1. Goals and philosophy

Mechanics of Manipulation

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Course content

- How does manipulation work?
    - Kinematic manipulation
        - Kinematics
        - Kinematic representation
        - Applications to manipulation:
          Motion planning; kinematic models of contact.

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        - Friction
        - Applications to manipulation:
          Grasping, fixtures, pushing, parts orienting.
    - Dynamic manipulation
        - Rigid body dynamics
        - Impact
        - Applications to manipulation:
          Quasidynamic parts orienting, juggling.

Why?

- Scientific curiosity.

    We want to know how manipulation works.

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    Use *robot's* knowledge of how manipulation works.

    Is it even possible to *not* . . . ? Perhaps an implicit model?

Why build model-based robots?

- Maybe you should not.

  For many tasks, you can build a robot based on your own knowledge of the mechanics of manipulation. Don't underestimate ad hoc engineering based on human intuition and experience.

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- Sometimes scientists should . . .

  As a properly skeptical scientist, how do you show that some phenomenon is critical in a given task? That you have properly modeled that phenomenon?

Course organization

- Lectures: MW 10:30 – 11:50. Five minute break.

- Makeup lectures as needed: F 10:30 – 11:50.

- Textbook: *Mechanics of Robotic Manipulation*, MIT Press, 2001.

- Conflict of interest: let's spend my royalties.

