Colonized Interstellar Vessel: Conceptual Master Planning

Steve Summerford, RLA, ASA, LEED AP
Project Designer, Hyperion
The Substance of Dreams

“Ships and sails proper for the heavenly air should be fashioned. Then there will also be people, who do not shrink from the dreary vastness of space.”

- Kepler 1609
The Substance of Dreams

“Ships and sails proper for the heavenly air should be fashioned. Then there will also be people, who do not shrink from the dreary vastness of space.”

- Kepler 1609
The Substance of Dreams

“Say goodbye to your two best friends...”
The Substance of Dreams

“Say goodbye to your two best friends, and I don’t mean your pals in the Winnebago!”

- Dark Helmet, Spaceballs
Spacecraft Design Vernacular
FACT
Design Vernacular

FACT

FICTION

Project Icarus: Son of Daedalus

“Flying Closer to Another Star”
Predecessor Designs
Predecessor Designs

The Sphere

source: nss.org
Predecessor Designs

The Sphere

source: nss.org
Predecessor Designs

The Sphere

The Cylinder
Predecessor Designs

The Sphere  The Cylinder

Source: nss.org
Predecessor Designs

The Sphere  The Cylinder

The Torus  The Banded Torus

source: nss.org
Predecessor Designs

The Sphere

The Cylinder

The Torus

The Banded Torus

source: nss.org
Striking a Balance
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- A great deal of focus on TECHNOLOGY (rightfully so)
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- But without thoughtful planning of the spatial, physical and psychological needs, even the most advanced technologies risk failure on the human level

1990 - workers installed the wrong windscreen screws, at altitude the captain was sucked out
- A great deal of focus on TECHNOLOGY (rightfully so)

- But without thoughtful planning of the spatial, physical and psychological needs, even the most advanced technologies risk FAILURE ON THE HUMAN LEVEL

2012 - Costa Concordia
Striking a Balance

- A great deal of focus on TECHNOLOGY (rightfully so)

- But without thoughtful planning of the spatial, physical and psychological needs, Even the most advanced technologies risk FAILURE ON THE HUMAN LEVEL

- Looking forward at ways that a vessel can NURTURE AND INSPIRE, rather than simply function as containment

The ability to perceive or think differently is more important than the knowledge gained.

- David Bohm
Designing for the Human Element

Beyond life systems.
Designing for the Human Element

- Allowing the user to **MODIFY** the configuration and visual appearance of a space
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- Creating long vistas and distant FOCAL POINTS
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- Varying materials, forms, shapes, textures, and colors to **ENGAGE THE MIND**
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Planning Densities and Programming

Scaling the Vessel: Population Driven

**Worldships vs. Colonized Interstellar Vessels (CIV)**

~10,000 PEOPLE

- Used by previous studies
- Promotes the development of a dynamic community
- Colleges, small towns, etc.
## Population Calculations

Note: Figures assume target population of 10,000 persons.

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Surface Area per Person (m²)</th>
<th>Total Colony Surface Area (m²)</th>
<th>Approx. Number of Floors</th>
<th>Projected Surface Area per Person (m²)</th>
<th>Total Colony Projected Surface Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td></td>
<td></td>
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<tr>
<td>Residential Dwellings</td>
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<td>Waste / Mechanical</td>
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<tr>
<td>Business (Retail, Offices)</td>
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<td>17,500</td>
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<td>Civic / Assembly Halls</td>
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<td>Recreation (Athletics)</td>
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<td>5,000</td>
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<td>1,000</td>
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<td>26,673</td>
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<tr>
<td>Livestock + Husbandry</td>
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<td>1.67</td>
<td>16,673</td>
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<tr>
<td>Processing + Collection</td>
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<td>40,000</td>
<td>3</td>
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<td>13,333</td>
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<td><strong>610,000</strong></td>
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<td><strong>203,333</strong></td>
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<td>1,599,500</td>
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<td>60.34</td>
<td>603,417</td>
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</table>

