Shuttle-Derived Vehicles:

A Brief History – A Long Future?

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25 October 2003

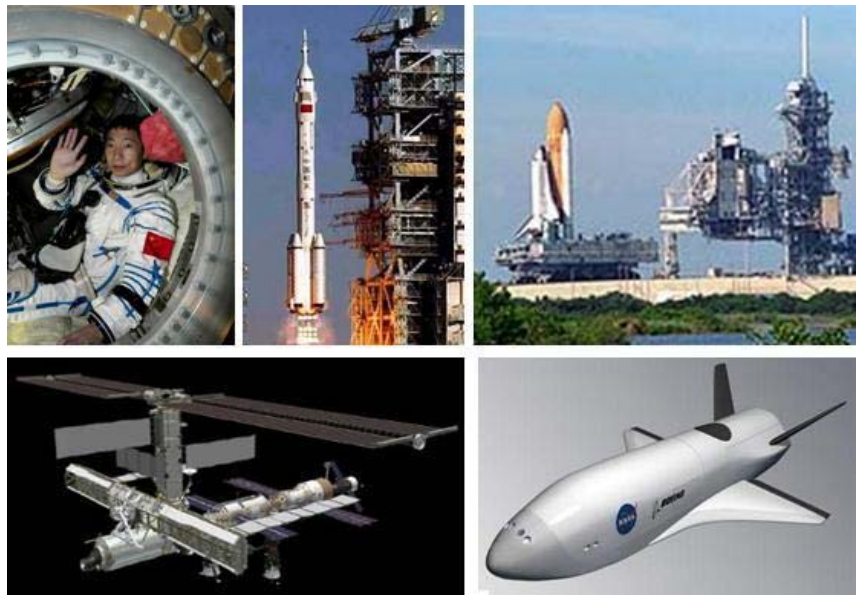
A presentation to the New York City chapter of the National Space Society

Edited 2 Nov 2003

A New Beginning?

Change Factors:

- China in Space
- Columbia Tragedy
- Shuttle Orbiter being phased out
- Space Station operational
- Orbital Space Plane



Basic change in space philosophy since 1981.

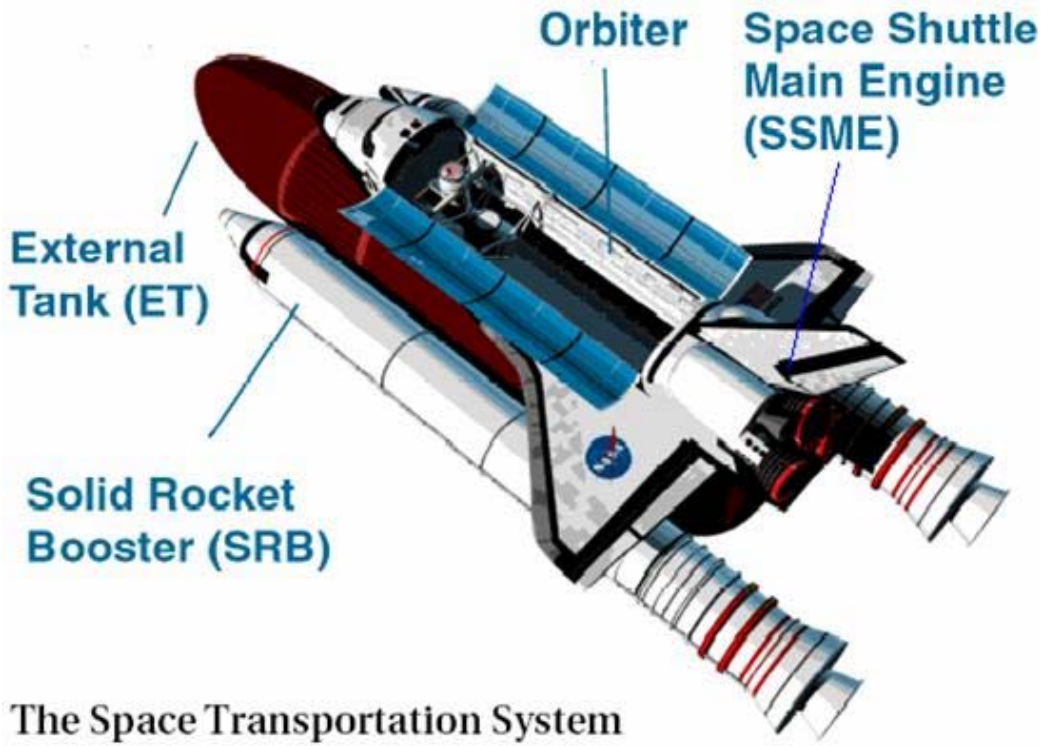
Now have "destination" in LEO, Orbiter phasing out, new competition.

