

Cyber-Physical Systems *for* Material Handling



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Material Handling?

“From raw material to finished goods”

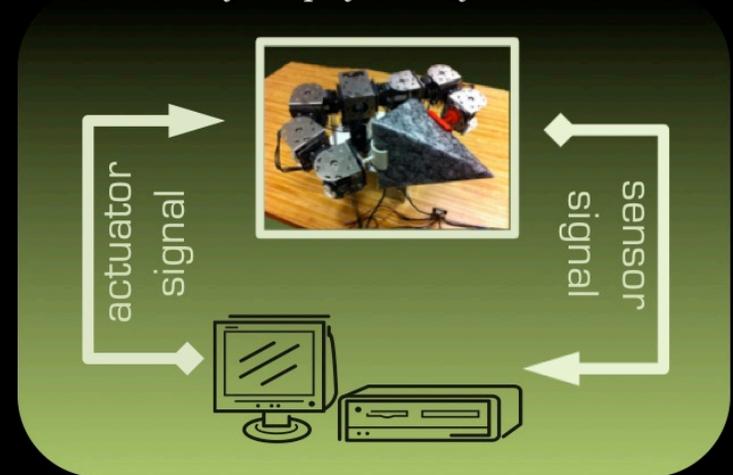
Economic standpoint:

The logistics side of material handling already accounts for \$1,300,000,000,000 (8.5% of GDP in the US) and handles 18,000,000,000,000kg of materials and goods valued at \$16,000,000,000,000 per year.

Technical standpoint:

A wide range of involved problems in material handling (for example, assembling or grasping parts) can be addressed by cyber-physical systems (CPS) approach: physical plant + control algorithm.

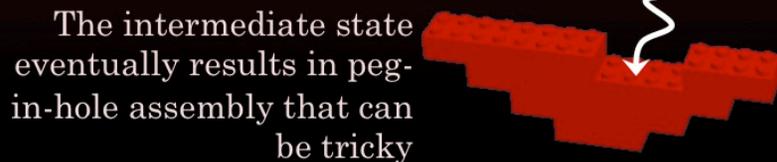
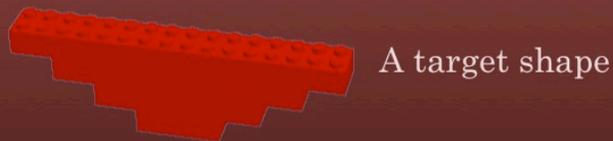
Cyber-physical system



Material Handling - Proposed Research

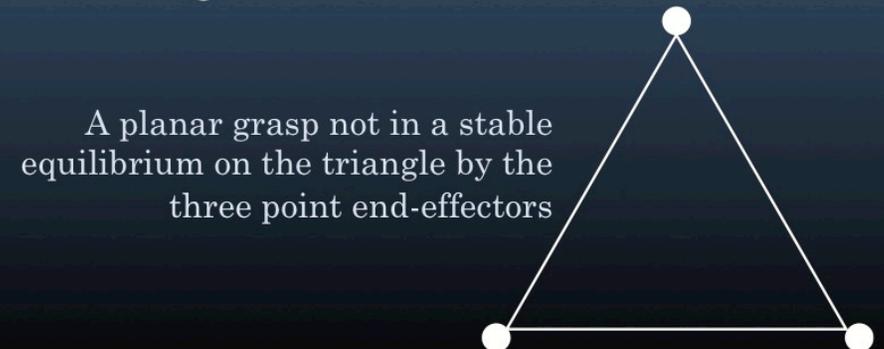
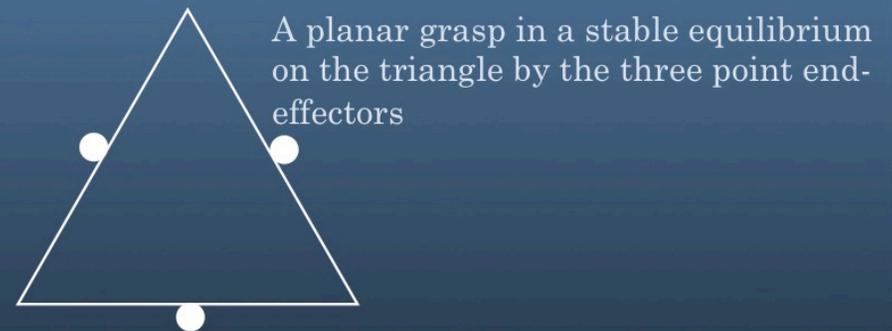
For the “Material” side:
Autonomous Robotic Assembly

One important issue here is the *feasibility* of the resultant assembly plan.



For the “Handling” side:
Autonomous Robotic Grasping

One important issue here is the *stability* of the resultant grasp.

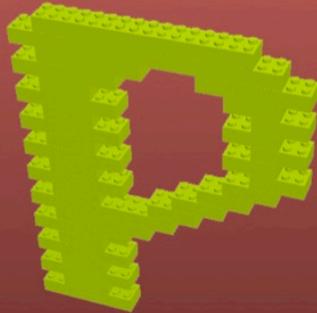


Material Handling – Our Approach

For the “Material” side:

Autonomous Robotic Assembly

Identical, modular building blocks docked in a common brick wall pattern



- LEGO-style docking
 - common brick wall pattern that is geometrically complete and structurally sound
- Assembly planning for feasibility
 - free of peg-in-hole assembly scenarios
 - further supports distributed assembling

Two examples of target shapes

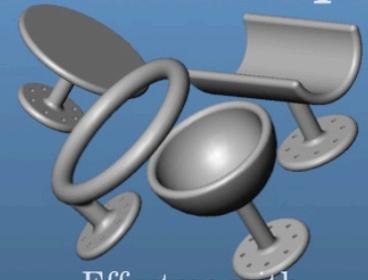


For the “Handling” side:

Autonomous Robotic Grasping



An object to grasp



Effectors with concave surfaces

- Effectors with concavity
 - All objects can be immobilized and caged by at most three concave effectors shown above.
- Grasp planning for stability
 - no need for instantaneous situational awareness.

Two examples of target grasps



Potential Impacts on Research and Industry

