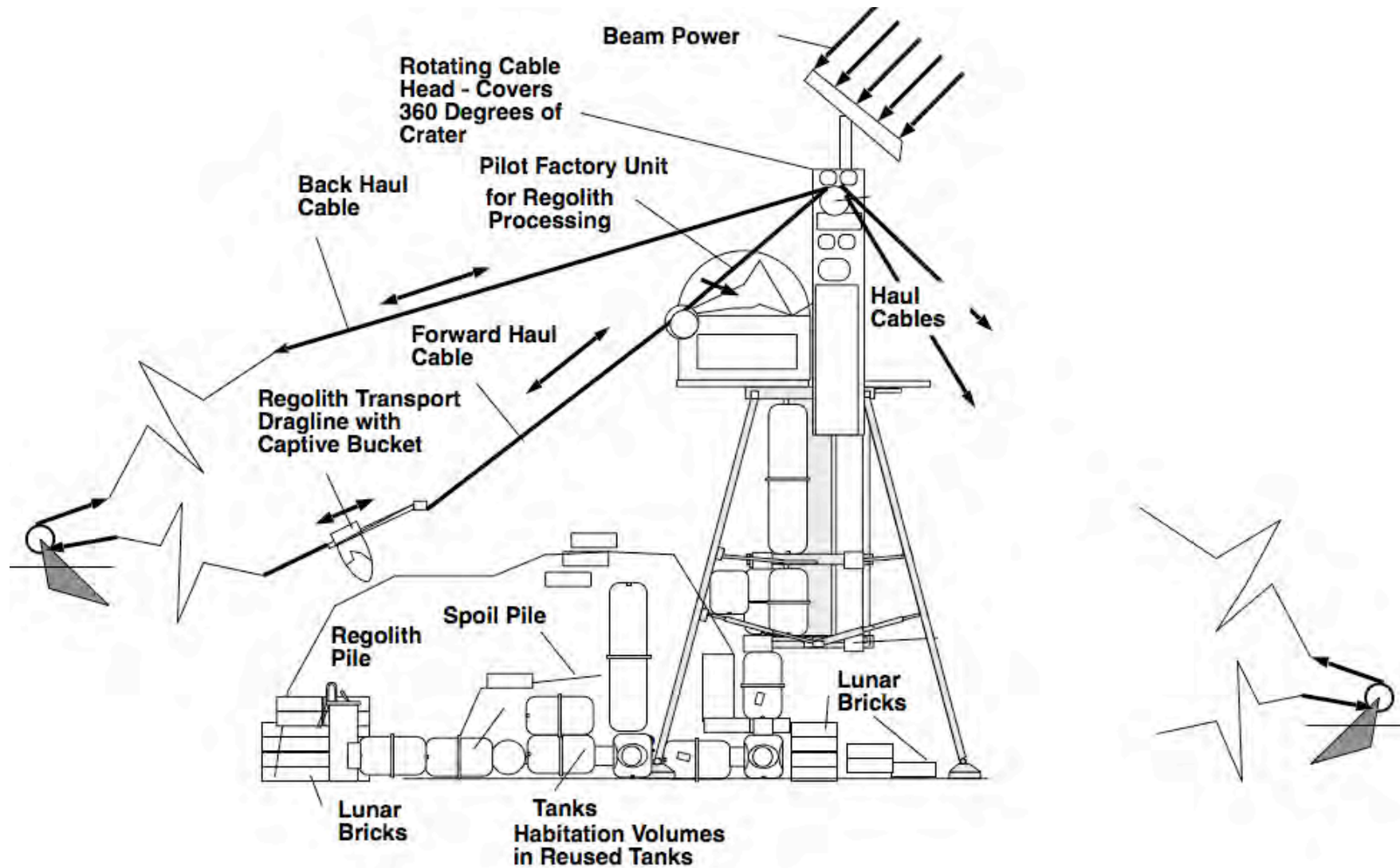
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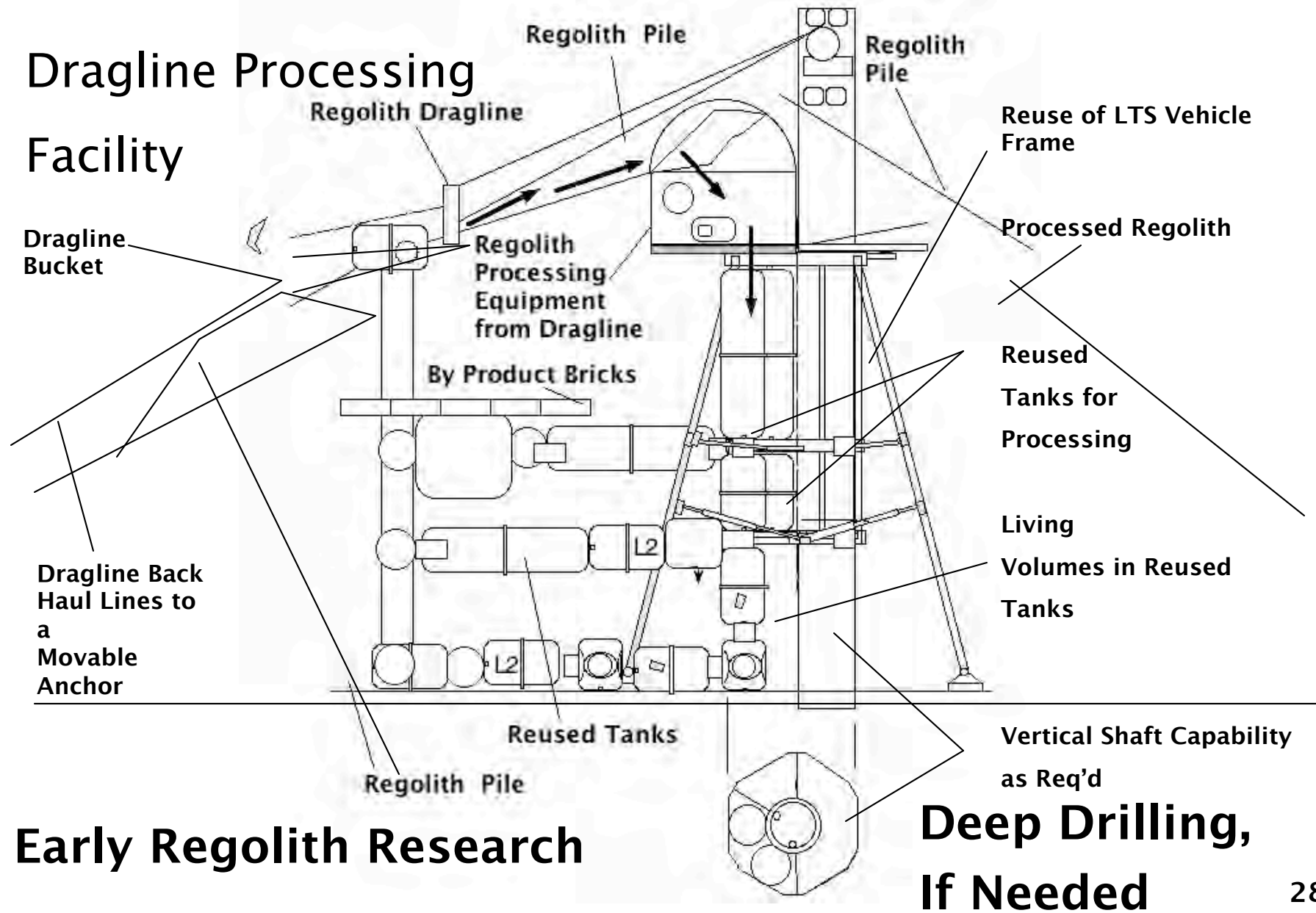
Regolith Research Tower

