A permanent settlement on Mars:
The architecture of the Mars Homestead Project

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1) DRM has been completed
   
   - Class II - prefabricated and surface assembled base.
   - Facilities for 12 people
     - Pressurized habitats
     - Functioning ECLSS
     - Rovers and other construction equipment
     - Sufficient ISRU capabilities

2) Phase I of Permanent Settlement
   
   - Class III - ISRU derived structure with integrated Earth components base
   - Space for 12 people
   - Potential to expand to ~100

Base Class definitions by Cohen and Kennedy AIAA1997
Elevation and Atmospheric Pressure

Mt. Everest = 320 mb
Potosi, Bolivia = 620 mb
Sea level = 1013 mb
Hellas Planitia = 10 mb
Mariana Trench

Olympus Mons = 1 mb

Elevation
Atmospheric Pressure
Radiation

Solar wind

Cosmic rays

Solar flares
Construction Methods
**Construction Methods**

**PRESSURE VESSELS**
- inflatables or rigid shell structures
- relatively simple deployment operations
- can be pre-tested

**MASONRY**
- manufacture masonry units using compressed and sintered regolith or cut stone
- using leaning arches and self supporting domes, one can construct a wide range of spaces using no scaffolding.
<table>
<thead>
<tr>
<th>membrane stress vs. weight of regolith cover</th>
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<tbody>
<tr>
<td>- allows views and surface access</td>
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<tr>
<td>- compartmentalized space</td>
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<tr>
<td>- optimize the shell as a pressure membrane</td>
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<tr>
<td>- cover with ~1m of regolith for radiation</td>
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<tr>
<td>and micrometeoroid protection</td>
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<tr>
<td>- allows larger open spaces</td>
</tr>
<tr>
<td>- no view</td>
</tr>
<tr>
<td>- 1.5 g/cm³ regolith density and 60kPa</td>
</tr>
<tr>
<td>internal pressure - 10 m of regolith are</td>
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<tr>
<td>required.</td>
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<tr>
<td>- Make sure that load lines for both</td>
</tr>
<tr>
<td>load pressurized and unpressurized load</td>
</tr>
<tr>
<td>case fit inside the masonry.</td>
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</table>

**Pressure vessels for spaces that require access to the exterior:**
- manufacturing, greenhouses, MEP, and private quarters.

**Regolith covered vaults for larger spaces with no view:**
- public areas, kitchen/dinning, labs, and baths.
pitched-brick vaults

self-supporting domes

- work to be done most telerobotically or automated
- where humans are needed they work inside a pressurized reusable construction tent
Construction tent
(c) 1987 Bruce Mackenzie
**Mars Society 2005**

**Standard Pressurized Modules**

- **Greenhouses**
  - Volume: 631 m³
  - Surface Area: 605 m²
  - Floor Area: 200 m²
  - Length: 33.5 m
  - Width: 6.2 m

- **Manufacturing/BOP**
  - Volume: 322 m³
  - Surface Area: 322 m²
  - Floor Area: 100 m²
  - Length: 17.5 m
  - Width: 6.0 m

- **Private/Garage**
  - Volume: 227 m³
  - Surface Area: 194 m²
  - Floor Area: 50 m²
  - Length: 8.5 m
  - Radius: 6.0 m

- **Short Standard Module**
  - Volume: 84 m³
  - Surface Area: 100 m²
  - Floor Area: 25 m²
  - Length: 7.2 m
  - Radius: 4.0 m

- **Long Standard Module**
  - Volume: 100 m³
  - Surface Area: 118 m²
  - Floor Area: 30 m²
  - Length: 8.5 m
  - Radius: 4.0 m

- **Round Connector**
  - Volume: 29 m³
  - Surface Area: 45 m²
  - Floor Area: m²
  - Radius: 1.9 m

- **Greenhouses**
  - Volume: 631 m³
  - Surface Area: 605 m²
  - Floor Area: 200 m²
  - Length: 33.5 m
  - Width: 6.2 m
Candor Chasma
Valles Marineris
High resolution images from MOC on MGS, superimposed on a context image.
Possible locations for landing zones that don’t overfly the settlement
Site - Terrestrial Scaled Comparisons

Scaled Earth city texture
- Venice, Italy
- US capitol, Washington DC
- North End, Boston MA
- Suburb, Champaign IL

Heights above plane
- settlement hill: 40 m
- large mesa: 70 m
- north hill: 100 m
## Site Data

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Latitude</td>
<td>6.3° S</td>
</tr>
<tr>
<td>Longitude</td>
<td>70.1° W</td>
</tr>
<tr>
<td>Elevation of Chamsa floor</td>
<td>-4800 m</td>
</tr>
</tbody>
</table>

### Noon Sun Angles

- **North Summer**: 59°
- **Spring/Fall**: 84°
- **North Winter**: 109°
Linear City
Derived from historical precedents by Arturo Soria and Le Corbusier.
**Efficiency** in transportation, infrastructure, **safety**, and **expandability**.

Separately pressurized segments with inflatables or regolith supported masonry

Keeps the settlers alive.
Utilities
Air, water and power distribution in sub floor panels
Entrance
Work spaces
Private quarters
Social spaces
Spaces arranged along the infrastructure organized through the relationship between the humans and the vegetation.
vegetation as symbol

A special place immediately between the main entrance and the formal meeting space.

Plant five special trees on arrival - one for each continent.

Symbolize hope in the future of the settlement.

The trees will grow as the settlement expands.

When people arrive from Earth the first thing they’ll see as they enter is the grove of trees.
Vegetation as mediation of views

Views of Mars are mediated by vegetation.

Look at the RED of Mars through the GREEN of terrestrial life.

Every private suite has a small garden area in front of its window.

Terminate connector segments with small gardens and a window to Mars.
vegetation as life support

Greenhouses have optimized, light, temperature, and structure for specially designed plants. Integrally tied to the life support infrastructure.
vegetation as green belt

Where work areas need to provide a connection, use a row of vegetation to separate the circulation from the work spaces.
vegetation as mediator of social life

Clearing in the woods
A Chinese garden

Social space is surrounded and protected by trees.

The edges of the space are hidden thus the limited size of the space is obscured.
vegetation as mediator of social life - variations
Welcome to Mars
Programming Team of the Mars Home Project:

- James Burk - communications
- Gary Fisher - waste recycling system
- Robert Dyck - mineral and gas processing systems
- Damon Ellender - manufacturing systems
- Krishnamurthy Manjunatha - computing systems
- Richard Sylvan - medical factors
- Inka Hublitz - greenhouse design
- Frank Crossman - plastics manufacturing
- William Johns - psychological factors