Departures from 'SP-415' Surface Area figures
1 Area slightly increased to round off calculations and slightly expand living space
2 Calculations based on 50 beds, approximately 58m² per bed

Departures from 'SP-415' Number of Levels figures
b Transportation needs will be stacked or elevated
c Civic institutions will be multiple floors
c Civic / Assembly Halls can exist on rooftops or within multi story structures
d Hospital and medical facilities will be multi-story except for the emergency department
e Proposed design utilizes additional floor stacking, resulting in a lower "Total Colony Projected Surface Area" as compared to the 670,000m² called for by 'SP-415'
# Project Icarus: Son of Daedalus

## Planning Densities and Programming

### Population Calculations

Note: Figures assume target population of 10,000 persons.

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<td>Residential Dwellings 1</td>
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<td>4</td>
<td>12.50</td>
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<tr>
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<td>100,000</td>
<td>1</td>
<td>10.00</td>
<td>100,000</td>
</tr>
<tr>
<td>Storage (Misc.)</td>
<td>5.00</td>
<td>50,000</td>
<td>4</td>
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<td>5,000</td>
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<tr>
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<td>3,000</td>
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### Agriculture Specific

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<td>146,667</td>
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<td>2.67</td>
<td>26,667</td>
</tr>
<tr>
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<td>50,000</td>
<td>3</td>
<td>1.67</td>
<td>16,667</td>
</tr>
<tr>
<td>Processing &amp; Collection</td>
<td>4.00</td>
<td>40,000</td>
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Departures from 'SP-413' Surface Area figures:
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Departures from 'SP-413' Number of Levels figures:
4. Transportation needs will be stacked or elevated
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### Population Calculations

**Residential Dwellings**

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<th>Use</th>
<th>m²</th>
<th>m²</th>
<th>qty.</th>
<th>m²</th>
<th>m²</th>
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<td>Storage (Relic)</td>
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<td>12,500</td>
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<td>Waste / Mechanical</td>
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<td>41500</td>
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<tr>
<td>Educational Facilities</td>
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<td>40000</td>
<td>3</td>
<td>1.33</td>
<td>13,333</td>
</tr>
<tr>
<td>Service / Utilities</td>
<td>420</td>
<td>42000</td>
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<td>2.10</td>
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<tr>
<td>Business (Retail, Offices)</td>
<td>750</td>
<td>75000</td>
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<td>1.65</td>
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</tr>
<tr>
<td>Civic / Assembly Halls</td>
<td>150</td>
<td>15000</td>
<td>2b</td>
<td>0.75</td>
<td>7,500</td>
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<tr>
<td>Recreation (Athletics)</td>
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<td>10000</td>
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<td>0.50</td>
<td>5,000</td>
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<tr>
<td>Medical Facilities 2</td>
<td>0.30</td>
<td>3000</td>
<td>3d</td>
<td>0.10</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Subtotal: 98,950 m², 989,500 m³, 40,010 m³, 400,083 m³

**Agriculture Specific**

<table>
<thead>
<tr>
<th>Use</th>
<th>m²</th>
<th>m²</th>
<th>m³</th>
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<td>14.67</td>
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<tr>
<td>Agriculture Drying</td>
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<td>Livestock + Husbandry</td>
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<tr>
<td>Processing + Collection</td>
<td>400</td>
<td>40,000</td>
<td>1.33</td>
</tr>
</tbody>
</table>

Subtotal: 610,000 m³, 203,333 m³

**Total Tabulations**

| Surface Area (m²)         | 159,950 | 1,599,500 | 60.34 | 603,417 |

---

Note: Figures assume target population of 10,000 persons.