What is an SDV?

- New vehicle using major components of NASA's Space Transportation System (STS).
- Modified and/or replaced:
  - Orbiter
  - Solid Rocket Boosters
  - External Tank
  - Engines (SSMEs)
- May be Piloted or Unpiloted

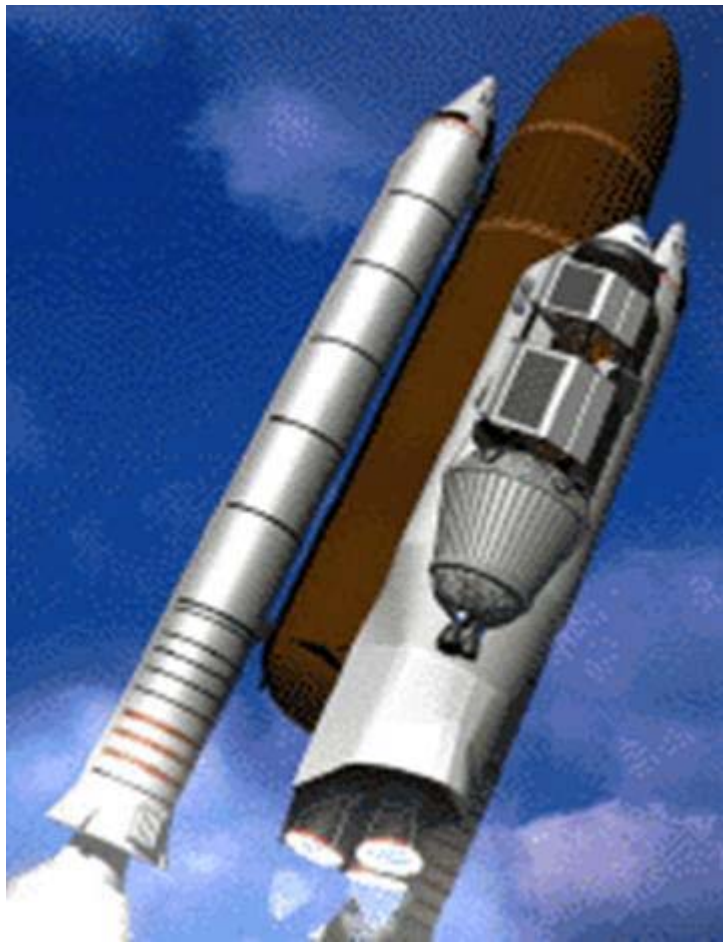
STS Components

- Orbiter
  - Crew, cargo, engines
  - 1.5 Mlbf thrust
- Solid Rockets
  - Main liftoff thrust (5.2 Mlbf)
  - “Pillars” on launch pad
- External Tank
  - 2 tanks: LOX, LH2
  - STS structural backbone
  - Brought almost to orbit, discarded