- Proof of Concept-Processing
- Uses Landing Hardware Again as Frame & Tanks
- Permits Odd Size Cargo
- Evolves with Commerce
- Requires Power/Crew
- After Valuable Resource is Found & Helps Confirm \$
- Requires Energy & Logistics
- Produces Multiple Products



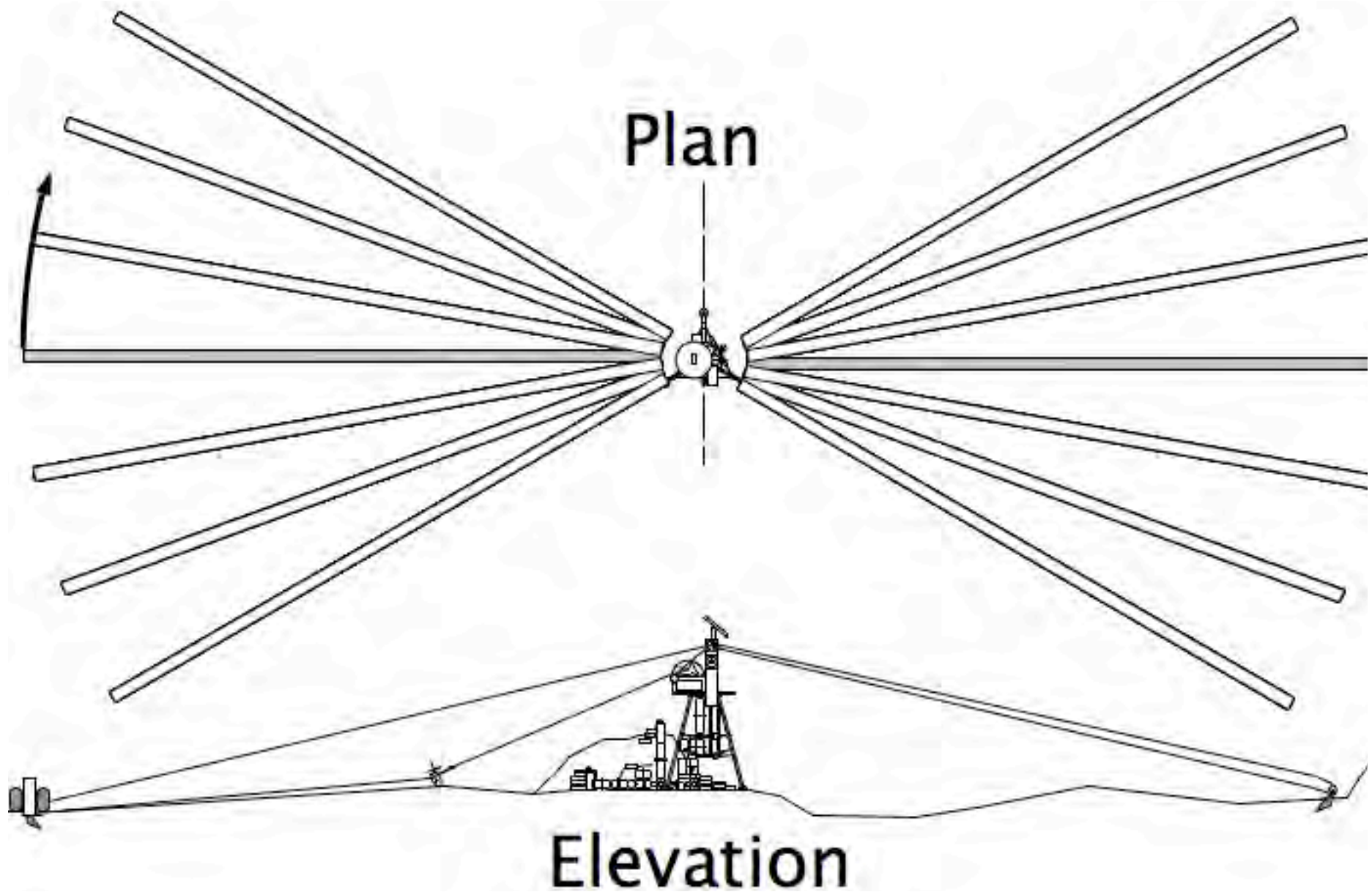


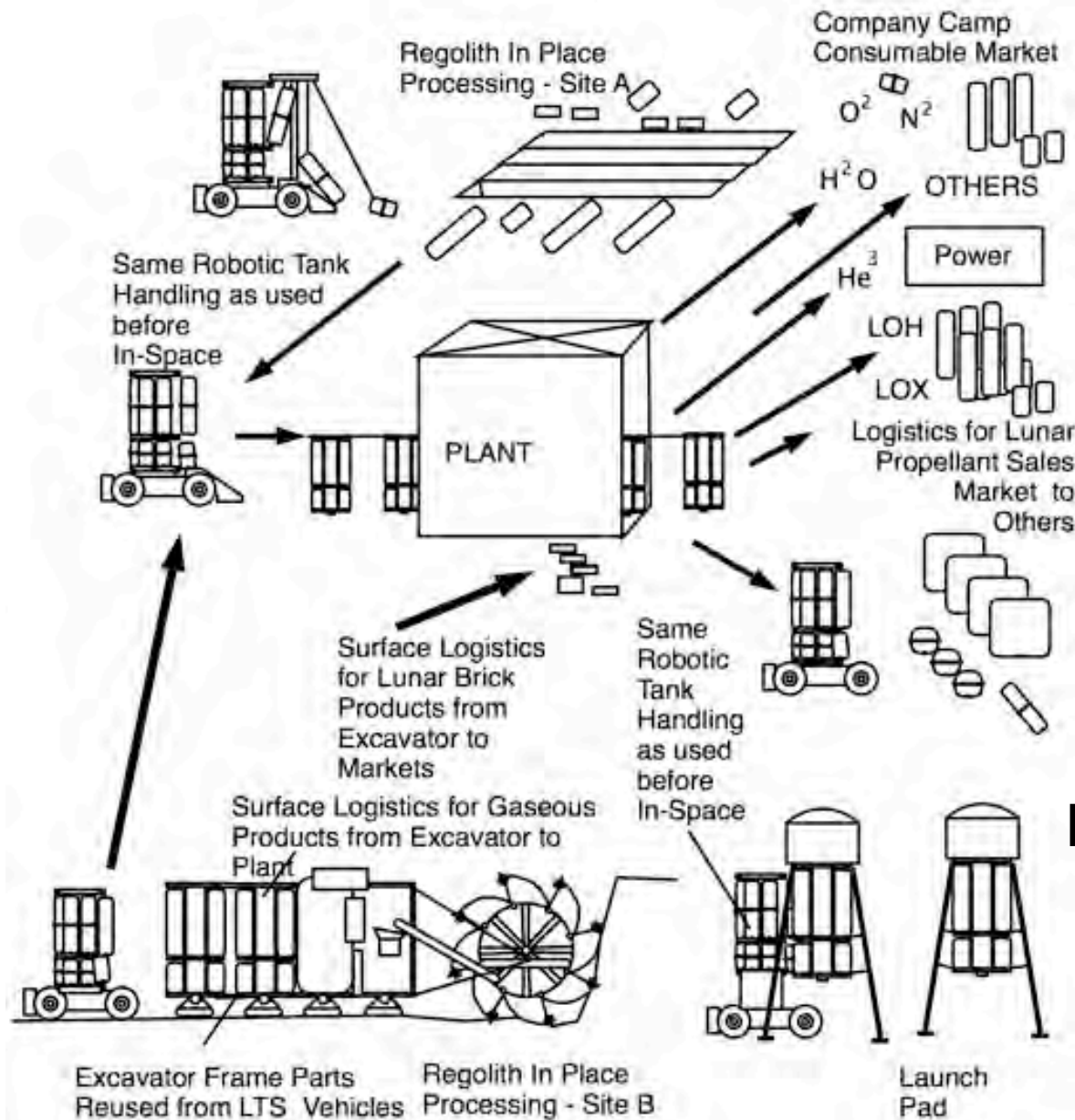
Dragline Processing Facility



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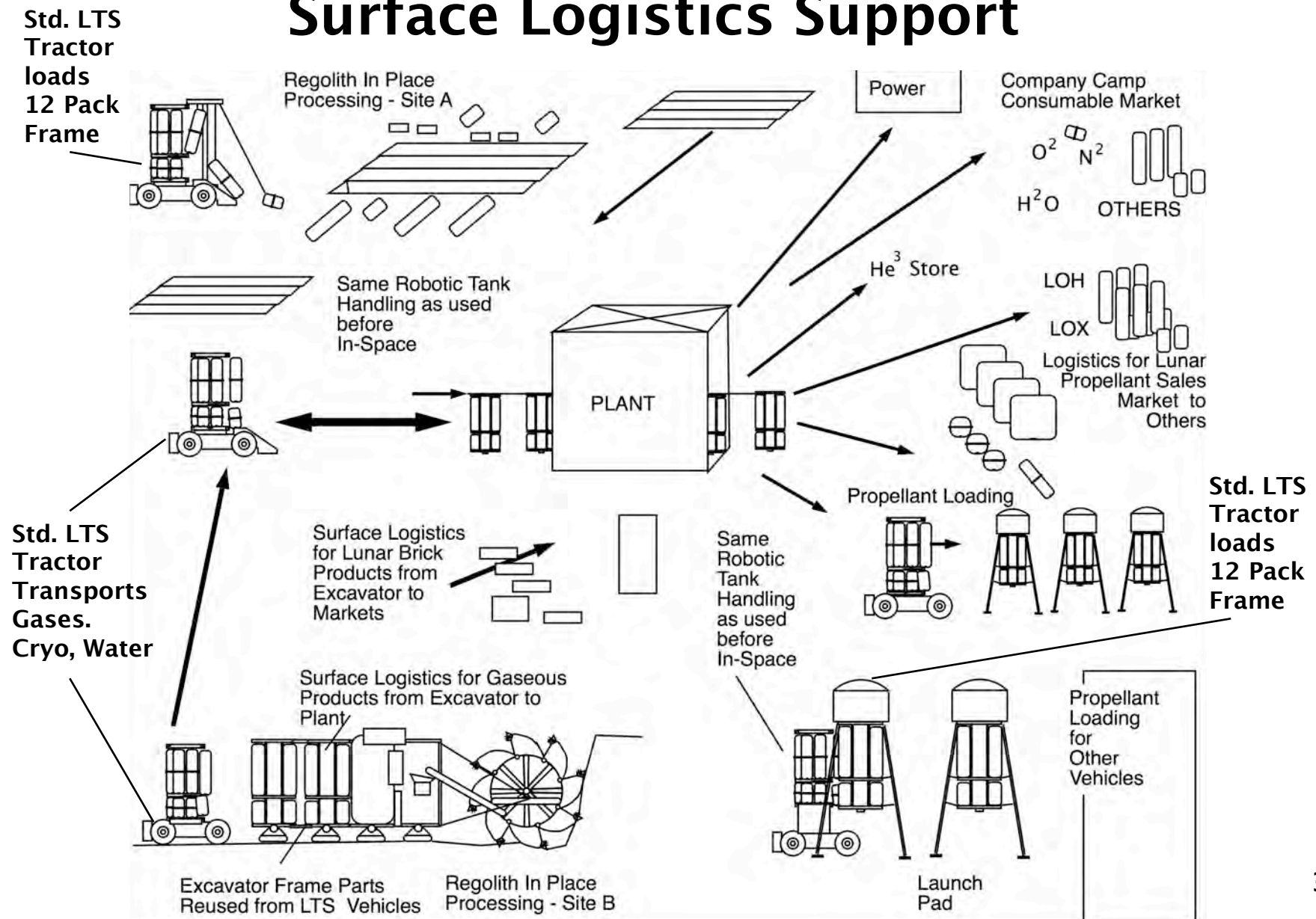