Deviations from 'SP-413' Surface Area figures:

1. Area slightly increased to round off calculations and slightly expand living space
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Planning Densities and Programming

## Population Calculations

A single individual requires 50 m$^2$ for living space. A project for 10,000 persons would require:

<table>
<thead>
<tr>
<th>Land Use</th>
<th>m$^2$</th>
<th>m$^2$</th>
<th>qty.</th>
<th>m$^2$</th>
<th>m$^2$</th>
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<tr>
<td><strong>General</strong></td>
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<td>Residential Dwellings</td>
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<td>Waste / Mechanical</td>
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<td>1.33</td>
<td>13,333</td>
</tr>
<tr>
<td>Service / Utilities</td>
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<td>1.61</td>
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<td>Business (Retail, Offices)</td>
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<tr>
<td>Civic / Assembly Halls</td>
<td>1.50</td>
<td>15,000</td>
<td>2b</td>
<td>0.75</td>
<td>7,500</td>
</tr>
<tr>
<td>Recreation (Athletics)</td>
<td>1.00</td>
<td>10,000</td>
<td>2c</td>
<td>0.50</td>
<td>5,000</td>
</tr>
<tr>
<td>Medical Facilities 2</td>
<td>0.30</td>
<td>3,000</td>
<td>3d</td>
<td>0.10</td>
<td>1,000</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>98.95</td>
<td>989,500</td>
<td></td>
<td>40.01</td>
<td>400,083</td>
</tr>
<tr>
<td>Agriculture Specific</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>44.00</td>
<td>440,000</td>
<td>3</td>
<td>14.67</td>
<td>146,667</td>
</tr>
<tr>
<td>Agriculture Drying</td>
<td>8.00</td>
<td>80,000</td>
<td>3</td>
<td>2.67</td>
<td>26,667</td>
</tr>
<tr>
<td>Livestock + Husbandry</td>
<td>5.00</td>
<td>50,000</td>
<td>3</td>
<td>0.50</td>
<td>5,000</td>
</tr>
<tr>
<td>Processing + Collection</td>
<td>4.00</td>
<td>40,000</td>
<td>3</td>
<td>1.33</td>
<td>13,333</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>61.00</td>
<td>610,000</td>
<td></td>
<td>20.33</td>
<td>203,333</td>
</tr>
<tr>
<td>Total Dwellings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Area (m$^2$)</td>
<td>159.95</td>
<td>1,599,500</td>
<td></td>
<td>60.34</td>
<td>603,417</td>
</tr>
</tbody>
</table>

Note: Figures assume target population of 10,000 persons.

- Departures from 'SP-415' Surface Area figures
  - Area slightly increased to round off calculations and slightly expand living space
  - Calculations based on 50 beds, approximately 58m$^2$ per bed

- Departures from 'SP-415' Number of Levels figures
  - Transportation needs will be stacked or elevated
  - Civic institutions will be multiple floors
  - Recreation facilities can exist on rooftops or within multi-story structures
  - Hospital and medical facilities will be multi-story except for the emergency department

- Proposed design utilizes additional floor stacking, resulting in a lower 'Total Colony Projected Surface Area' as compared to the 670,000 m$^2$ called for by 'SP-415'
**Population Calculations**