- Grading 60/30/10:
  1. Assignments. Probably just four or so.
  2. Term project. Spend 20-40 hours. Proposal. Report.
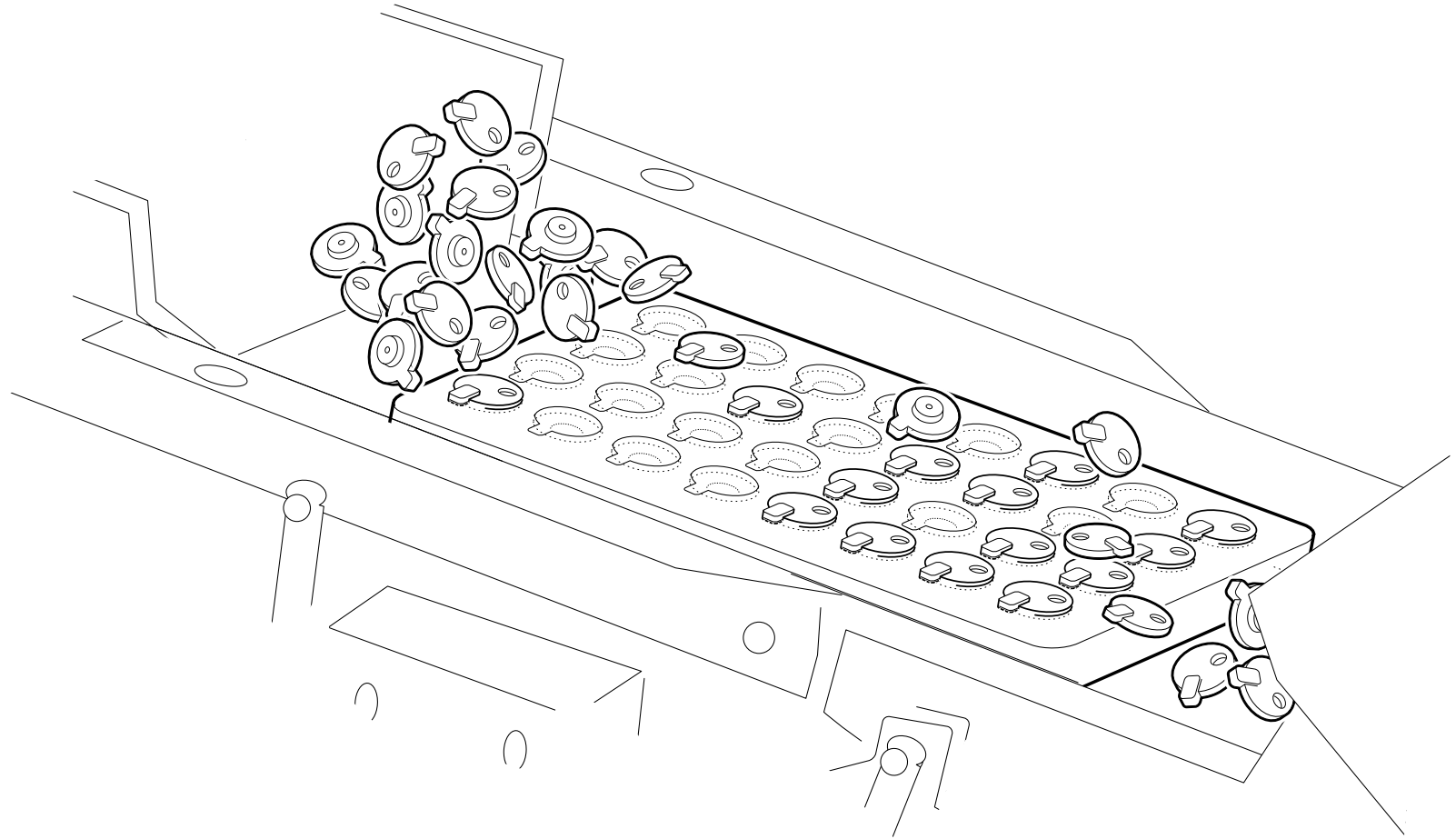 3. Final. Last day of class.
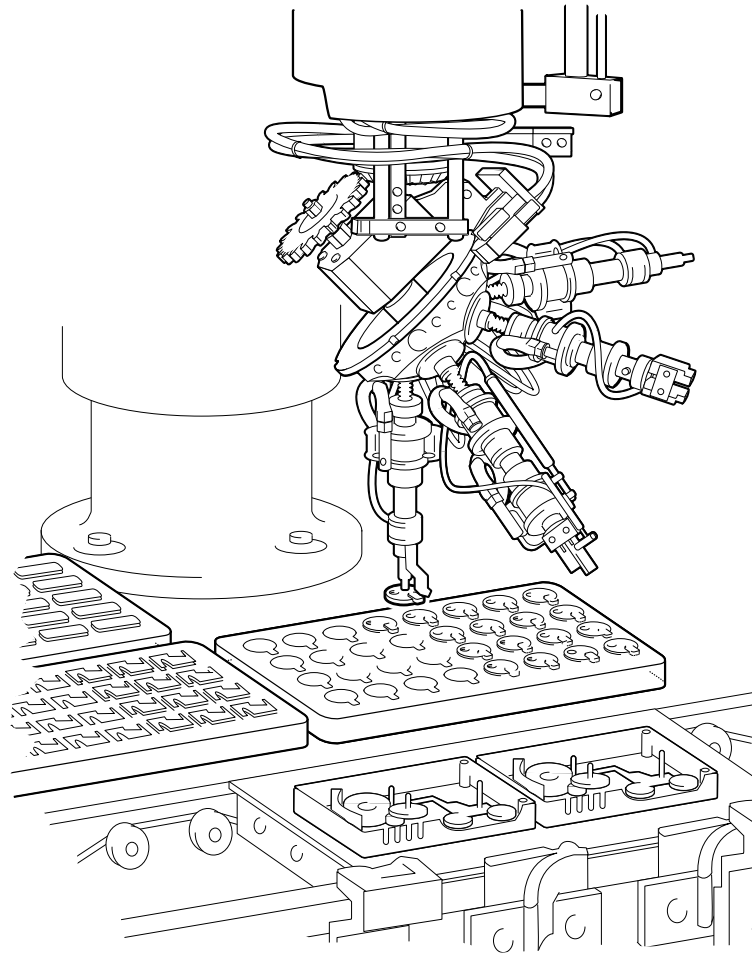
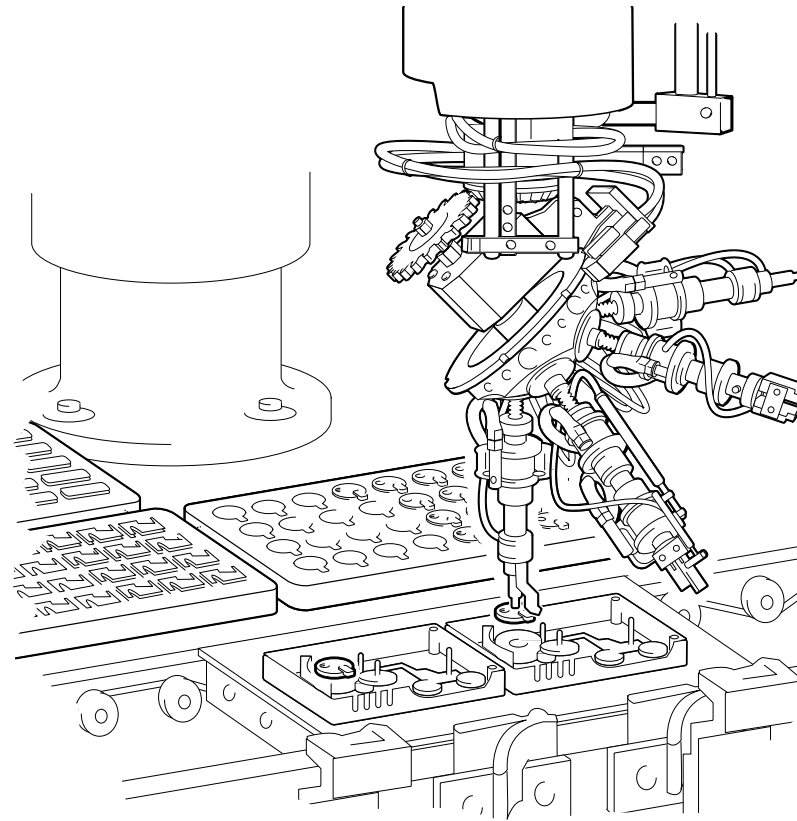# What is manipulation? First example: human.
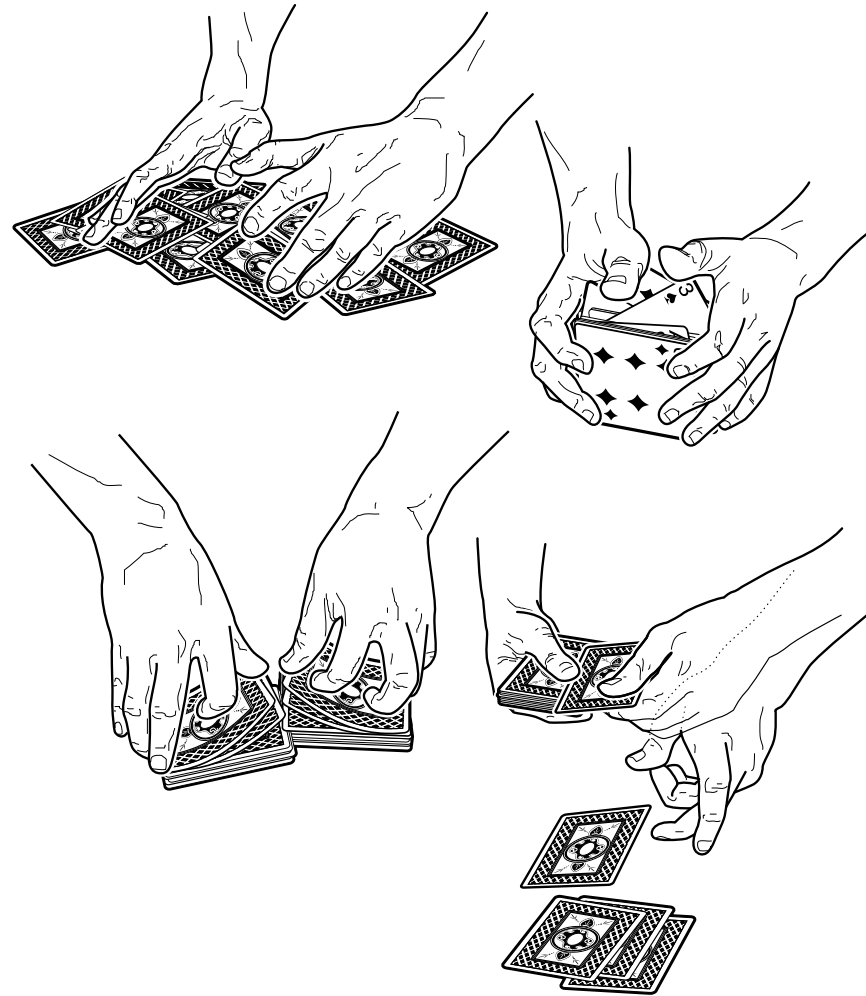
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    - *Design the product!!!*
    - Design the APOS trays and vibrations.
    - Design the gripper.
    - Design the pick and place motions.
    - There's probably a lot more . . .

What is manipulation? Example 3: Viki.

Hayes, K. C., and Hayes, C. Journal Comp. Physiol. Psychol. 45 450. 1952.

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What is manipulation? Example 4: Chimps.

It is a little daunting to discover—on the very technological grounds on which human superiority is often claimed—that after months of apprenticeship, human scientists cannot do as well as preadolescent chimps. Teleki remained generous and good-natured about his failure. In the acknowledgments at the end of the paper, among thanks to various organizations for financial and logistical support, there appears this sentence: "I am, in addition, more than grateful to the patient and tolerant Leakey, whose termite-collecting skills so out-stripped mine."

—http://www.mc.maricopa.edu/dept/d10/asb/primates/termiting.html

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Not to give the chimps the last word . . .