Expendable vehicles are for one way pioneers/explorers.

None ever returned, most were building materials for structures at the destination.
Sustained use, maintained, & scheduled vehicles enabled business incubation & growth
“I have an IDEA”

We tried something like that before!

Let’s play the devil’s advocate.

I like it myself, but……

A word of caution…

A little radical….

Its just not us!

I wish it were that easy.

“Oh! It was just an idea.”

It Was Just an Idea !!!
Wilbur!! This thing is going to cost us our profit margin this year, and think of our liabilities. Let’s give it up & make bicycles.

Orville’s right! How will I ever make my fortune if I’m the only passenger.

In Today’s Environment, the Wright’s first, last and only flight.
Test Conditions Equal to SCRAMJET Combustor Pressure, Temperature and Velocity for Mach 8 Cruise Flight

Color Schlieren

IR Photograph in H₂O bands

Circa 1961

See ASD-TDR-63-236 and 63-131
MDC McAir 1960’s

McDonnell Aircraft
Advanced Design Dept.
1958 to 1967
Mr. H.D. Altis, Director
Hypersonic Gliders, AFFDL
VTOHL, Rocket Boosted, circa 1960

FDL-5
FDL-6
FDL-7

FDL-7MC
FDL-8
X-24B
X-24C
Evolution of a Hypersonic Glider Based on AFFDL FDL-7C

MDAC  R. Masek

MDC  P. Tanabe

HyperTech Concepts  KLIN

MDAC  R. Krieger
Spectrum of Operation
McDonnell Douglas Astronautics
MDC Physics Lab Arc Heater
0.5 inch radius nose, for 4300 seconds
Tyranno Cloth Metal Matrix Composites

Ube Corp. Tokyo, Japan, 1988
“The scientists from Franklin to Morse were clear thinkers and did not produce erroneous theories. The scientists of today think deeply instead of clearly. One must be sane to think clearly, but one can even think deeply and be quite insane.”

“Today’s scientists have substituted mathematics for experiments and they wander off through equation after equation and eventually build a structure that has not relation to reality.”
Earth-to-Orbit SYSTEM Challenges in the 21st Century

NASA Institute for Advanced Concepts
Georgia Center for Advanced Telecommunications Technology
Atlanta, Georgia
November 7-8, 2000

Professor Paul A. Czysz
Parks College of Engineering & Aviation
Saint Louis University
St. Louis, Missouri
Expendable vehicles are for one way pioneers/explorers

None ever returned, most were building materials for structures at the destination
Sustained use, maintained, & scheduled vehicles enabled business incubation & growth
Wilbur!! This thing is going to cost us our profit margin this year, and think of our liabilities. Let’s give it up & make bicycles.

Orville’s right! How will I ever make my fortune if I’m the only passenger

In Today’s Environment, the Wright’s first, last and only flight
Avoid Ápriori Launch Assumptions

payload = 7 tons

\( \tau = 0.063 \)

\( \tau = 0.200 \)

WING LOADING (kg/m\(^2\))

TRANSITION MACH NUMBER

Gross Weight (tons)

WR Weight Ratio to Orbital Speed

3.0 4.0 5.0 6.0 7.0
OEW = 3.912 ¥ WR + 20.94
The Less Carried LOX the Less the WR

Weight Ratio to Orbital Speed

On-Board (Carried) Oxygen to Fuel Ratio (CO/F)
GET THE LOX OUT!

- Reduce or Eliminate the carried Oxygen
- Enable Global airport operations
- Increase the relative speed fraction of airbreathing propulsion
- Let requirements set configuration and launch attitude not bureaucracy
- **DO NOT ASSUME A COMBINATION OF ENGINES IS A COMBINED CYCLE ENGINE**
- Avoid believing the status quo is best
Launch Costs, Hydrogen

10 or Less Fleet Flights per Year

From Lindley and Penn
Launch Costs, Hydrogen

100 or Less Fleet Flights per Year

From Lindley and Penn
Launch Costs, Hydrogen
1,000 or Less Fleet Flights per Year

From Lindley and Penn
New Propulsion System

ATREX running on test stand at Kakuda, Japan
MagnetoHydroDynamic Propulsion & Directed Energy

