

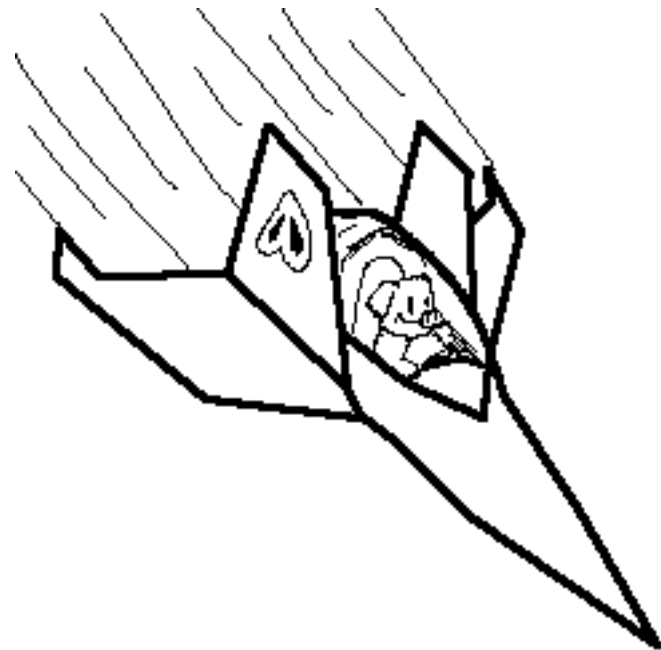
Long Voyages in Space

by Deuce =^.=.

(art by Verace Xenirvana - VeraceX@gmail.com)

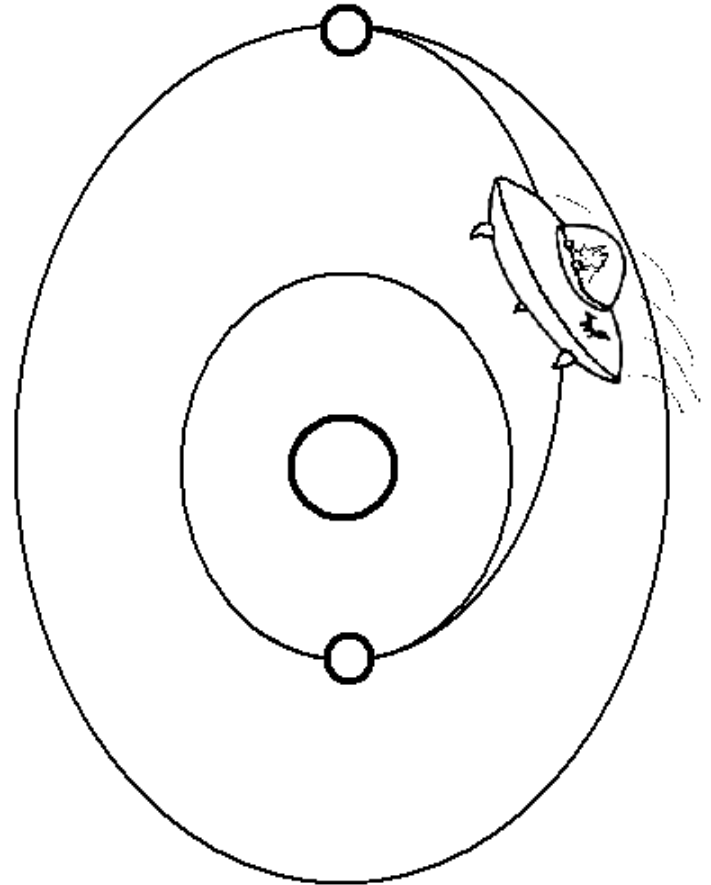
Getting There is Half the Fun

- Going places in space takes a long time (years).
- Space is a hostile environment.
- Plan ahead!
 - Route plan, propulsion.
 - Shielding, environment systems.
 - Supplies, recycling.
 - Need a destination!



Plotting a Course

- Limited fuel, limited supplies.
- Hohmann transfer orbit
 - Low fuel cost; have to schedule.
- Direct transfer
 - High fuel cost, shorter trip, no scheduling.
- Slingshots, etc.
 - Very low fuel costs, very long trip, harder to schedule.

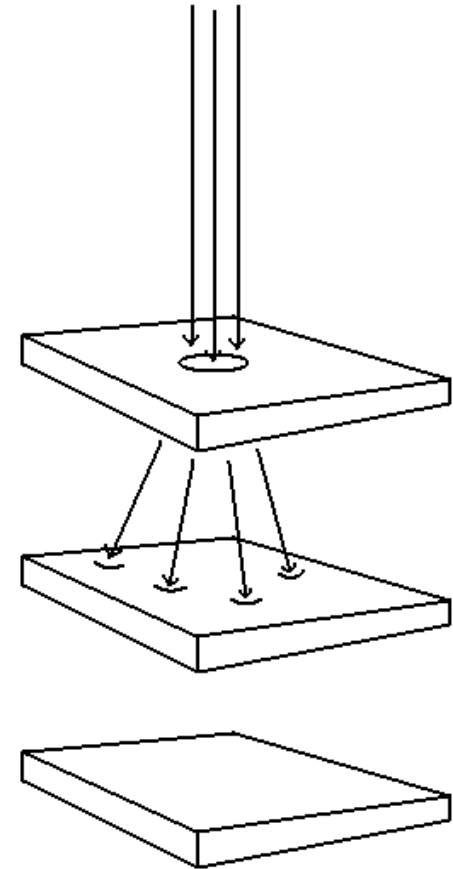


Space Hazards

- Space Radiation
 - Cosmic rays will kill you!
 - Half from sun, half from everywhere else.
 - Magnetic storms also cause radiation.
- Solve with dead weight.
 - Stopping power is directly related to weight.
 - Light elements are better than heavy elements.
 - Can use structure, water supply, fuel supply as shielding.

