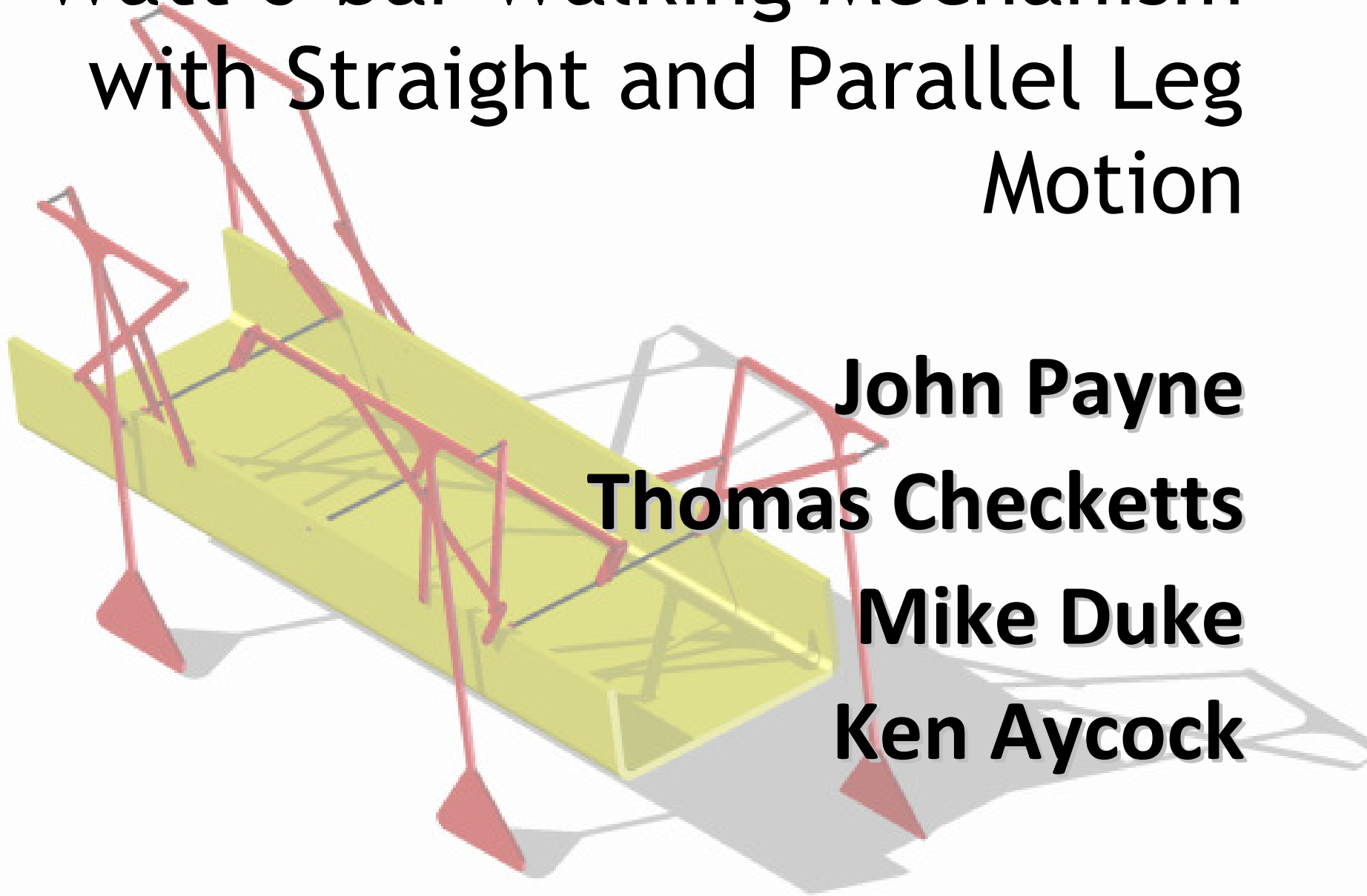


Watt 6-bar Walking Mechanism with Straight and Parallel Leg Motion



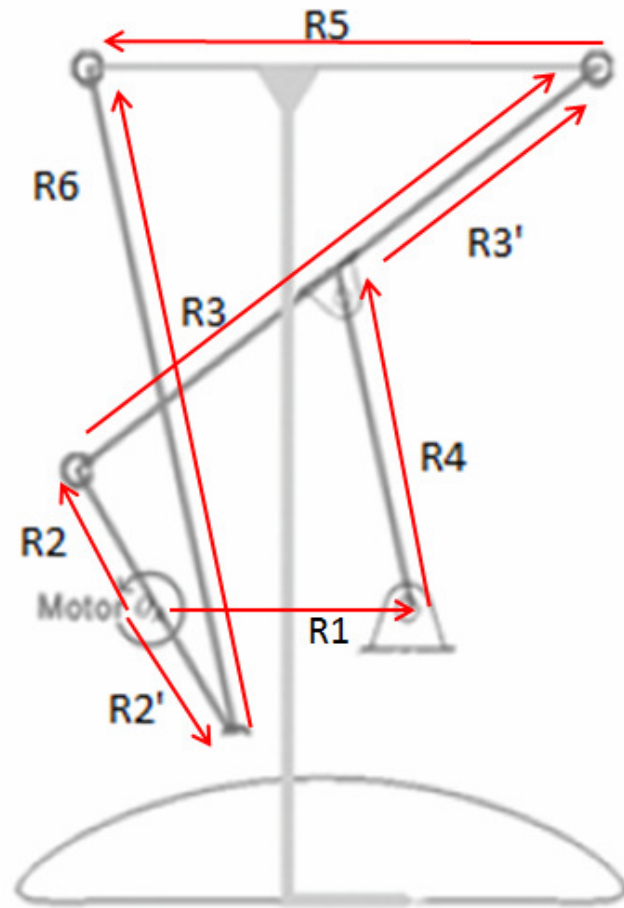
John Payne
Thomas Checketts
Mike Duke
Ken Aycock

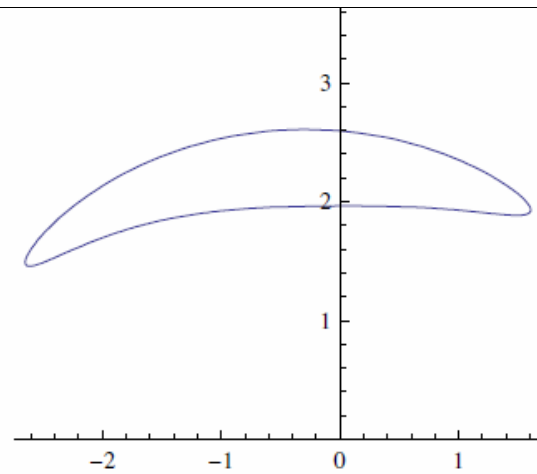
Introduction

- Wheeled vehicles have limited mobility
- Legged locomotion can traverse uneven terrain
- "Optimization of Watt's Six-bar Linkage to Generate Straight and Parallel Leg Motion" (Mehdigholi and Akbarnejad)