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Surface Logistics Support



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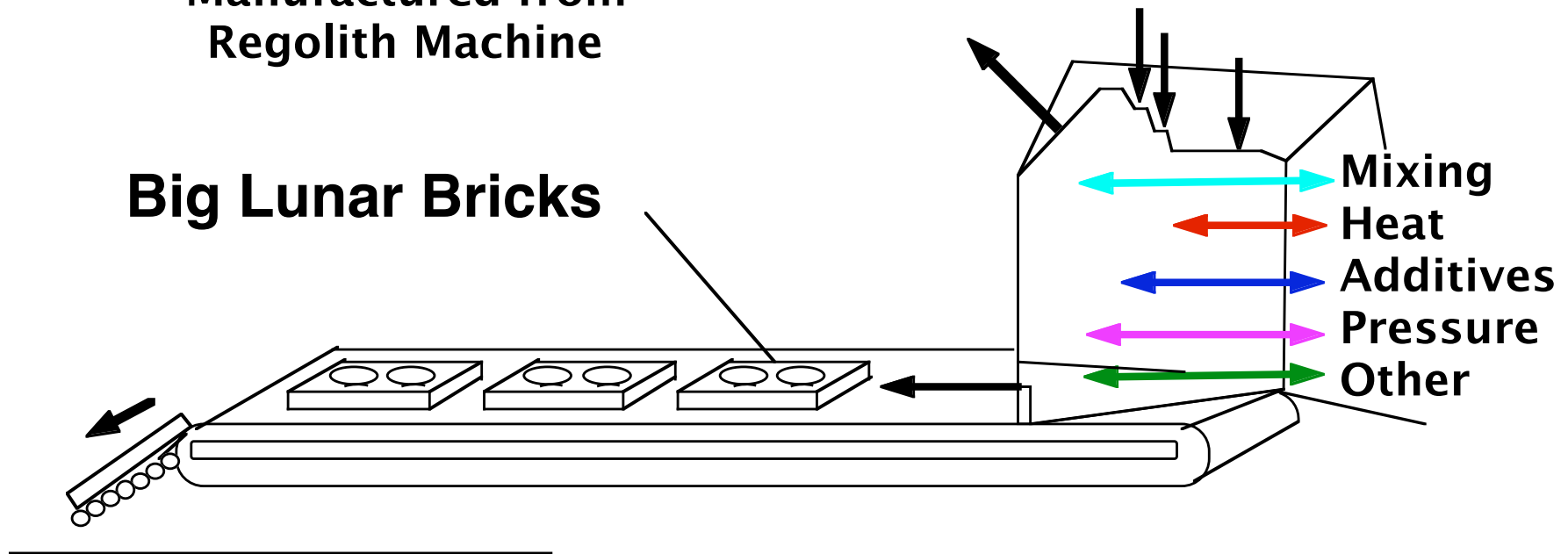


Products from Regolith

**Construction Material
Manufactured from
Regolith Machine**

**From Fluidized Chamber, Heater
and/or Screw Conveyors**

Big Lunar Bricks



Trade Routes Used to Develop Prudhoe Bay Energy Gaps in the Past

The Senate Energy Committee is considering the largest construction project in the history of mankind. **Natural Gas Pipeline is #5 Trade Route.**



1. Barges
2. Air
3. Trucks
4. Pipeline





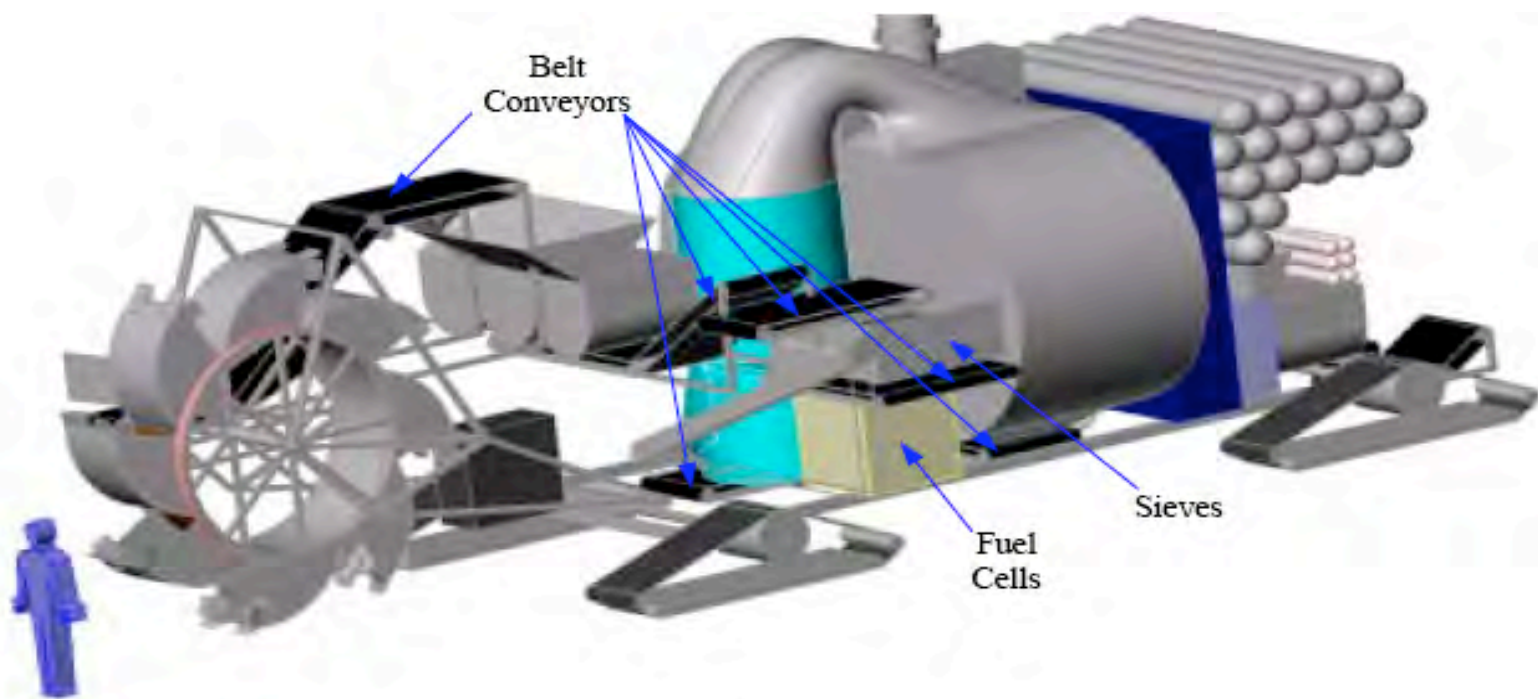
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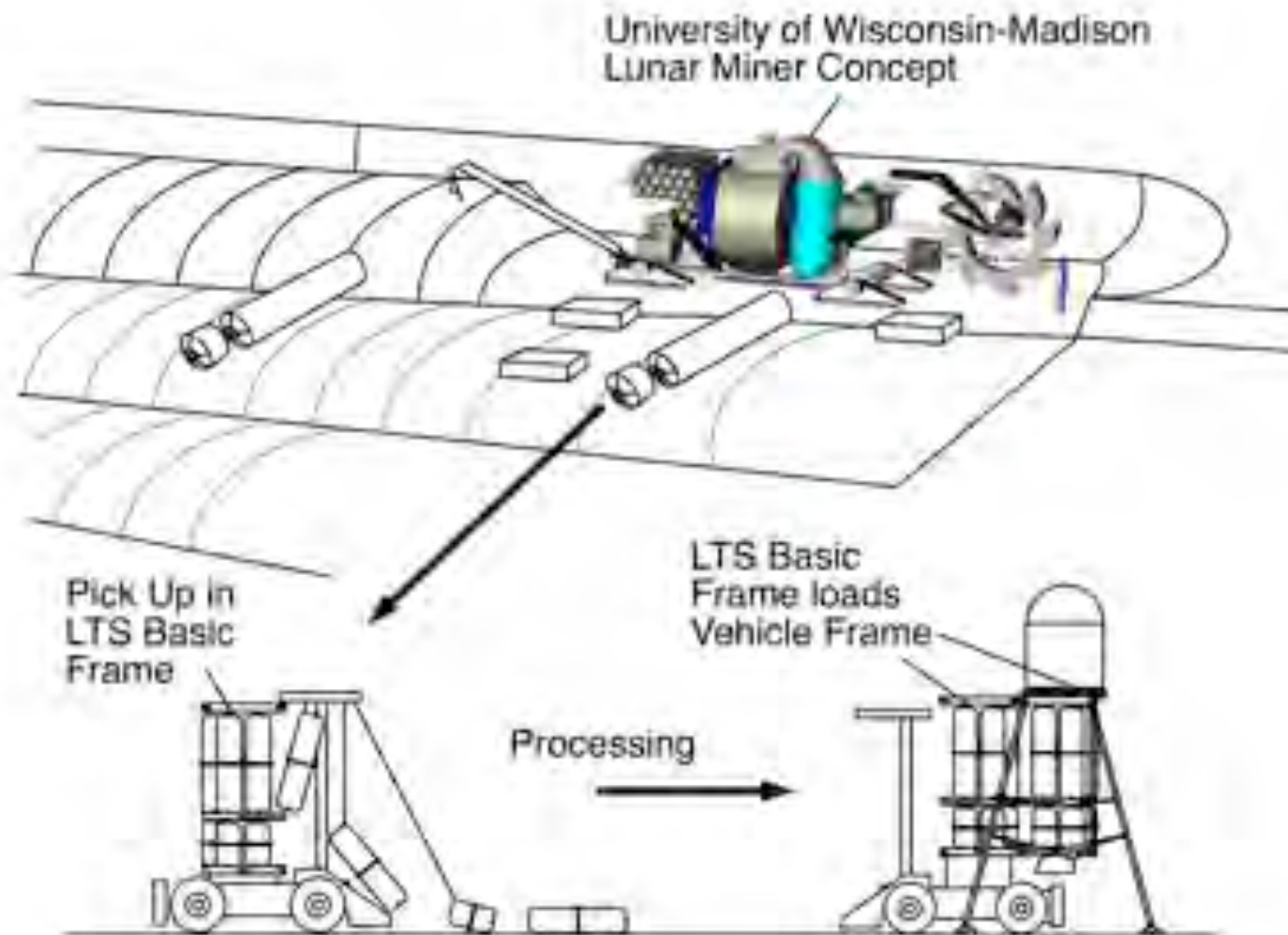
June 2010