Vladimir Freistadt, St. Petersburg, Russia, circa 1993

AYAKS
Takeoff and landing
Exploration of Our Galactic Neighborhood

NASA Institute for Advanced Concepts
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Parks College of Engineering & Aviation
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St. Louis, Missouri
Exploring the:

- Near Earth Potentials
- Lunar base Potentials
- Terrestrial Planets
- Jovian Planets
- Heliosphere
- Nearest stars, Alpha Proxima
  Proxima Centauri
- Nearest Galaxy-like object, Magellanic cloud
- Nearest Galaxy. Andromeda
Terrestrial Planets

- Jupiter
- Asteroids
- Mars
- Earth
- Venus
- Mercury
- Sun
- 1 AU
- 5.20 AU
Jovian Planets

5.20 AU

Kuiper Belt

Pluto

39.4 AU

Uranus

Neptune

50 AU

12 light-hours

13.46 light-hours

Jovian Planets

100 AU

heliopause

Heliosphere
Near Galactic Space

- 100 AU
  - 1 light-month
- 63,136 AU
  - 1 light year
- 149,318 AU
  - 2.365 light years

Alpha Proxima

Oort Cloud
Transit time at escape $\Delta V$

Accelerate to 10.97 km/sec, coast, then decelerate to initial speed

<table>
<thead>
<tr>
<th>Planet</th>
<th>min./max. time</th>
<th>one-way communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>99 / 185 days</td>
<td>6 - 11 minutes</td>
</tr>
<tr>
<td>Venus</td>
<td>40 / 244 days</td>
<td>2 - 15 min.</td>
</tr>
<tr>
<td>Mars</td>
<td>75 / 360 days</td>
<td>5 - 21 min.</td>
</tr>
<tr>
<td>Asteroids</td>
<td>240 / 525 days</td>
<td>14 - 31 min.</td>
</tr>
<tr>
<td>Jupiter</td>
<td>1.6 / 2.4 years</td>
<td>35 - 52 min.</td>
</tr>
<tr>
<td>Saturn</td>
<td>3.3 / 4.1 years</td>
<td>1.2 - 1.5 hours</td>
</tr>
<tr>
<td>Uranus</td>
<td>7.1 / 7.9 years</td>
<td>2.5 - 2.8 hr.</td>
</tr>
<tr>
<td>Neptune</td>
<td>11.3 / 12.1 years</td>
<td>4.0 - 4.3 hr.</td>
</tr>
<tr>
<td>Kuiper Belt</td>
<td>11.0 / 19.4 years</td>
<td>4.0 - 7.1 hr.</td>
</tr>
<tr>
<td>Pluto</td>
<td>14.9 / 15.7 years</td>
<td>5.3 - 5.6 hr.</td>
</tr>
<tr>
<td>Heliopause</td>
<td>38.1 years</td>
<td>13.46 hr.</td>
</tr>
</tbody>
</table>
for 20 year round trip

Mass ratio for each acceleration = 8.0

<table>
<thead>
<tr>
<th></th>
<th>ΔV (km/sec)</th>
<th>Isp (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uranus</td>
<td>9.07 – 10.07</td>
<td>402 - 446</td>
</tr>
<tr>
<td>Neptune</td>
<td>14.50 – 15.49</td>
<td>642 - 686</td>
</tr>
<tr>
<td>Kuiper Belt</td>
<td>14.97 – 24.95</td>
<td>663 - 1,105</td>
</tr>
<tr>
<td>Pluto</td>
<td>19.17 – 20.16</td>
<td>848 - 893</td>
</tr>
<tr>
<td>Heliopause</td>
<td>49.9</td>
<td>2,209</td>
</tr>
<tr>
<td>Oort Cloud</td>
<td>500.</td>
<td>22,105</td>
</tr>
<tr>
<td>1 light-year</td>
<td>31,500.</td>
<td>1,396,000</td>
</tr>
</tbody>
</table>
Time to one light-year

