

CDIO EMFF Test Bed Design Concept

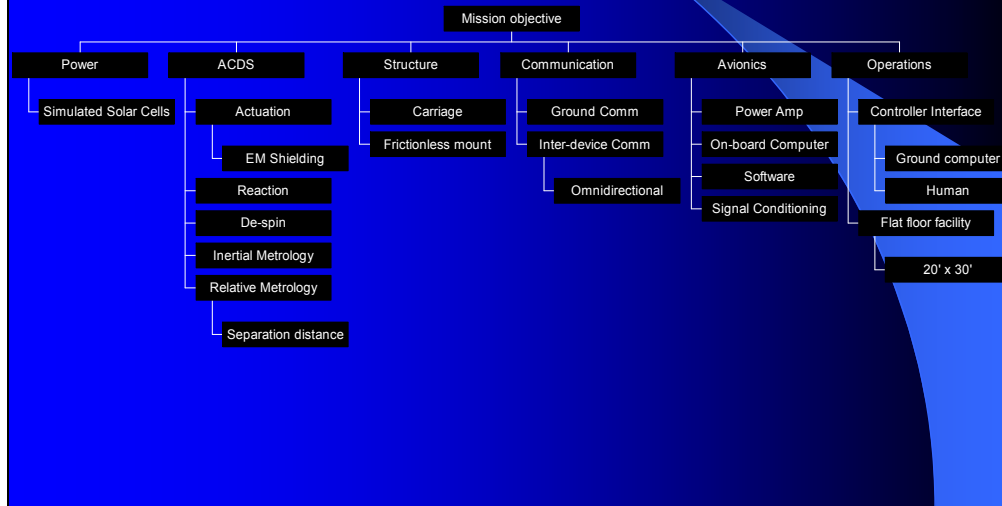
CDIO Space Systems Product Development
Databasing Team
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Mission Objective

- Demonstrate the feasibility of electromagnetic control for formation-flying satellites.
- 2-D Flat floor test bed → Simplifies problem while achieving objective
- 3 independent devices → Proves feasibility of planar control
- 3 DOF per device → Simplifies dynamics

Planar control vs. linear control... it takes 3 points to make a plane. Plus, if we can prove controllability for 3 devices, adding more should be... trivial...

Requirements Flowdown



Separation distance: O(10cm)-O(1m)

Design Trades

- Mass
- Cost (\$)
- Time
- Control accuracy
- Control precision
- Electrical power (current, voltage, resistivity)
- Feasibility
- B-field

Design Concept: Part I

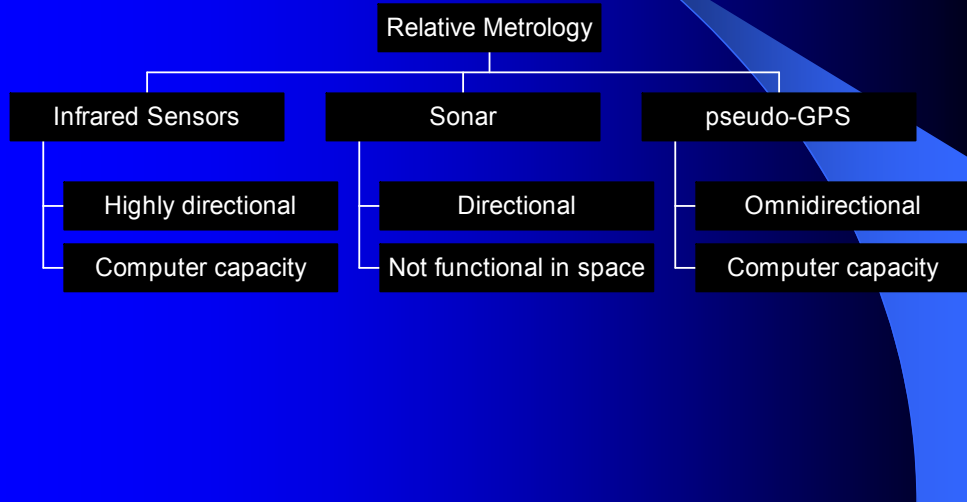
- External power source
 - ↑ Simplifies problem while achieving objective
 - ↓ Not configuration used in space
- Air bearing
 - ↑ Provides near-frictionless test environment
 - ↑ Effective representation of dynamics
 - ↓ Cost
 - ↓ Requires air supply
- Bumpers
 - ↑ Safety consideration
 - ↑ Low cost

Power: Also, can take more data at various power levels.

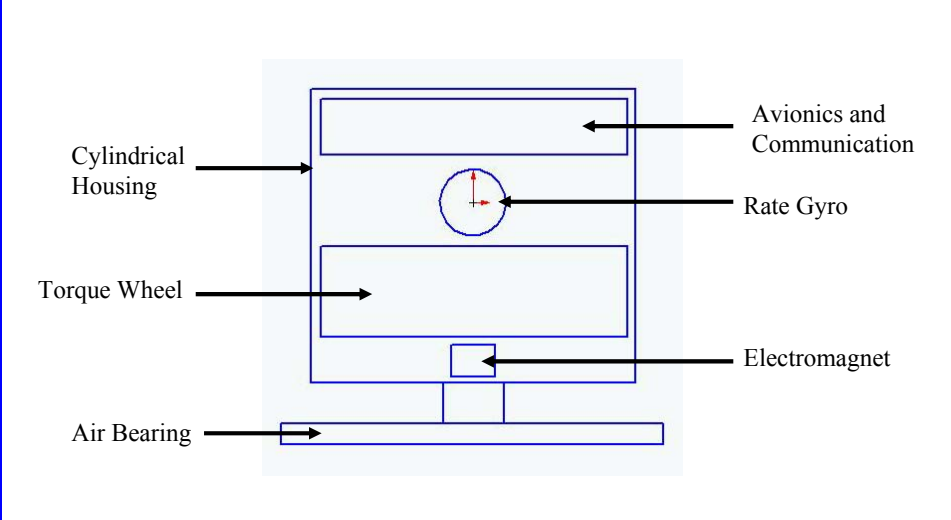
Design Concept: Part II

- One electromagnet, reaction wheel assembly per device
 - ↑ Permits full range of motion
 - ↑ Simplified dynamics
 - ↑ Less mass
 - ↓ Need more for control of more DOF
- All circuitry oriented to move with EM package (aligned with field)
 - ↑ Reduces magnetic interference with circuits
 - ↑ Reduces need for shielding
- Shielding using high-permeability materials
 - ↑ Prevents magnetic interference
 - ↓ Mass vs. cost tradeoff

Design Concept: Inter-device Positioning



Design Concept



Operations Concept

- Human interface via laptop computer
 - ↑ Familiar to users
 - ↑ Portable
 - ↑ Supports adequate software packages
 - ↓ Not used in actual space mission
- Ground/device communication via RF wireless modem
 - ↑ Applicable to actual operational situation
 - ↑ Fast
- Disturbance rejection autonomous; no input required
 - ↑ Simulates actual operational situation
 - ↓ More complicated avionics

Questions?