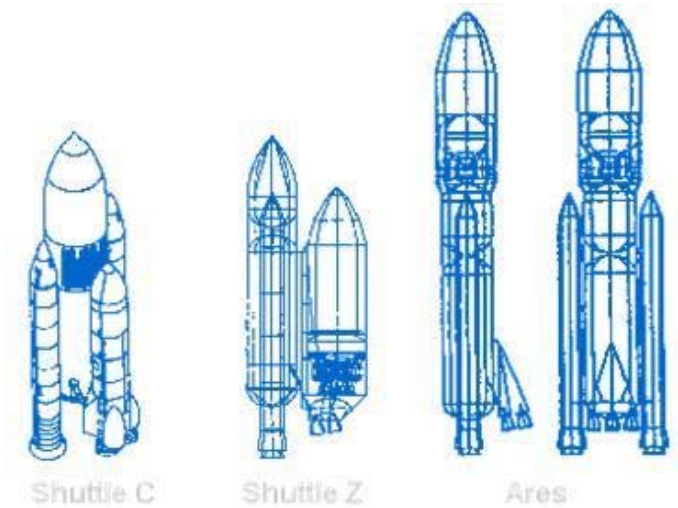
Why an SDV?

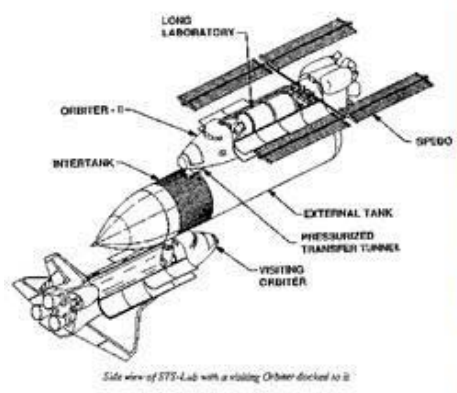
- New missions
  - Cargo to LEO and beyond
  - New piloted-vehicle launch platform
  - Large planetary missions
- Cargo versions: 2x-3x Orbiter Payload
  - About 80 to 150 klb to LEO
  - Shuttle Orbiter: 50 to 65 klb
- Reduced development costs
- Use of STS infrastructure
  - Launch facilities
  - Ground support and processing
  - Design and production heritage



Some SDV Approaches

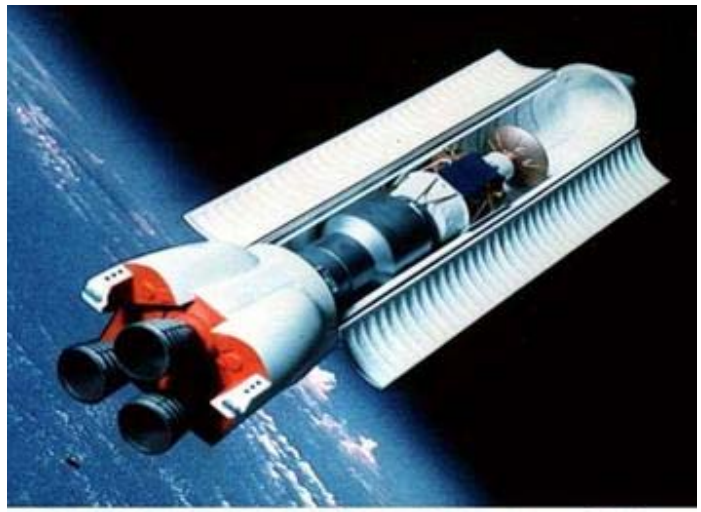
- **Shuttle-C, Shuttle-Z, Shuttle-B (new)**
  - Replace Orbiter with cargo module, upper stage, etc.
- **Inline HLLVs (e.g. Ares)**
  - Adapt engines, tankage, solids for new launch vehicle
- **New Booster Rockets**
  - Liquid, Flyback, Hybrid
- **Wingless Orbiter**
  - ET reaches orbit with non-returning piloted vehicle
- **SRB-X**
  - All-solid launcher using Shuttle Solid Rocket Boosters