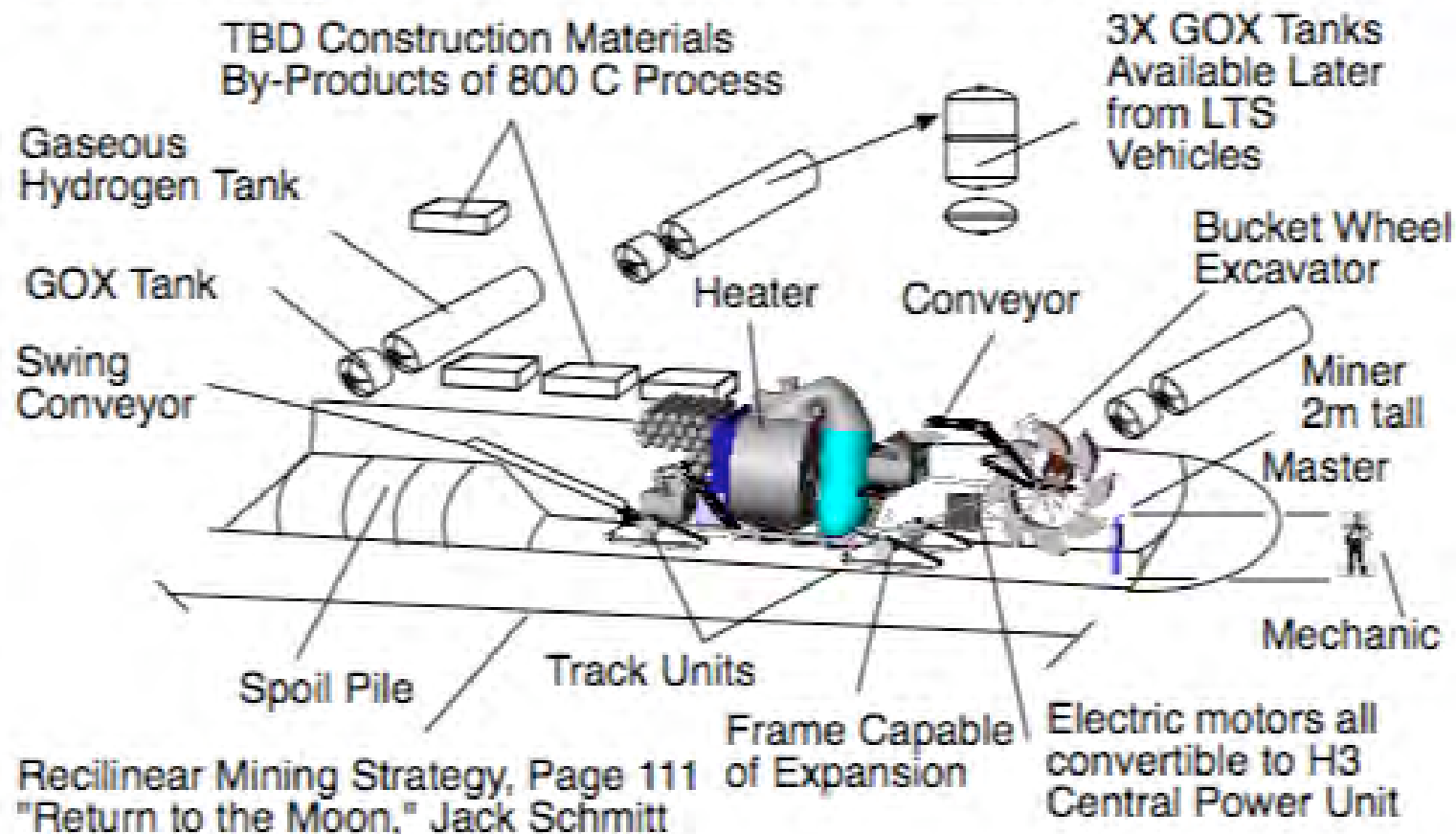
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Lunar Transportation Systems, Inc.





