



# Space Assembly and Service via Self-Reconfiguration

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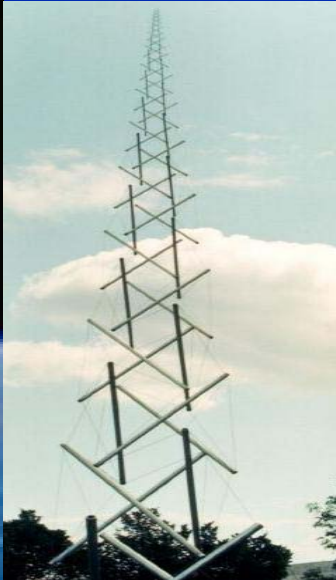
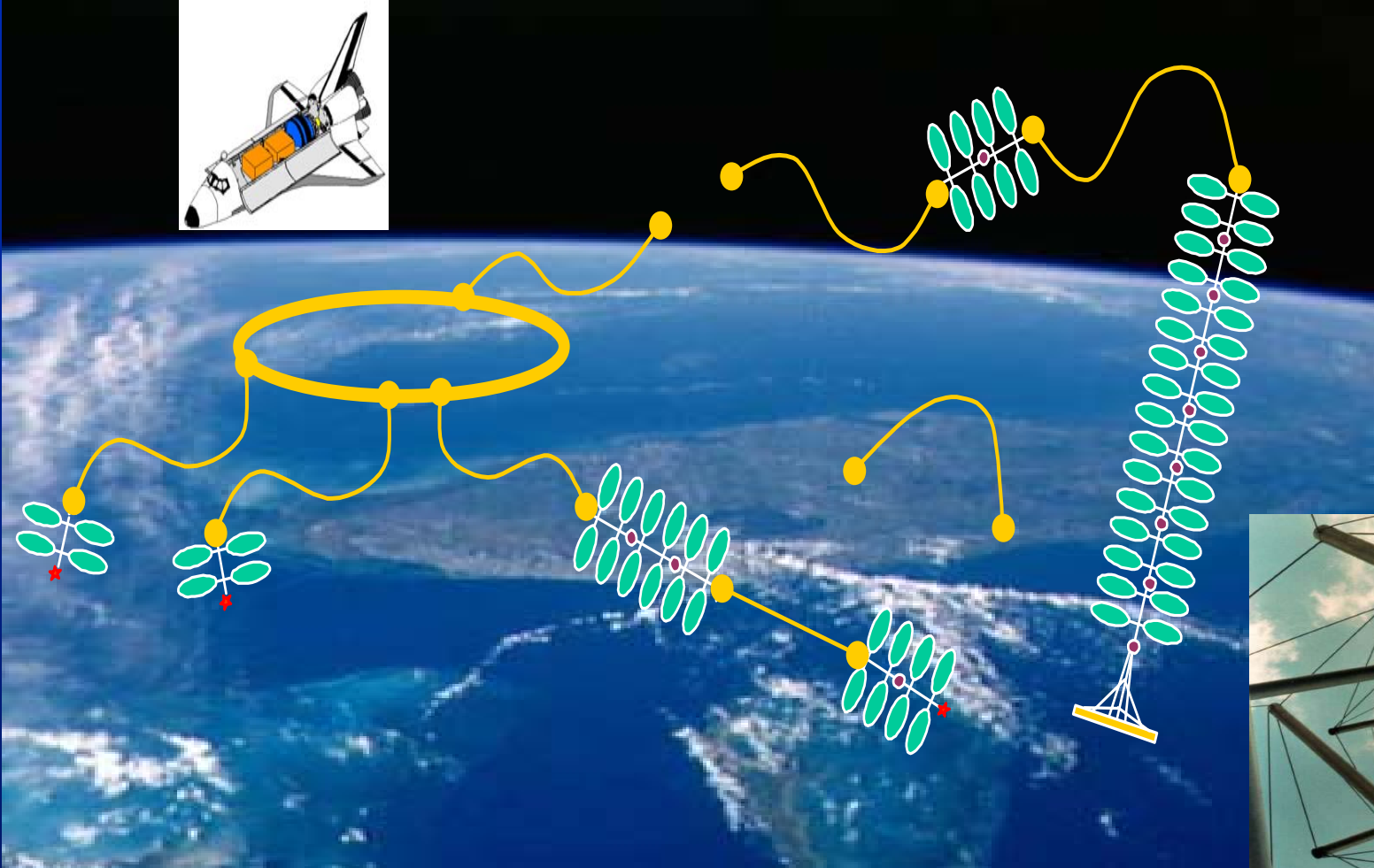
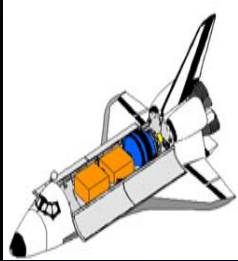