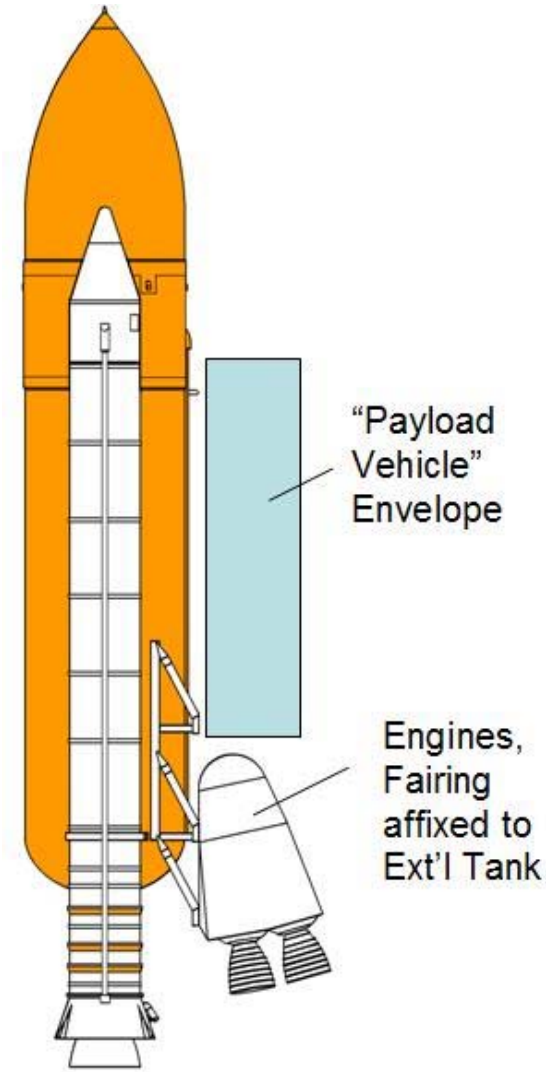
Shuttle-C

- Cargo canister replaces Orbiter
  - 2-3 SSMEs in Orbiter "boat-tail"
  - Engines, canister destroyed on re-entry
- 100 – 150 klb to LEO
- Closest SDV to reality
  - NASA-funded 1987-91
  - Killed by other Space Station Freedom needs



New Concept: Shuttle-B

- Use new expendable engines
  - Boeing RS-68, now used on Delta-IV
  - Northrop Grumman TR-106, ground tested
- Engines fixed to, discarded with ET
- Launcher-independent “payload vehicles”
  - Attached to ET above engines
    - Cargo Carrier
    - Orbital Space Plane
    - Payloads / Upper Stages
- Configuration shown is “schematic”
  - Early baseline drawing by Greg Zsidisin

