Lego Knee Project

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Stability	Poor	Excellent	Excellent	Excellent	Excellent
Cost	Low	Low	Mid	High	High
Gait Efficiency	Poor	Poor	Mid	Excellent	Excellent
Weight	Low	Low	Mid	High	High

Image by MIT OpenCourseWare.

Prosthetic Knee Joints:
Cost/Performance Comparison

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Prosthetic Knee Joints:
Jaipur/Stanford Model

Stanford-Jaipur Knee:
Current Model Benefits

- Polycentric
- Good gait-efficiency
- Withstands 2 million cycles (~2 years)
- Affordable (<$30)

Engineering drawing of Stanford-Jaipur Knee removed due to copyright restrictions.

Limitations of Stanford-Jaipur Knee

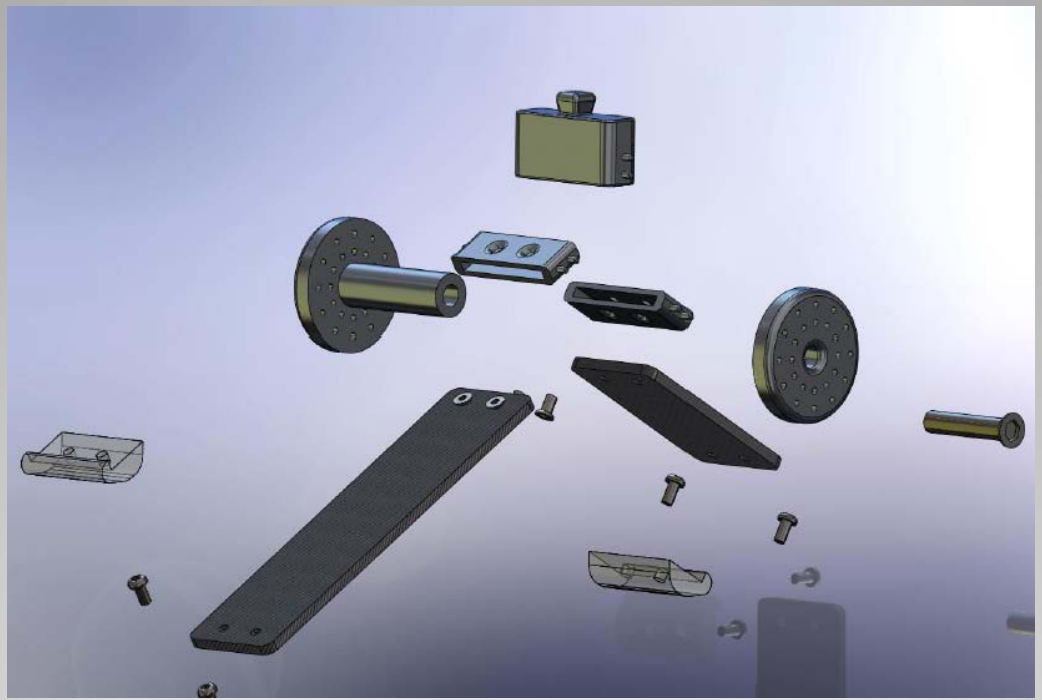
- Wide and bulky
- Noise (Click!)
- Shock / Discomfort

Photo of boy walking with Stanford-Jaipur Knee removed due to copyright restrictions.

- Better manufacturing?
  - Requires milling or molding
  - Each site requires a mold

Our Project part 1

- Revise the Stanford-Jaipur knee
  - No milling, no molding
- Build a prototype at Fab Lab
  - Also introduce small improvements (e.g. no bolts sticking out)
- Test our prototype



Engineering drawing of LegoLeg courtesy of Giovanni Talei Franzesi, Jacquelyn Kunkel, and Matthew Rodriguez. Used with permission.

Lego Foot

Waterjet Cutter

- Easy to use
- Fast
- Economical
- Can slice carbon-fiber sheets into various shapes
- No molds required

Waterjet Cutter

- Available at Fab Lab
- Omax 2652 can handle up to 26in x 52in

Test our prototype

- Is our modified Stanford-Jaipur knee as good as the original?

Images of MIT's Tim the Beaver and the Stanford Tree mascot have been removed due to copyright restrictions.

Fatigue test

Image of the Stanford-Jaipur Knee undergoing a stress test has been removed due to copyright restrictions.

- Apply adduction moment
  - ~3% x bw x ht =34.1 Nm
- 2 million cycles

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Ultimate Strength Test

- Increase force at 20N/s (1Nm/s)
- Stanford knee failed at 3500N (175Nm)

Wear Test

Image of the Stanford-Jaipur Knee undergoing a wear test has been removed due to copyright restrictions.

- Wear from cyclical rotary motion within the knee joint bearing surfaces

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Our Project part 2: Dampers

- Viscous damping during swing phase
- Reduces impact
- Preserves joints
- Natural gait.

Pneumatic dampers

- More suitable for low cost knee designs than are hydraulic dampers
- Medium is environmental air
- Already incorporated

Adam Dahl's design

Engineering model of pneumatic device removed due to copyright restrictions.

- Pneumatic
- low cost
- long throw

- Step 1: Redesign Stanford-Jaipur Knee
  - No milling, no molding

Summary

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- Step 2: Build a prototype @Fab Lab & test

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- Step 4: Introduce damper into the knee

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- Step 5: Optimize the damper

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1~3 weeks per step

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We have 7 weeks after spring break

Role of each student

- David – research on pneumatic dampers
- Amber – modify design so that it can be waterjetted
- Ryu – incorporate improvements Dr. Pooja suggested

EC.722 Special Topics at Edgerton Center:Developing World Prosthetics

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