# Motivation for Self-Assembly

- Cost Effective
  - For a 10KM SSPS
    - >2,500 hours of astronaut space walk
      - 4/11/2002, girder assembly (2\*6 hours)
    - >\$3 billion for assembly cost
- Feasible Strategy
  - Most jobs by self-assembly
  - Critical jobs done by astronauts



# A Vision for Space Self-Assembly



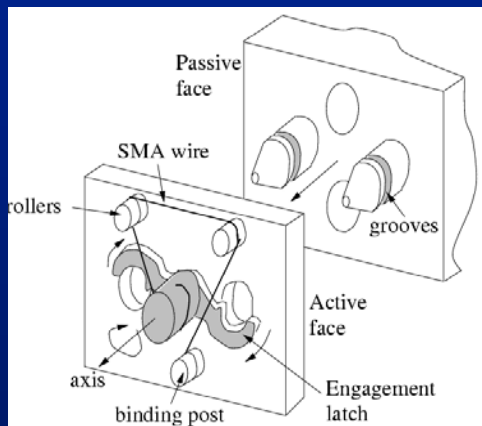
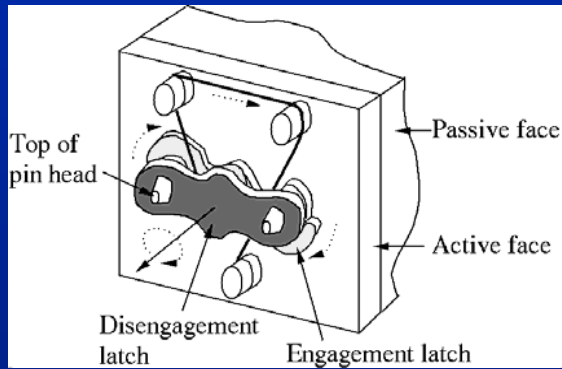
# Three Enabling Technologies

- Intelligent and Reconfigurable Component (IRC)
  - Can *free-float* and *dock* to form structures
- Free-flying Fiber Match-Maker Robots (FIMER)
  - Can *search*, *navigate*, *bring-together* and *dock* IRCs
- Distributed Process Controller (DPC)
  - Can *plan* self-assembly in a distributed manner and *recover* from unexpected situations