- **Residential Dwellings**: $50.00 \times 10,000 = 500,000 \text{ m}^2$

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Surface Area per Person (m²)</th>
<th>qty.</th>
<th>Total Colony Surface Area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage (�)</td>
<td>10.00</td>
<td>1</td>
<td>10.00</td>
</tr>
<tr>
<td>Waste / Mechanical</td>
<td>4.15</td>
<td>2</td>
<td>8.30</td>
</tr>
<tr>
<td>Educational Facilities</td>
<td>4.00</td>
<td>2</td>
<td>8.00</td>
</tr>
<tr>
<td>Service / Utilities</td>
<td>4.00</td>
<td>2</td>
<td>8.00</td>
</tr>
<tr>
<td>Business (Retail, Offices)</td>
<td>4.00</td>
<td>2</td>
<td>8.00</td>
</tr>
<tr>
<td>Misc. Space</td>
<td>3.50</td>
<td>2</td>
<td>6.75</td>
</tr>
<tr>
<td>Civic / Assembly Halls</td>
<td>1.50</td>
<td>2b</td>
<td>3.00</td>
</tr>
<tr>
<td>Recreation (Athletics)</td>
<td>1.00</td>
<td>2c</td>
<td>2.00</td>
</tr>
<tr>
<td>Medical Facilities</td>
<td>0.30</td>
<td>3d</td>
<td>0.90</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>98.95</td>
<td></td>
<td>98,950</td>
</tr>
<tr>
<td>Agriculture Specific</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>44.00</td>
<td>3</td>
<td>132.00</td>
</tr>
<tr>
<td>Agriculture Drying</td>
<td>8.00</td>
<td>3</td>
<td>24.00</td>
</tr>
<tr>
<td>Livestock + Husbandry</td>
<td>5.00</td>
<td>3</td>
<td>15.00</td>
</tr>
<tr>
<td>Processing + Collection</td>
<td>4.00</td>
<td>3</td>
<td>12.00</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>61.00</td>
<td></td>
<td>183.00</td>
</tr>
<tr>
<td><strong>Total Colonies</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Area (m²)</td>
<td>1,599,500</td>
<td>60.34</td>
<td>95,950</td>
</tr>
</tbody>
</table>

- Departures from 'SP-413' Surface Area figures
  1. Area slightly increased to round off calculations and slightly expand living space
  2. Calculations based on 50 beds, approximately 58m² per bed

- Departures from 'SP-413' Number of Levels figures
  1. Transportation needs will be stacked or elevated
  2. Civic institutions will be multiple floors
  3. Recreation facilities can exist on rooftops or within multi-story structures
  4. Hospital and medical facilities will be multi-story except for the emergency department
  5. Proposed design utilizes additional floor stacking, resulting in a lower 'Total Colony Projected Surface Area' as compared to the 670,000m² called for by 'SP-413'
### Planning Densities and Programming

**Population Calculations**

**Residential Dwellings**

- **Surface Area per Person:** 50.00 m²
- **Total Colony Surface Area:** 500,000 m²
- **Approx. Number of Floors:** 4

**Table: Land Use**

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Surface Area per Person (m²)</th>
<th>Total Colony Surface Area (m²)</th>
<th>Approx. Number of Floors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Residential Dwellings</strong></td>
<td>50.00</td>
<td>500,000</td>
<td>4</td>
</tr>
<tr>
<td><strong>Storage (Telos)</strong></td>
<td>5.00</td>
<td>50,000</td>
<td>4</td>
</tr>
<tr>
<td><strong>Waste / Mechanical</strong></td>
<td>4.15</td>
<td>41,500</td>
<td>2</td>
</tr>
<tr>
<td><strong>Educational Facilities</strong></td>
<td>4.00</td>
<td>40,000</td>
<td>3</td>
</tr>
<tr>
<td><strong>Service / Utilities</strong></td>
<td>4.20</td>
<td>42,000</td>
<td>2</td>
</tr>
<tr>
<td><strong>Business (Retail, Offices)</strong></td>
<td>7.80</td>
<td>38,000</td>
<td>2</td>
</tr>
<tr>
<td><strong>Misc. Space</strong></td>
<td>3.50</td>
<td>35,000</td>
<td>2</td>
</tr>
<tr>
<td><strong>Civic / Assembly Halls</strong></td>
<td>1.50</td>
<td>15,000</td>
<td>2</td>
</tr>
<tr>
<td><strong>Recreation (Athletics)</strong></td>
<td>1.00</td>
<td>10,000</td>
<td>2</td>
</tr>
<tr>
<td><strong>Medical Facilities</strong></td>
<td>0.30</td>
<td>3,000</td>
<td>3</td>
</tr>
</tbody>
</table>