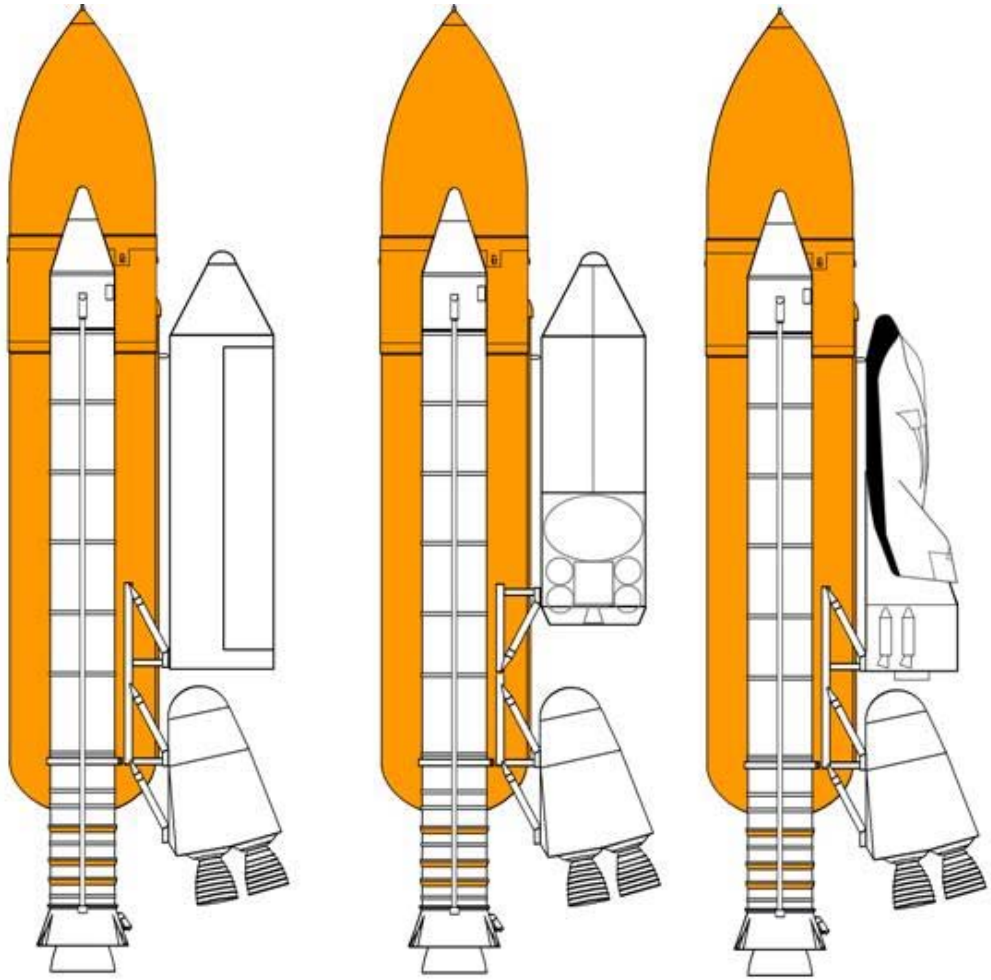


Shuttle-B Configurations

- Cargo
- Upper Stage
- Orbital Space Plane

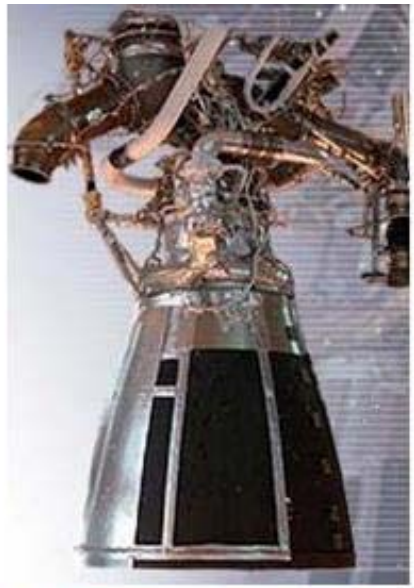
NOTE:

Configurations, payloads shown are speculative.



Shuttle-B Expendable Engines

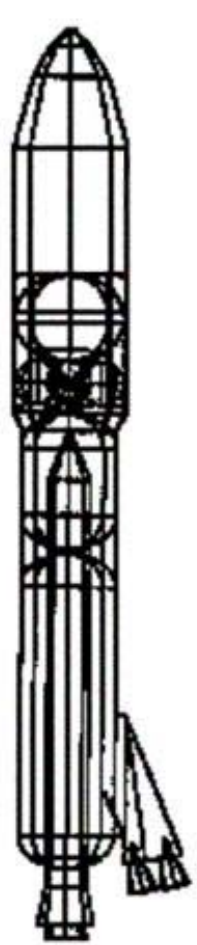
- **Boeing RS-68**
  - 750 klbf thrust (vs 500 klbf SSME)
  - Two RS-68s at 100% rated thrust match three SSMEs at 109% rated thrust
  - Some payload penalty: Isp 410 sec (vs 452 sec for SSME)
  - Reduced parts count, not man-rated.
  - Now flying, on Delta-IV Evolved Expendable Launch Vehicle (EELV).