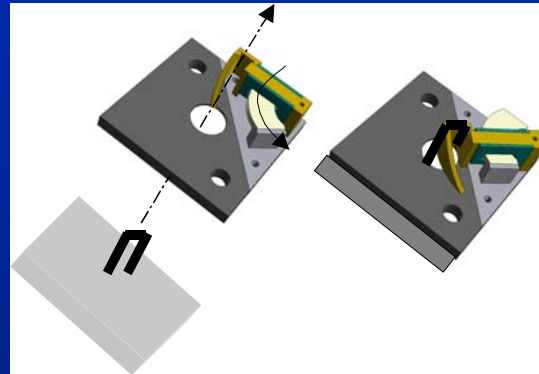


# Reconfigurable Connectors

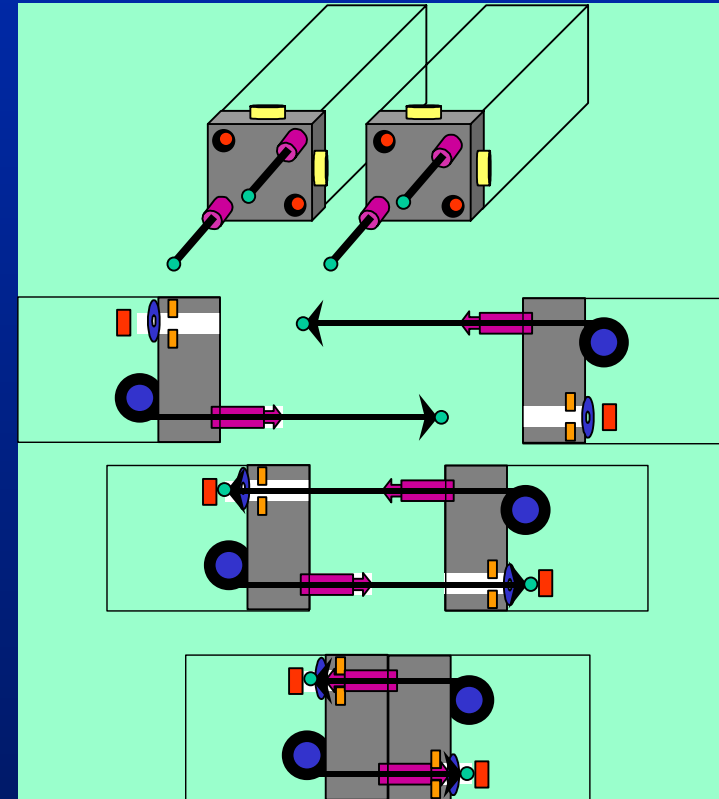
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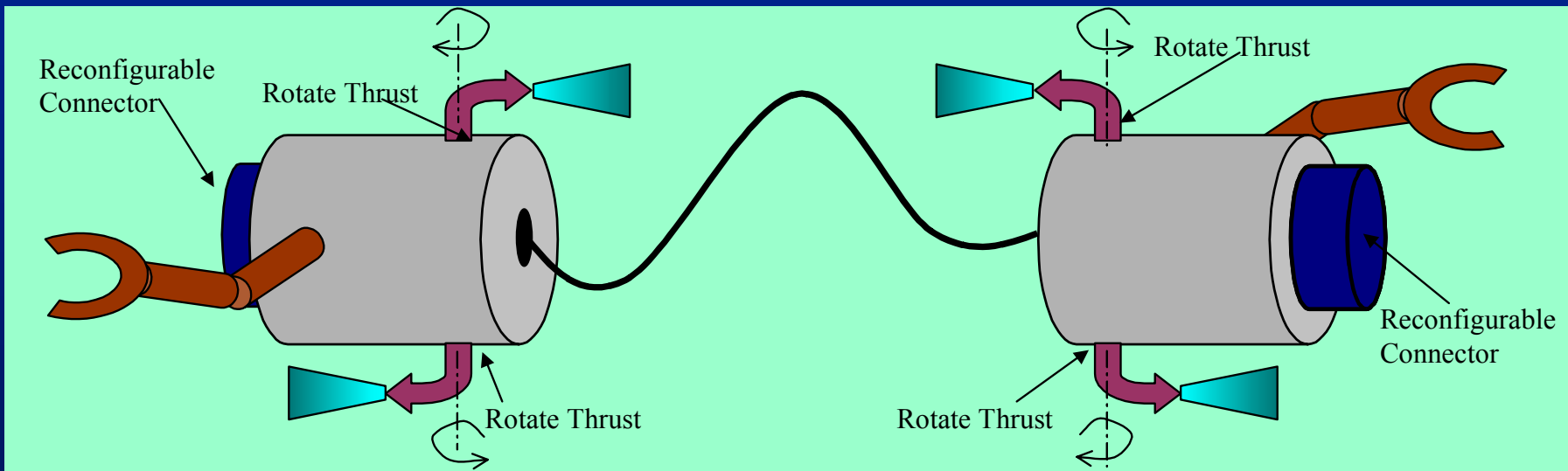
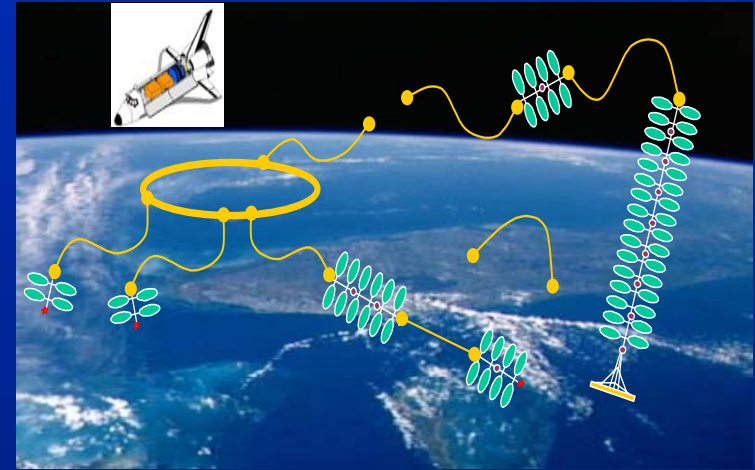