**Subtotal:**

- **Surface Area (m²):** 98,95 m²
- **Total Colony (m²):** 989,500 m²

**Agriculture Specific**

- **Surface Area (m²):** 44,00 m²
- **Total Colony (m²):** 440,000 m²

**Subtotal:**

- **Surface Area (m²):** 61,00 m²
- **Total Colony (m²):** 610,000 m²

**Total Colonies**

- **Surface Area (m²):** 159,95 m²
- **Total Colony (m²):** 1,599,500 m²

**Note:** Figures assume target population of 10,000 persons.

**Departures from 'SP-41' Surface Area figures:**

1. Area slightly increased to round off calculations and slightly expand living space
2. Calculations based on 50 beds, approximately 58 m² per bed

**Departures from 'SP-41' Number of Levels figures:**

4. Transportation needs will be stacked or elevated
5. Civic institutions will be multiple floors
6. Recreation facilities can exist on rooftops or within multi-story structures
7. Hospital and medical facilities will be multi-story except for the emergency department
8. Proposed design utilizes additional floor stacking, resulting in a lower 'Total Colony Projected Surface Area' as compared to the 670,000 m² called for by 'SP-413'
Planning Densities and Programming

Population Calculations

- Residential Dwellings: $50.00 \times 500,000 = 125,000$ m$^2$

- Stack 4 Floors

- Total Projected Area (m$^2$)
  - General: 1,250,000
  - Agriculture Specific: 416,000
  - Total: 1,666,000

- Departures from 'SP-413' figures:
  - Area slightly increased to round off calculations and slightly expand living space
  - Calculations based on 50 beds, approximately 58m$^2$ per bed

- Additional floor stacking, resulting in a lower 'Total Colony Projected Surface Area' as compared to the 670,000m$^2$ called for by 'SP-413'
**Planning Densities and Programming**

### Population Calculations

- **Residential Dwellings**
  - Surface Area per Person: 50 m²
  - Total Colony Surface Area: 500,000 m²
  - Approx. Number of Floors: 4
  - Area Per Person: 12.5 m²
  - Total Colony Area: 125,000 m²

- **Projected Area Per Person (m²):**
  - General: 12.5 m²
  - Agriculture Specific: 12.5 m²

- **Surface Area Figures:**
  - Agriculture: 440,000 m²
  - Agriculture Drying: 80,000 m²
  - Livestock + Husbandry: 50,000 m²
  - Processing + Collection: 40,000 m²

- **Subtotal Surface Area:**
  - 610,000 m²

- **Surface Area Comparison:**
  - Proposed: 603,417 m²
  - SP-413: 670,000 m²

---

**Note:** Figures assume target population of 10,000 persons.

1. Area slightly increased to round off calculations and slightly expand living space
2. Calculations based on 50 beds, approximately 58 m² per bed
3. Transportation needs will be stacked or elevated
4. Civic institutions will be multiple floors
5. Recreation facilities can exist on rooftops or within multi story structures
6. Hospital and medical facilities will be multi-story except for the emergency department
7. Proposed design utilizes additional floor stacking, resulting in a lower Total Colony Projected Surface Area as compared to the 670,000 m² called for by SP-413
What is a Floor to Area Ratio?

The ratio of total building surface area (adding up all floors) in relation to the total site (land) area

Enforces density / open space control measures by setting a maximum allowable FAR.
Planning Densities and Programming

For comparison:

<table>
<thead>
<tr>
<th>Land Use</th>
<th>FAR Range</th>
<th>Reference Source</th>
<th>Reference City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Family Residential (Detached)</td>
<td>0.35-0.55</td>
<td>Seattle Municipal Code [9]</td>
<td>Seattle, WA, USA</td>
</tr>
<tr>
<td>Medium Density Urban Residential</td>
<td>1.0-1.5</td>
<td>Seattle Municipal Code [9]</td>
<td>Seattle, WA, USA</td>
</tr>
<tr>
<td>Mixed Use (Retail + Residential); Urban</td>
<td>1.0-2.5</td>
<td>Seattle Municipal Code [9]</td>
<td>Seattle, WA, USA</td>
</tr>
<tr>
<td>Mixed Use (Retail + Residential); Urban</td>
<td>5.0</td>
<td>Atlanta Code of Ordinances [3]</td>
<td>Atlanta, GA, USA</td>
</tr>
<tr>
<td>High Density Urban (City) Residential</td>
<td>10.0</td>
<td>New York City Planning [5]</td>
<td>New York, NY, USA</td>
</tr>
</tbody>
</table>

| COLONY DESIGN TARGET             | 1.25-1.75 |                                      |                      |
Applied Principles