University of Wisconsin-Madison Miner

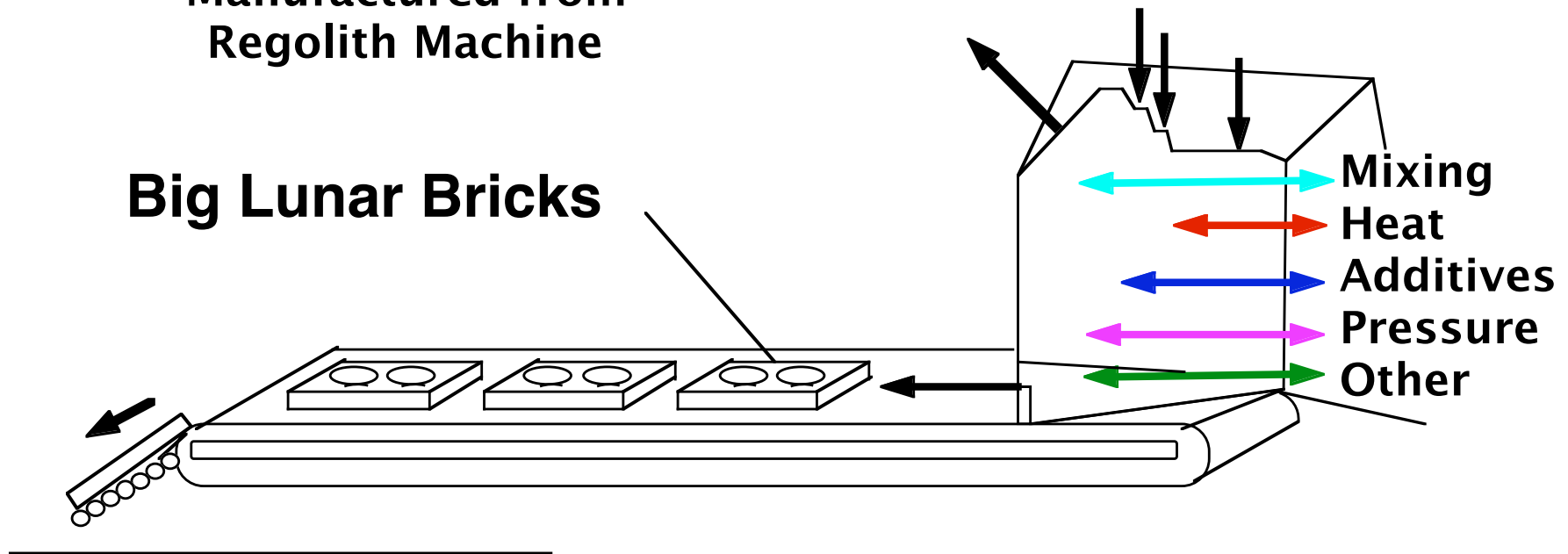


Products from Regolith

**Construction Material
Manufactured from
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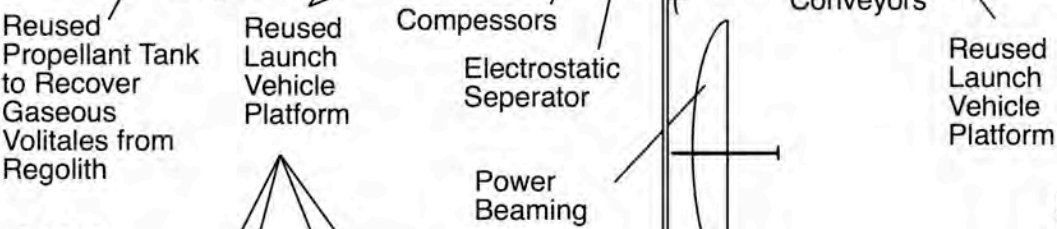
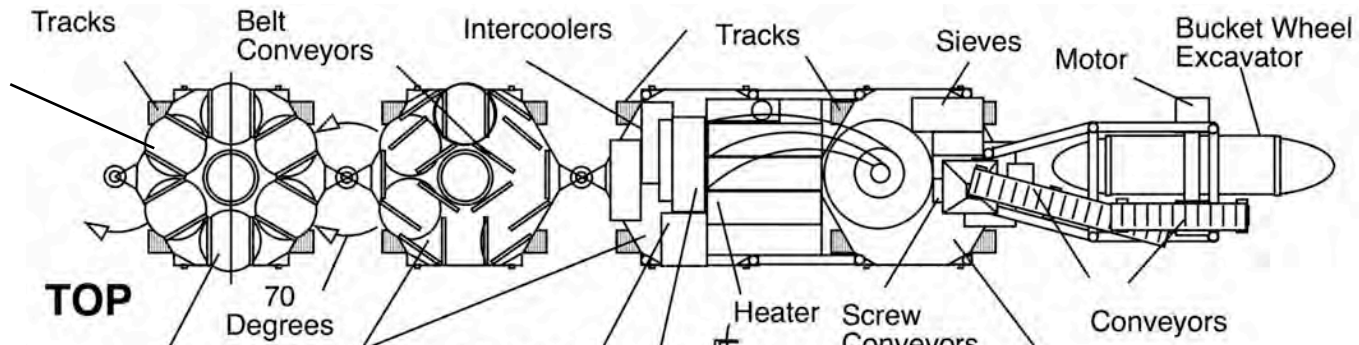
**From Fluidized Chamber, Heater
and/or Screw Conveyors**