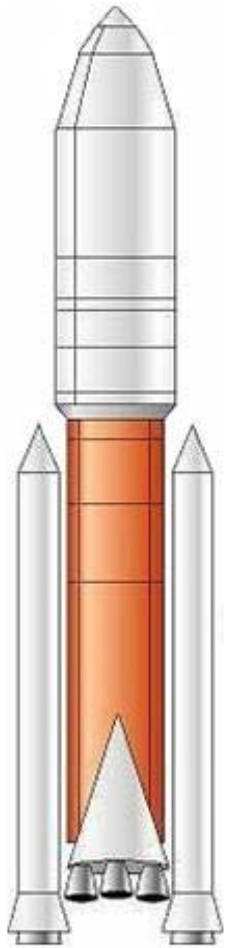


- **Northrop Grumman (TRW) TR-106**
  - Pintle-injection (similar to LEM descent engine)
  - 650 klbf thrust
  - Northrop Grumman claims one-half to one-fourth cost of RS-68 due to simplicity.
  - Limited test-firings in 2000; would require development, man-rating

Ares Launcher

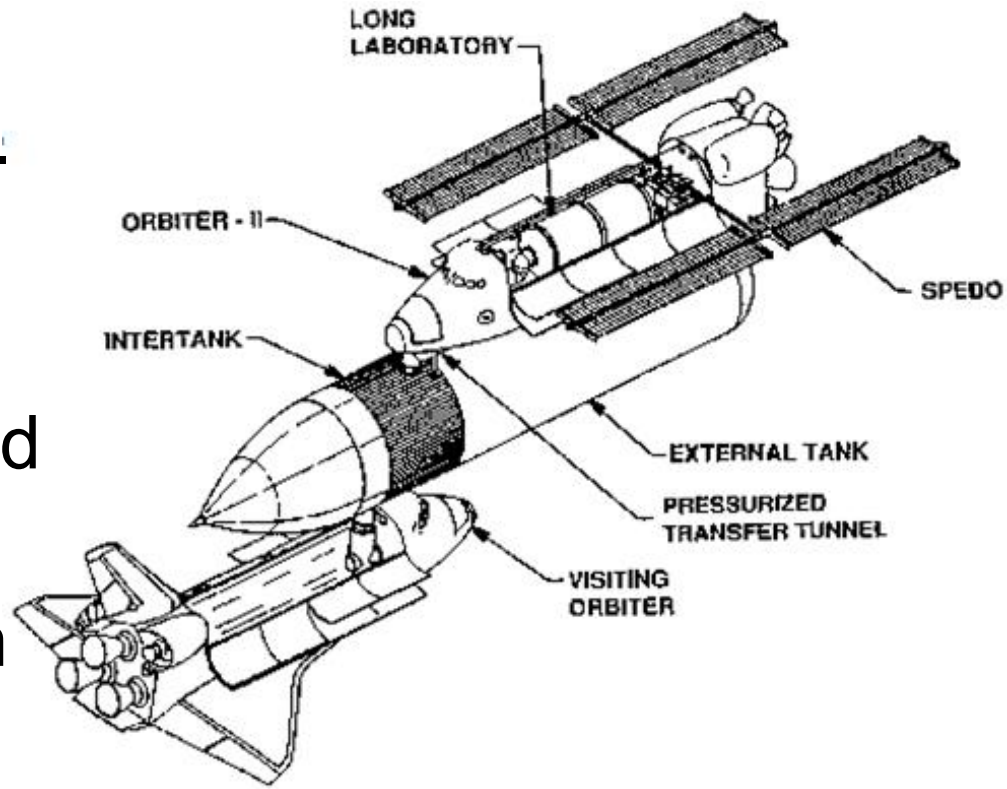
- Direct ascent for “Mars Direct”
  - Robert Zubrin, David Baker, Owen Gwynne
  - Circa 1991, Lockheed Martin
- Semi-Inline Concept
  - Use ET, SRBs
  - Side-mounted engines
  - Top-mounted cryogenic upper stage and payload
- Payload: 104,000 lb to Mars
  - Earth Return Vehicle
  - Habitation Module & Crew