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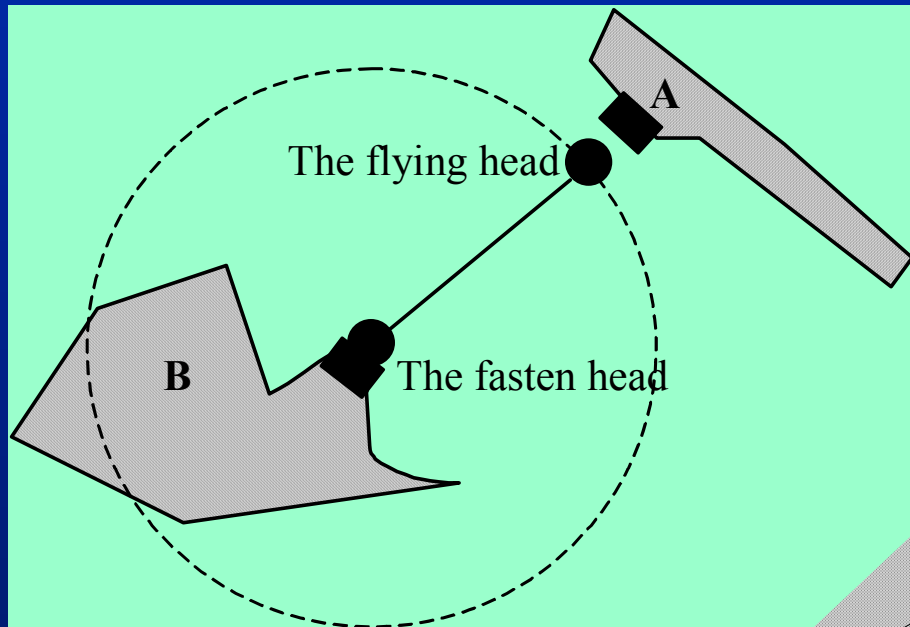
# FIMER Robots

- Two-headed fiber/rope
- Free-flying head (6DOF)
- Navigate and dock to the connectors
- Rail-in fiber to bring parts together
- Simple arms to assist dock
- Onboard power or refuel capability



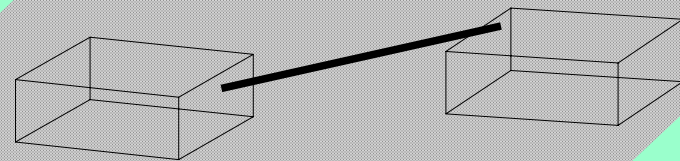
# FIMER Dynamics and Control

Find relevant connectors based on their location information  
Railing in the fiber only when there is no tension



## Research Issues:

- \* Dynamics of tethered objects in zero-gravity environment
- \* Speed control
- \* Collision control
- \* Prevent tangling

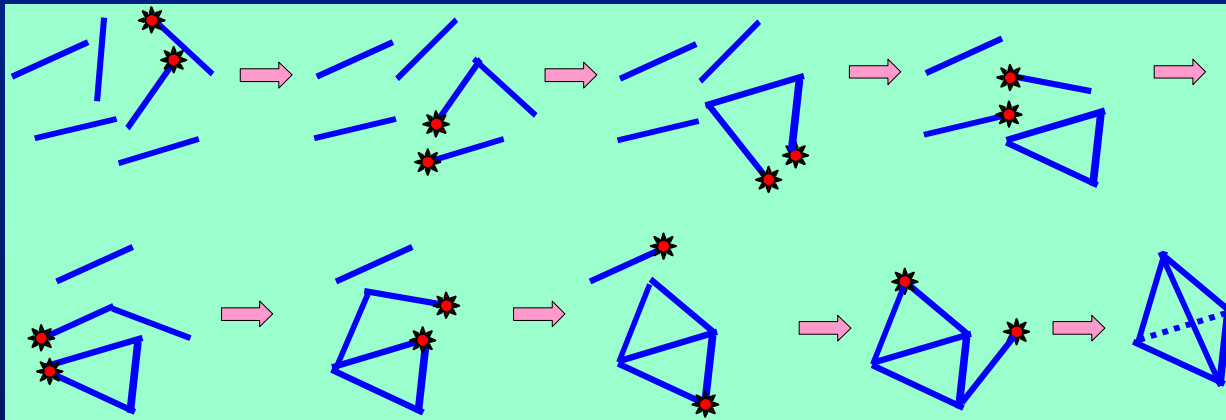


# The Global Process Control

- How do modules know *when* and *where* to connect?
- Advantages for distributed control
  - Coordination of autonomous modules without fixed brain
  - Support dynamic configuration topology
  - Asynchronous: communication without global clocks
  - Scalable: support growing structures
  - Fault-tolerance
  - Self-repairing capability
  - Self-replanning for unexpected events