Big Lunar Bricks

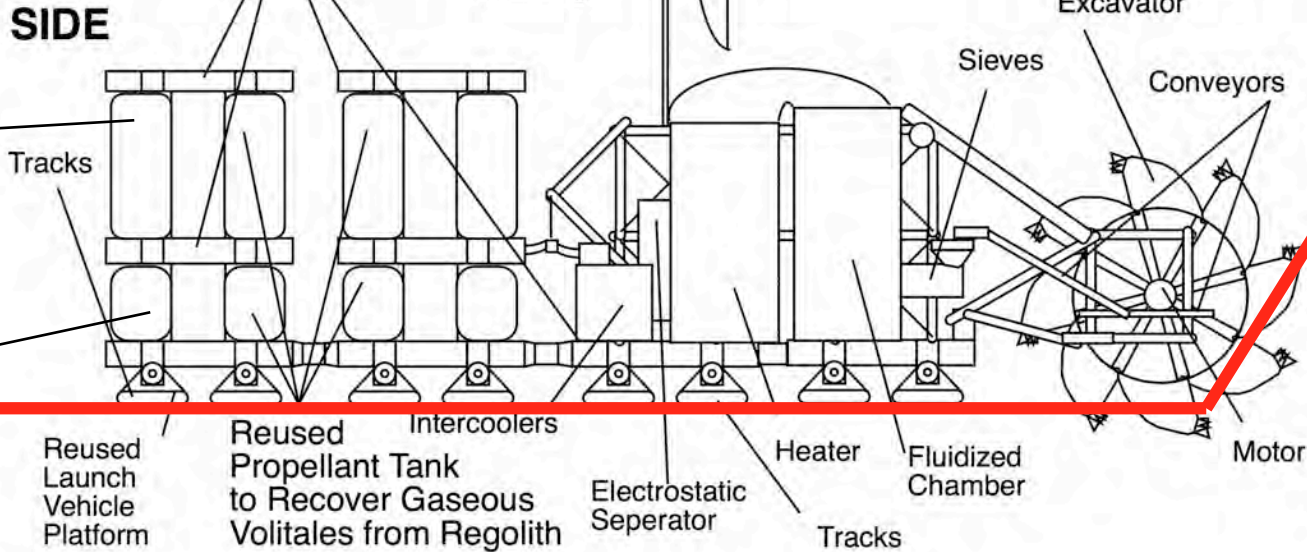


Process Regolith in Place

**Std. LTS
Frame
becomes
12 Pack
Frame**



**Std. LTS
Tanks
Transport
Gases.
Cryo, Water
And Use LTS
Robotics
To change
tanks**



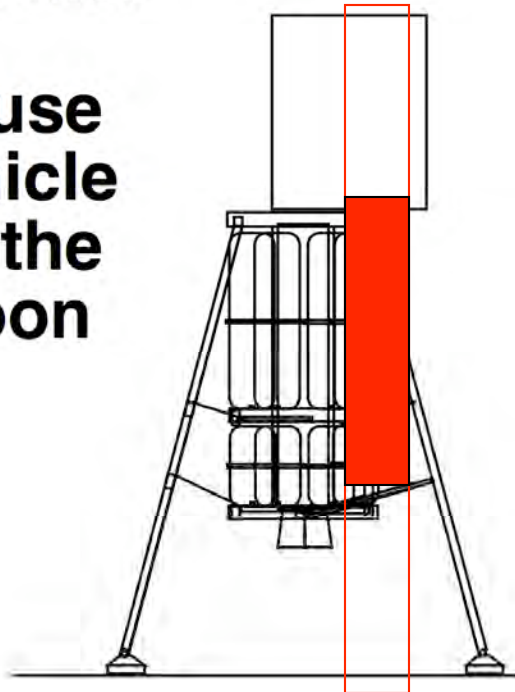
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Vertical Shaft Recovery

LTS, Inc.

**Reuse
Vehicle
on the
Moon**



- Reuse LTS Stack
- Encourage innovation
- Design to Drill
- Telescope to cut the cost
- Hardware depends on the recovered resource recovery and value

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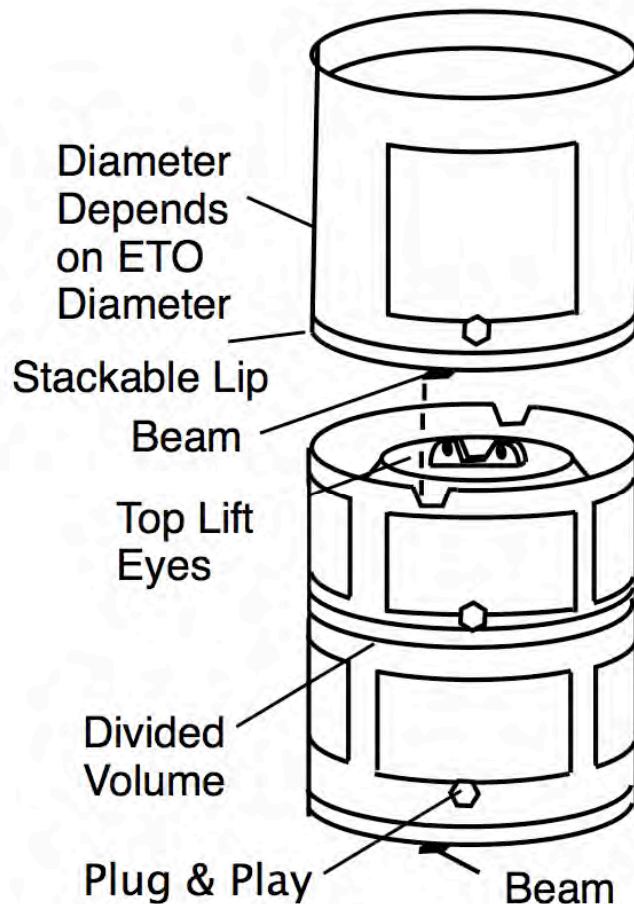
LEO as a Shoreline



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Containerized Cargo



- No tie to vehicle
- No Integration
- Standard size
- Oversize Equipment
- Special Features
 - Solar Cells - sm Power
 - Plug & Play
 - Customer configured
 - Liquid, Dry, Pressure,
 - Hatches, Cryogenic,
 - Good Labeling



Conclusions

- More than one Trade Route Solution is Safer, if Logistics Vehicles are Delayed
- Learn from previous Resource Remote Bases
- 10-12 Early Markets Exist on Lunar Surface
- Innovation & LOTL can help reduce costs
- Cost Reduction stimulates increased Private Investment from Non Government sources & Stimulates Lunar Commerce
- Innovation and LOTL go together
- Commerce is the Way Earth Works Globally

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Tom Taylor
Lunar Trade Route Costs
Lunar Transportation Systems, Inc.

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Info on our proposal to buy 3 Shuttles

<http://public.me.com/taylorT>
[plus paper and](#) viewgraphs

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Mid-Deck Locker Research Entrepreneurial Team

- Entrepreneurial Innovation reduced the Cost of Manned Tended Research in Shuttle & our P/L Integration & Sp Opns
- PriceWaterhouse Study estimated 9 times less hardware cost & **Order Of Magnitude** reduction in costs to the research customer
- 23 NSTS missions
- Leases to NASA for \$42m
- Early successful space commerce company (1982)
- Stimulated ~ 2,000 Micro G Experiments in Orbit





SPACEHAB Module Space Shuttle

One of Four Logistics Routes



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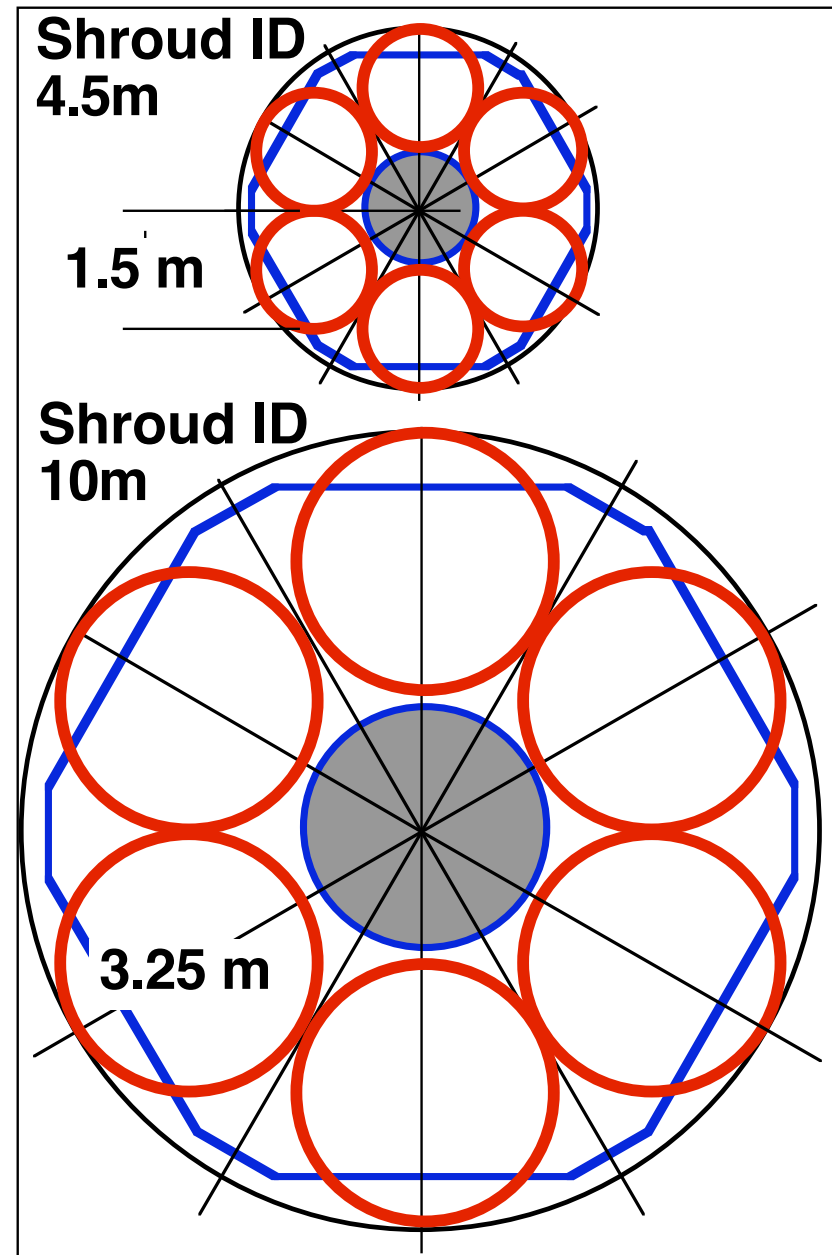