Spatial dimensionality guidelines
Applied Principles

Spatial dimensionality guidelines
## Vessel Modules Proposed

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Proposed</th>
<th>SP-413 Interpretation for Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projected Area (m²)</td>
<td>740,000</td>
<td>670,000</td>
</tr>
<tr>
<td>Required to achieve projected area:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Modules (Total)</td>
<td>* 40.00</td>
<td>35.00</td>
</tr>
<tr>
<td>Number of Bays</td>
<td>** 8.00</td>
<td>7.00</td>
</tr>
<tr>
<td>Number of Modules per Bay</td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Assumes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area per Module (m²)</td>
<td>18,500</td>
<td>19,143</td>
</tr>
<tr>
<td>Area per Bay (m²)</td>
<td>92,500</td>
<td>95,714</td>
</tr>
<tr>
<td>Results In:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Bay Length (m)</td>
<td>775.00</td>
<td>775.00</td>
</tr>
<tr>
<td>Total Module Length (m)</td>
<td>155.00</td>
<td>155.00</td>
</tr>
<tr>
<td>Total Bay and Module Width (m)</td>
<td>119.35</td>
<td>123.50</td>
</tr>
<tr>
<td>Total Habitable Length (m)</td>
<td>6,200.00</td>
<td>5,425.00</td>
</tr>
</tbody>
</table>

* Assumes 5 additional modules.

** Assumes 1 additional bay.
Applied Principles

Based on:
- Predecessor designs
- Quantity and dimensionality of the planning elements
- A reversal of thinking with regard to the orientation of the living bays
- Economics and constructability

A massing diagram begins to emerge

This is just one approach and doesn’t begin to address life support or propulsion considerations.
Applied Principles

Potential land use percentages (not actual locations)
Vessel Characteristics

- Radius: ~400m
- Target Population: 10,000-12,000
- 1.0g @ ~1.5 RPM
- 40 Initial Modules: 120m X 155m
- 8 Bays (5 Modules / Bay) 775m

REACTIVE SCALABILITY
Vessel Characteristics

– Interconnected through 15-25m wide pedestrian viaducts.

– Vertical elevators embedded within armatures provide transit to central core.

– Central hub for operations, mechanical equipment, and low-g experimentation / recreation.

– Accommodation of leading propulsion system at the time of vessel inception.

– Minimal cross section exposing leading vessel edges. Edges are beveled and reinforced to reduce damage from particle impact, a situational threat to all interstellar travel.

REACTIVE SCALABILITY
Vessel Characteristics

Relative Scale

BERNAL SPHERE
(16km dia.)

O'NEILL CYLINDER
(8km dia. each)

STANFORD TORUS
(1.8km dia.)

PROPOSED VESSEL
(700m dia.)
Vessel Characteristics

Relative Scale

- BURJ KHALIFA, Dubai, UAE
- TAIWAN SKYTREE, Tokyo, Japan
- CN TOWER, Toronto, ON, Canada
- SEARS TOWER, Chicago, IL, USA
- PETRONAS TOWERS, Kuala Lumpur, Malaysia
- ONE WORLD TRADE, New York, NYC, NY
- EMPIRE STATE BUILDING, NYC, NY
- CIV PROPOSAL, Side Elevation
- CIV PROPOSAL, Front Elevation
Land Uses - Residential

- 10,000 colonists will require approx. 24 different types of modules

- Multi-use spaces

- Life systems, service, mechanical, etc. located beneath or behind structures
Land Uses - Residential