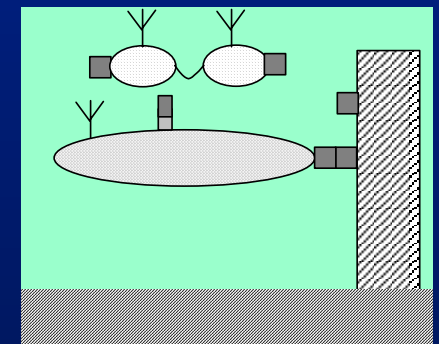
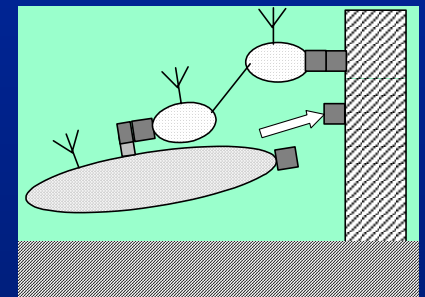
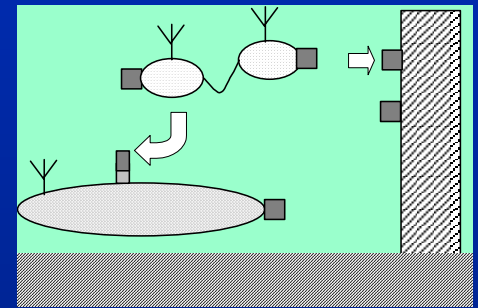
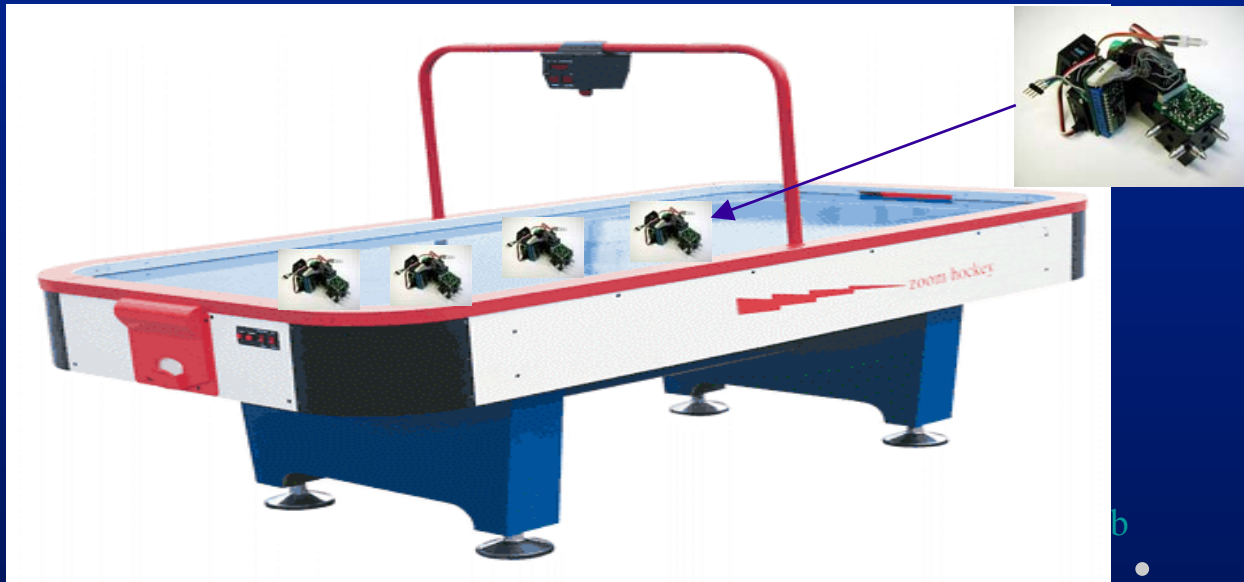
# Proposed Process Control