Wingless Orbiter

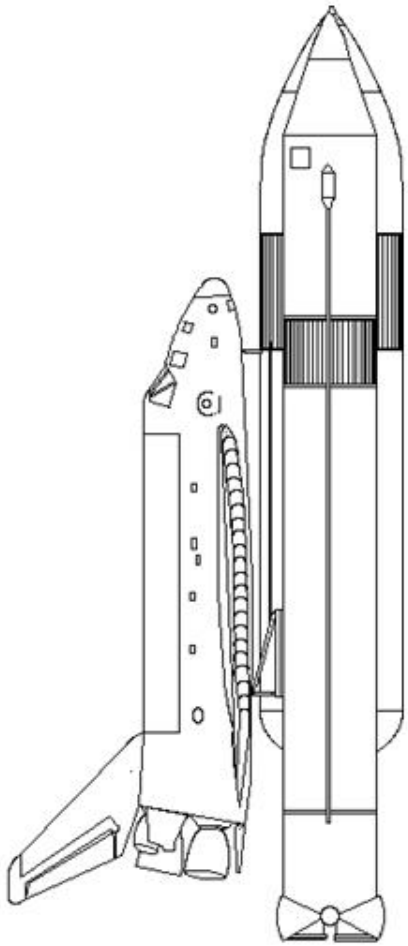
- General Dynamics, External Tanks Corp.
- Orbiter w/o wings lofted (no return)
- Connected to emptied Ext'l Tank
- Large-volume station with Orbiter crew cabin, payload bay



Side view of STS-Lab with a visiting Orbiter docked to it.

Liquid Rocket Boosters

- Advantages
  - Throttleable
  - Handling
- Issues
  - Complexity
  - Thrust
  - Cost
  - Reusability

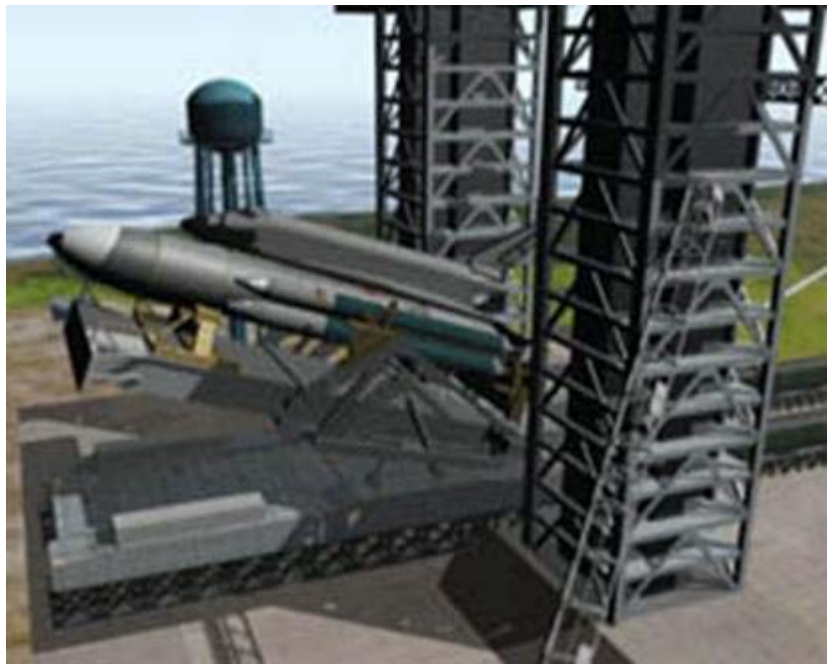


Flyback Booster Concept

- Replace SRBs with liquid boosters that fly back to launch site.
- Jet engines for powered landing. Unpiloted.
- Flyback boost part of many early STS designs.
- Probably dead issue for STS following Columbia, Orbiter phase-out.
- May be an element in future SDV concepts.

Space Island Group

- Adapt STS and Buran concepts for private venture
  - Launch systems
  - Space structures from tankages
- Fast, loose with realities



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