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Larger Tanks on SDV or CEV

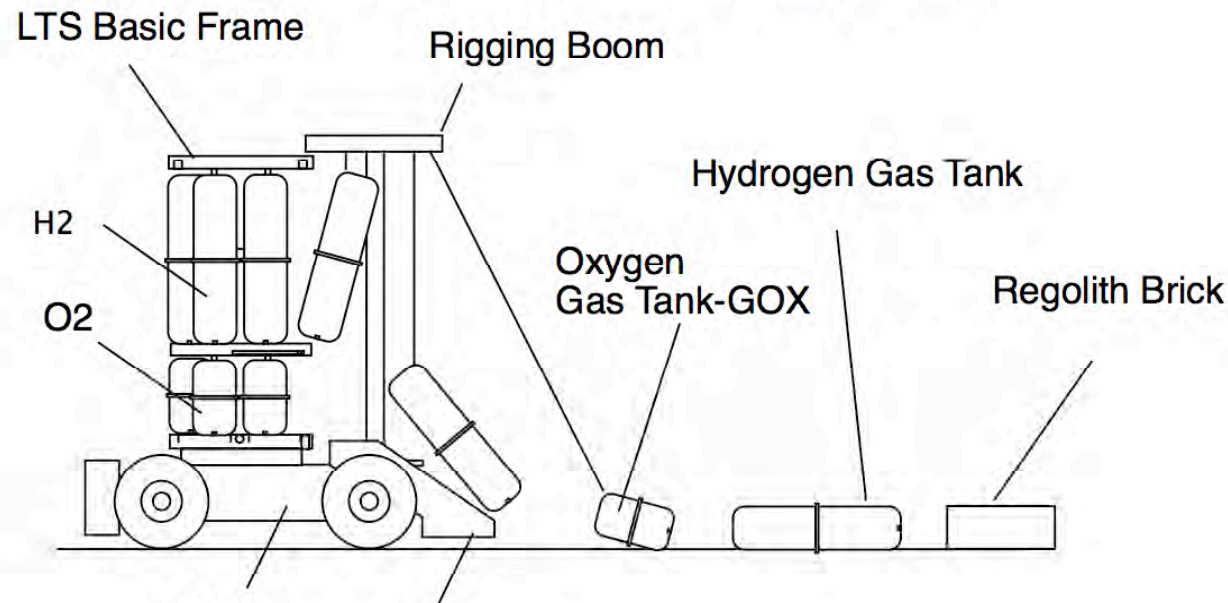
- Now uses Delta IV
- Scalable to SDV
- Larger tanks
- Growth options
- Commercial lunar transportation both ways
- SDV helps evolution to transport nodes
- Not starting transportation from zero again



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Pick Up Gaseous Volatiles



Ground Vehicle Tractor

- Basic Frame, Double Power Take Off Units, Platform Lift
- Components Small enough for LTS P/L Bay & Assemble
- Manned & Pressurized Cabin & Remote Control Earth
- Electric Wheel Units capable of Reuse in all Vehicles
- Growth Capable & Sharing with others, Low Tipping Cap.

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First Leg - Commercial EELS's



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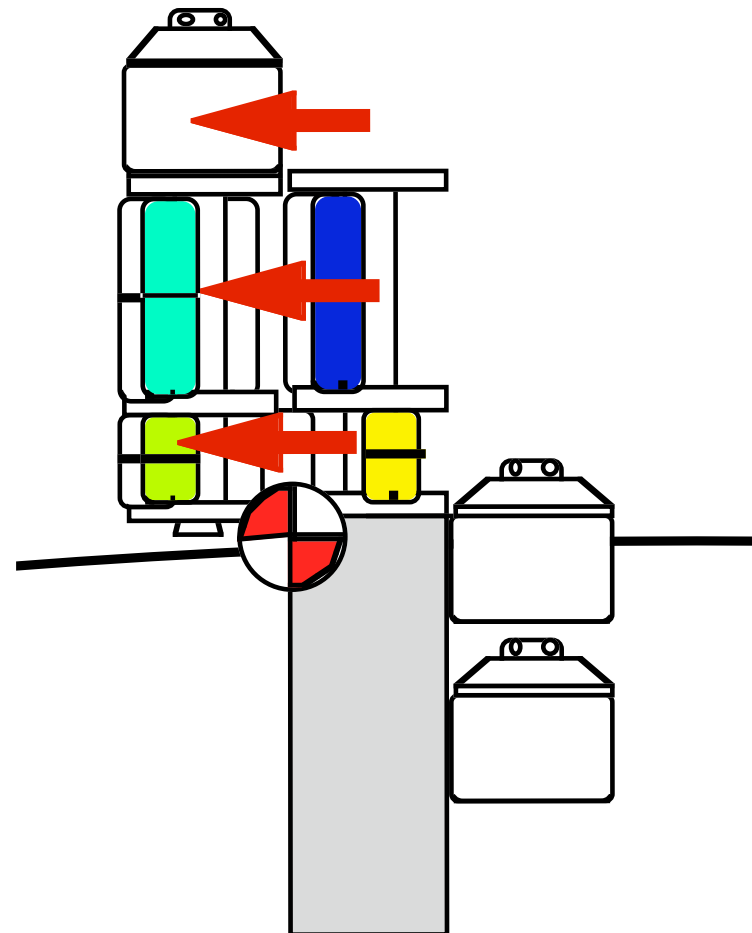
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Lunar Transportation Systems, Inc.

Autonomous Propellant Tank Transfer

Transferring cryo propellant between big tanks is expensive.

- Transfer Tanks instead of cryo propellants using low cost plant robotics
- Discard tanks until reusable tanks work economically
- Nodes emerge as filling stations
- Don't throw away any \$10k/lb mass



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