- Assumptions
  - Modules have unique identifiers
  - Assembly sequence embedded in modules
- Procedures
  - Activate self when receiving a call for its ID or type
  - Call FIMER robots to assist docking (when activated)
  - Activate the next connectors to be docked



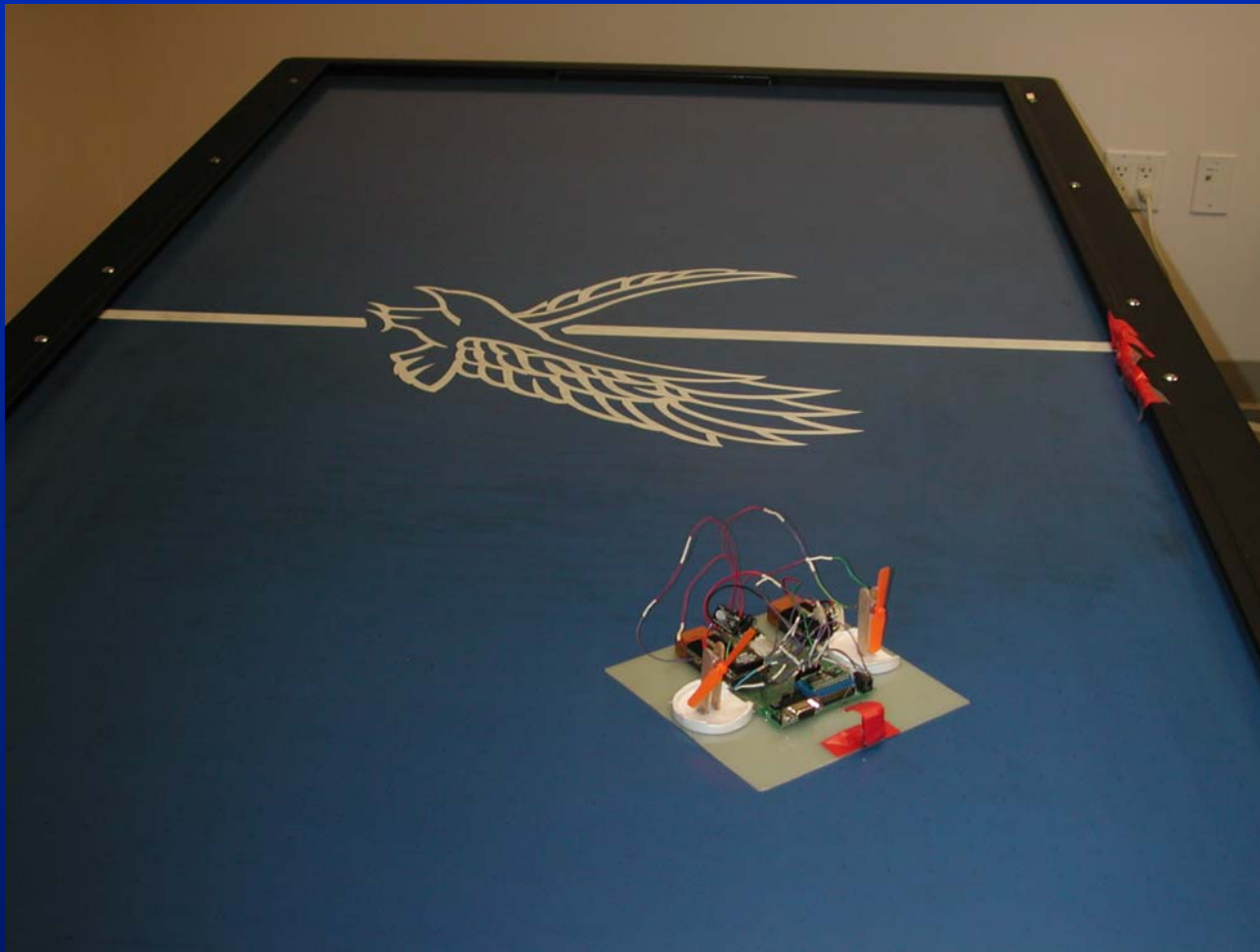
# Proposed Experiments

- Build modules for autonomous planning, navigation, & docking
- “2D flight-test” on an air hockey table
- Extensible to future 3D flight-test in micro-gravity environment



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# Flying Module Prototype



# Flying Module Detail