- Group decided to build a four-legged walking mechanism using a modified design of this Watt six-bar linkage

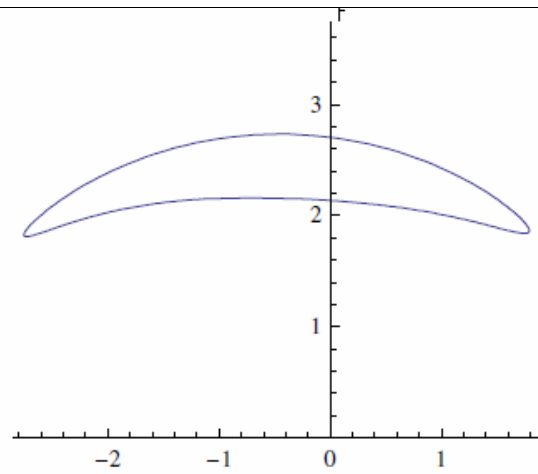
Analysis

- Issues:
 - Mehdiigholi's report: not to scale
 - The diagram published in the paper was only a two-dimensional model
- Genetic algorithm used to optimize the link lengths (motion generation)
- Optimization parameters:
 - $\Delta y \rightarrow 0$ over some rotation of the input link
 - $\theta \rightarrow 180^\circ$ for a full rotation
- 200,000 iterations performed to maximize 'fitness'