- 10,000 colonists will require approx. 24 different types of modules

- Multi-use spaces

- Life systems, service, mechanical, etc. located beneath or behind structures
Land Uses - Residential

- 10,000 colonists will require approx. 24 different types of modules

- Multi-use spaces

- Life systems, service, mechanical, etc. located beneath or behind structures
## Land Uses - Residential

### Residential Demographics

<table>
<thead>
<tr>
<th>Type</th>
<th># of Occupants</th>
<th>Floor Area (m²)</th>
<th>Floors</th>
<th>Dimensions</th>
<th># Colony Dwellings</th>
<th>Colony Occupants</th>
<th>% Colony Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Dwelling</td>
<td>1</td>
<td>50</td>
<td>1</td>
<td>5m x 10m</td>
<td>2,000</td>
<td>2,000</td>
<td>20%</td>
</tr>
<tr>
<td>Couple Dwelling</td>
<td>2</td>
<td>100</td>
<td>1</td>
<td>7m x 14.25m</td>
<td>1,500</td>
<td>3,000</td>
<td>30%</td>
</tr>
<tr>
<td>Family Dwelling</td>
<td>3-4</td>
<td>200</td>
<td>1</td>
<td>7m x 14.25m</td>
<td>1,250</td>
<td>5,000</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>14m x 14.25m</td>
<td>1,250</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>4,750</strong></td>
<td><strong>10,000</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Table 28 - Initial target demographics and colony dwelling-type allocations (based upon studies contained within ‘SP-413’) [7]

<table>
<thead>
<tr>
<th>Type</th>
<th>Units in Module</th>
<th>Population in Module</th>
<th>Module FAR</th>
<th>Residential Density DU/Acre (Units/Acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Dwelling</td>
<td>74</td>
<td>74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Couple Dwelling</td>
<td>82</td>
<td>164</td>
<td>1.40</td>
<td>49.44</td>
</tr>
<tr>
<td>Family Dwelling</td>
<td>76</td>
<td>245</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td>226</td>
<td>483</td>
<td>1.40</td>
<td>49.44</td>
</tr>
</tbody>
</table>
Land Uses

FAR + Spatial dimensionality guidelines = Neighborhood Module
Land Uses

Neighborhood Module in Elevation

LEGEND
- Business / Admin
- Retail / Dining
- Transit
- Single Family Residential
- Townhomes
- Single Apartments
- Open Space
- Neighborhood Agriculture
- Civic / Institutional
Planning Considerations

Pedestrian Streets + Perceived Openness

Tactile Natural Elements

Open Gathering Space

Vegetation

Transit Access

Cultural + Civic Identity
Pedestrian Streets + Perceived Openness
Tactile Natural Elements
Open Gathering Space
Transit Access
Cultural + Civic Identity
Vegetation
Consider Perception
Consider Perception
Consider Perception
Consider Perception

There may not be sunlight or stone, but why can’t it seem like there is?
Consider Perception

The following slides are exaggerations, but consider how each one makes you feel, how it could affect your mood...
Spatial Evocation
Spatial Evocation
Spatial Evocation
Spatial Evocation

Project Icarus: Son of Daedalus
Spatial Evocation

Project Icarus: Son of Daedalus

“Flying Closer to Another Star”
Spatial Evocation
Spatial Evocation
Spatial Evocation

Project Icarus: Son of Daedalus

"Flying Closer to Another Star"
Moving Forward

Challenges to consider:

- What is the right population
- Weight penalty - structural design
- How long is too long, How far is too far
- Is there a currency
- Social structure (democracy, oligarchy, commander?)
- Knowledge transfer
- Roles / Occupations
- Supplies / Sustainability / Material durability
- Disembarkation at arrival
- Population control
- Disaster preparedness
- Primary stakeholders
Please contact me with any questions or comments: ssummerford@icarusinterstellar.org