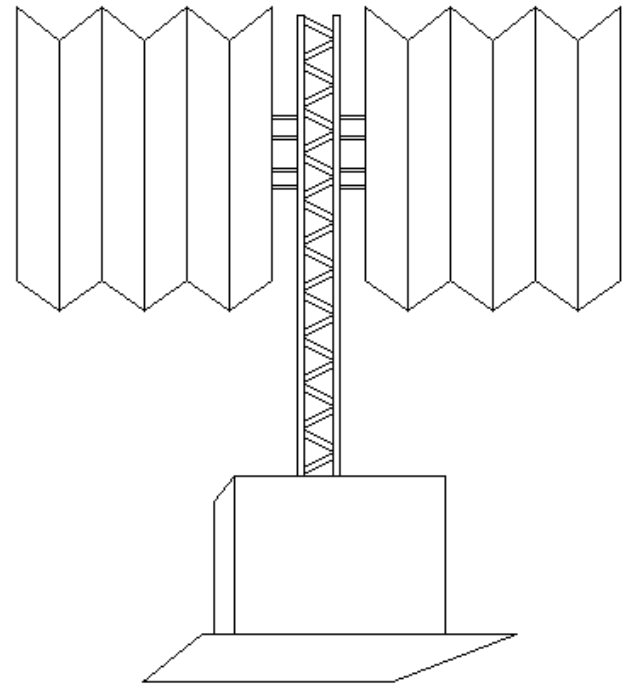
Space Hazards

- Space Debris
 - Mostly the size of sand/grit.
 - Artificial debris near Earth.
 - Natural debris near planets, in Lagrange points, and near rings.
- Solve with specialized armor.
 - Whipple shield: first layer breaks up the debris, inner layers stop it.



Environment - Temperature

- Space is a great insulator!
- Too much heat: cook.
 - From the sun, or from the ship.
 - Reduce sun with reflectors.
 - Dump excess with radiators.
- Too little heat: freeze.
 - Some systems, or maybe everything, needs heating.

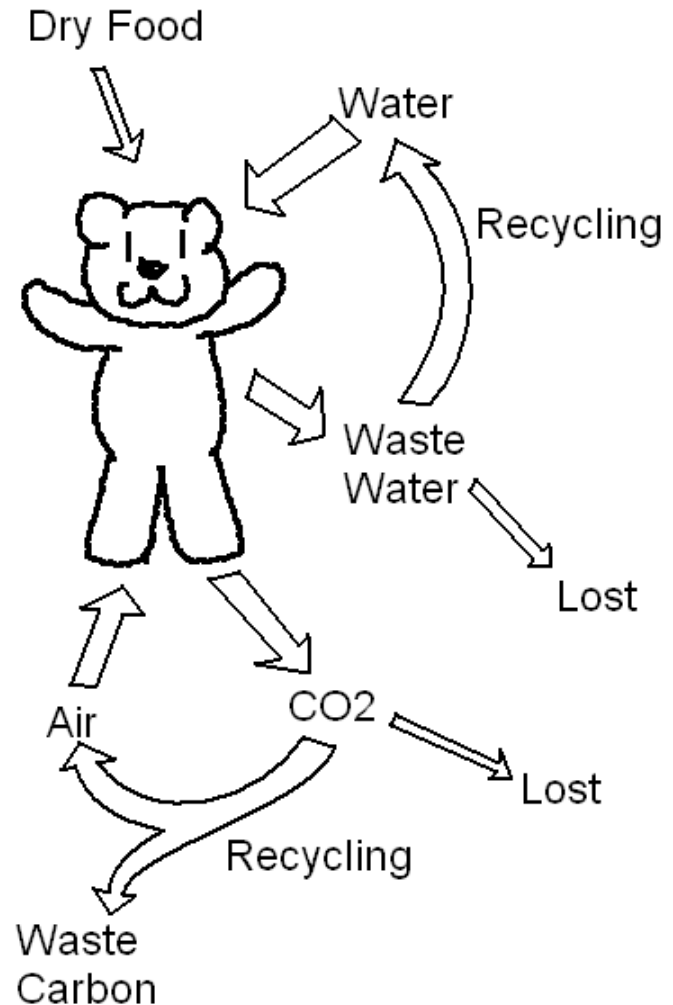


Environment – Zero Gravity

- People need gravity to stay healthy.
 - Atrophy, bone loss.
 - Child development.
 - Going somewhere with gravity!
- Machines work best in gravity.
 - Liquids draining, dust settling.
- Solution: Centrifugal Force.
 - Spin some or all of the ship to imitate gravity.

Environment – Air and Water

- Air: Add O₂, scrub CO₂.
 - Short-term: “Oxygen Candle”.
 - Long term: Bosch or Sabatier recyclers.
- Water: Control humidity, reclaim waste.
 - Reclaim from air with dehumidifier.
 - Reclaim from waste by distillation.
- Reclaiming isn't perfect!



Ten Years' Packed Lunches

- Food: Can't recycle mechanically.
- Partial Solution: Dehydrate.
 - Dried or dehydrated food reconstituted with water.
 - Water can be recycled!
- Limit to trip length is food, water, oxygen you can store!

We're There; Now What?

- Colonies need to last forever, not a few years.
 - Can exchange material with their environment.
- Space stations have it worse than ships!
 - More shielding.
 - More space and weight if grow food.
 - Need re-supply if don't.



Looking Forward

- Current ships and stations have frequent resupply.
- Mars trip won't!
- Technologies being explored now:
 - Water recycling (ISS)
 - Air recycling
 - Growing food
- Farther ahead: Colonies! Stay tuned.