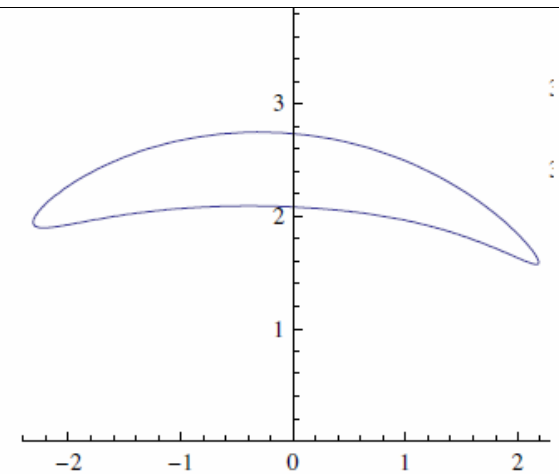




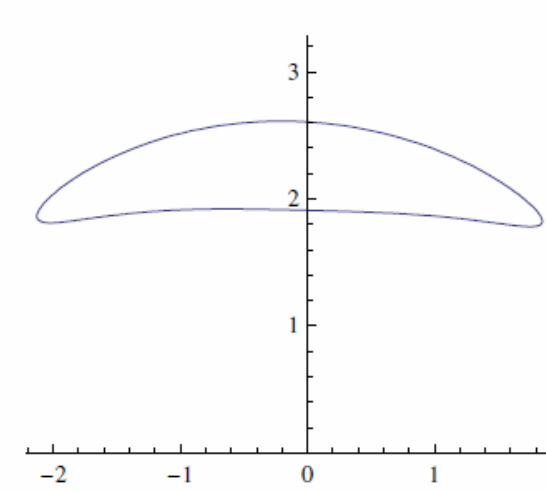
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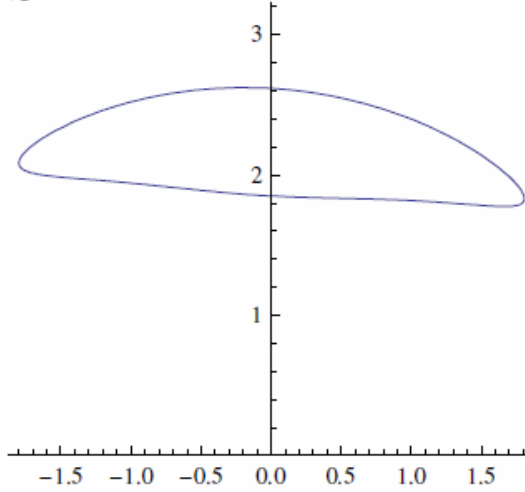
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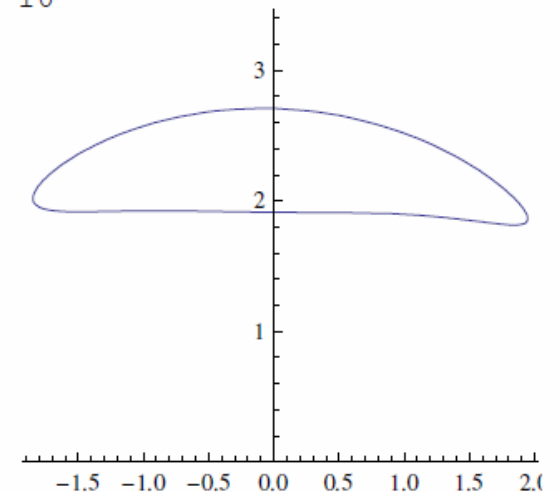
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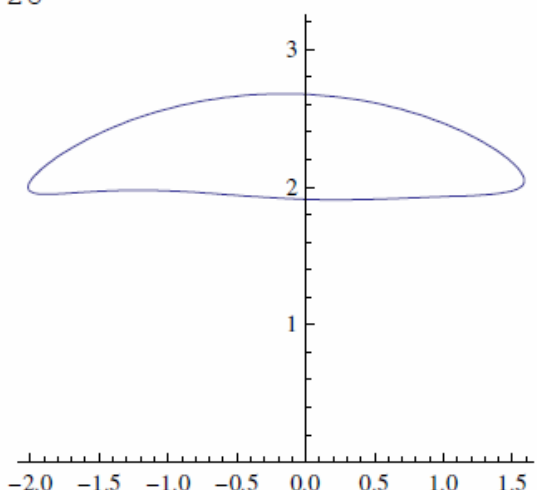
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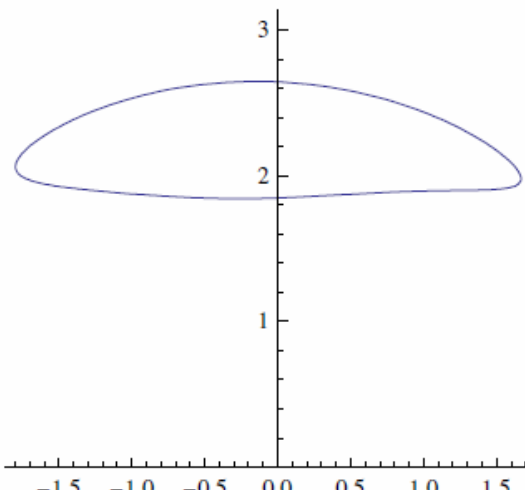
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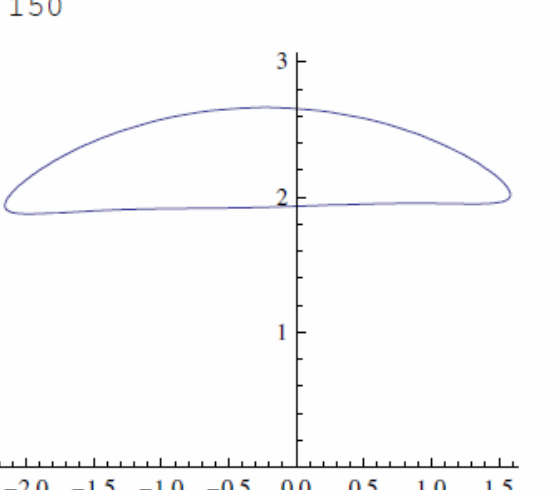
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169