Time to One Light Year

Accelerate to light speed, coast, then decelerate to initial speed

Light-year = 9.4608 x 10^{12} \text{ km}
Galactic Space

Earth's Solar System

20,000 light-years

32,000 light-years

1000 light-years

100,000 light-years
Exploring:

- Near Earth, 150 to 1800 km
- Lunar base, 400,000 km
- Terrestrial Planets, 0.5 AU to 2.5 AU
- Jovian Planets, 4 AU to 40 AU
- The Heliopause, 100 AU
- Stars, Alpha Proxima, 2.36 light-years, Proxima Centauri, 4.3 light-years
- Magellanic clouds, 200,000 light-years
- Andromeda, 2,000,000 light-years
Spaceways Entering the 21st century

Chart by Bill Gaubatz
4. ДОСТАВКА МНОГОЦЕЛЕВОГО КОСМИЧЕСКОГО АППАРАТА
ИЛИ ДОЛГОВРЕМЕННОЙ ОРБИТАЛЬНОЙ СТАНЦИИ
НА ОРБИТУ ИСКУСССЕННОГО СПУТНИКА ЛУНЫ.

Средства доставки: УРКТС "Энергия" + КРБ.
Масса КА: 21,5 + 23 т.
Время полёта: 5 суток.

Этапы полёта:
① Старт УРКТС "Энергия".
② Довыведение на круговую орбиту ИСЗ с помощью КРБ.
③ Ракета к Луне с помощью КРБ.
④ Перелёт Земля - Луна.
⑤ Переход на орбиту ИСЗ с помощью КРБ.

Chart by Vladimir Gubonov
Growth of the Spaceways Routes

Chart by Bill Gaubatz
5. ДОСТАВКА МОДУЛЕЙ ПОСТОЯННО-ДЕЙСТВУЮЩЕЙ ЛУННОЙ БАЗЫ.

Средства доставки: УРКС "Энергия" + КРБ + БТК

Масса модулей: 9 × 10 т

Время полёта: 5 + 7 суток

Этапы полёта

1. Старт УРКС "Энергия".
2. Дознавание на круговую орбиту ИСЗ о помощи КРБ.
3. Разгон к Луне о помощи КРБ.
4. Перелёт Земля - Луна.
5. Переход на орбиту ИСЛ о помощи КРБ.
6. Торможение и спуск на Луну о помощи БТК.
In-Space Operations

NASA Institute for Advanced Concepts
Georgia Center for Advanced Telecommunications Technology
Atlanta, Georgia
November 7-8, 2000

Professor Paul A. Czysz
Parks College of Engineering & Aviation
Saint Louis University
St. Louis, Missouri
Where we almost are 2000

Spaceways Entering the 21st century

By Bill Gaubatz
Where we need to be

By Bill Gaubatz
InSpace Operations Corporation

An original concept by the late Fred “Bud” Redding

Space Cruiser

An Earth orbit switch engine
InSpace Operations Corporation

SINGLE-SEAT

TANDEM

LIFECRAFT

WORKSHOP

AFT VIEW (Elliptical) VELCRO DOCKING/UNDOCKING

From briefing by the late “Bud” Redding
InSpace Operations Corporation

From briefing by the late “Bud” Redding
Commercial Services in Orbit

Global Outpost Platform incorporating Space Cruisers

Tom Taylor
Global Outpost
InSpace Operations Corporation

From briefing by the late “Bud” Redding
Spaceways Servicing the Space Frontier
Global Outpost Platforms incorporating ElectroDynamic Tethers and Space Cruisers

Electrodynamc Tether for Orbital Markup & High Speed Tether - Vehicle Momentum Exchange on Both Ends, Length Varies.

Tom Taylor
Global Outpost
As Tom Stafford Said, “Back to the Moon”

From a briefing by V. Gubonov
Emerging Commercial Space Frontier Around Earth and Moon

Tom Taylor
Global Outpost
From a briefing by V. Gubonov
We Have a Long Road Ahead to Achieve Sustained Self-Sufficiency

- Habitats for Factories and Services
- Power Generation for Orbital Systems
- Power Generation for Earth
- Fueling Stations
- Repair Bases
- Orbital Switch Engine to Move Material
- Orbital Transfer System