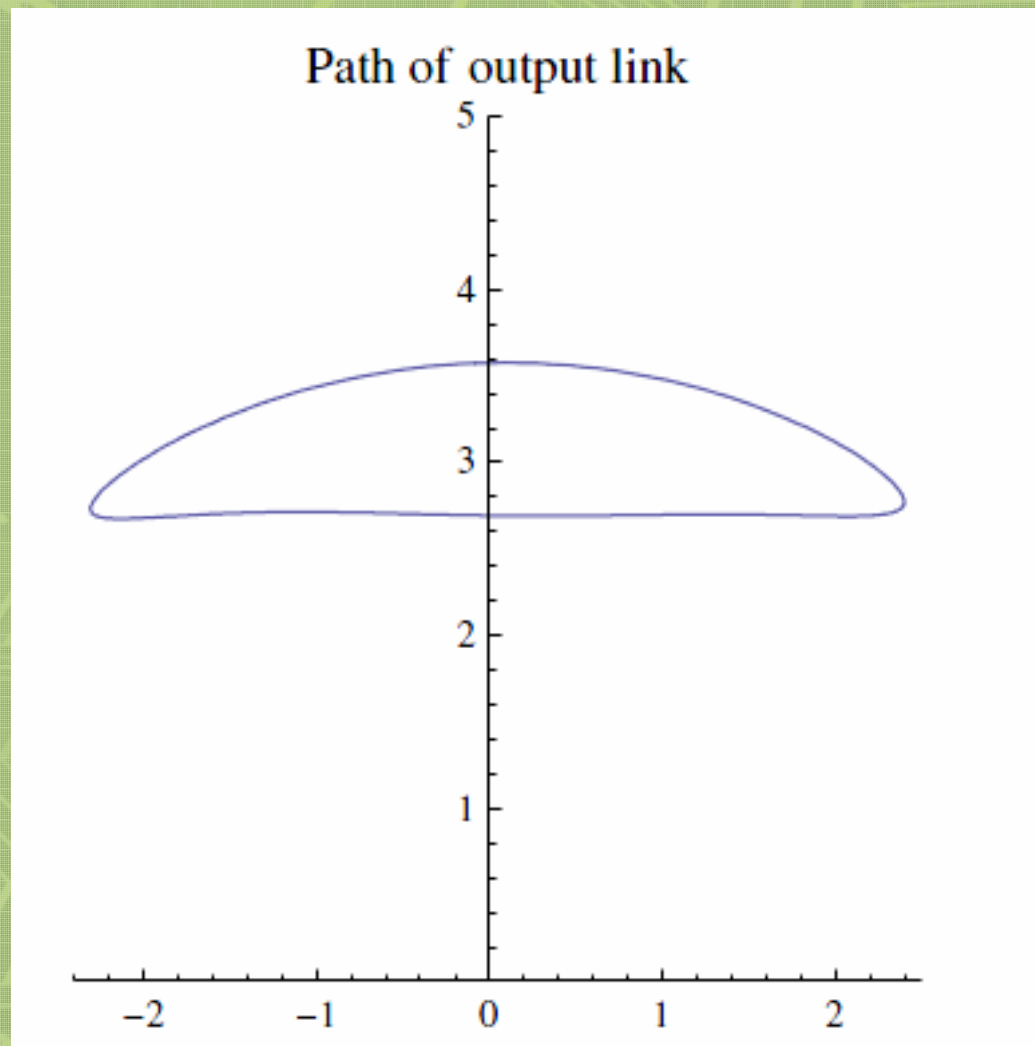


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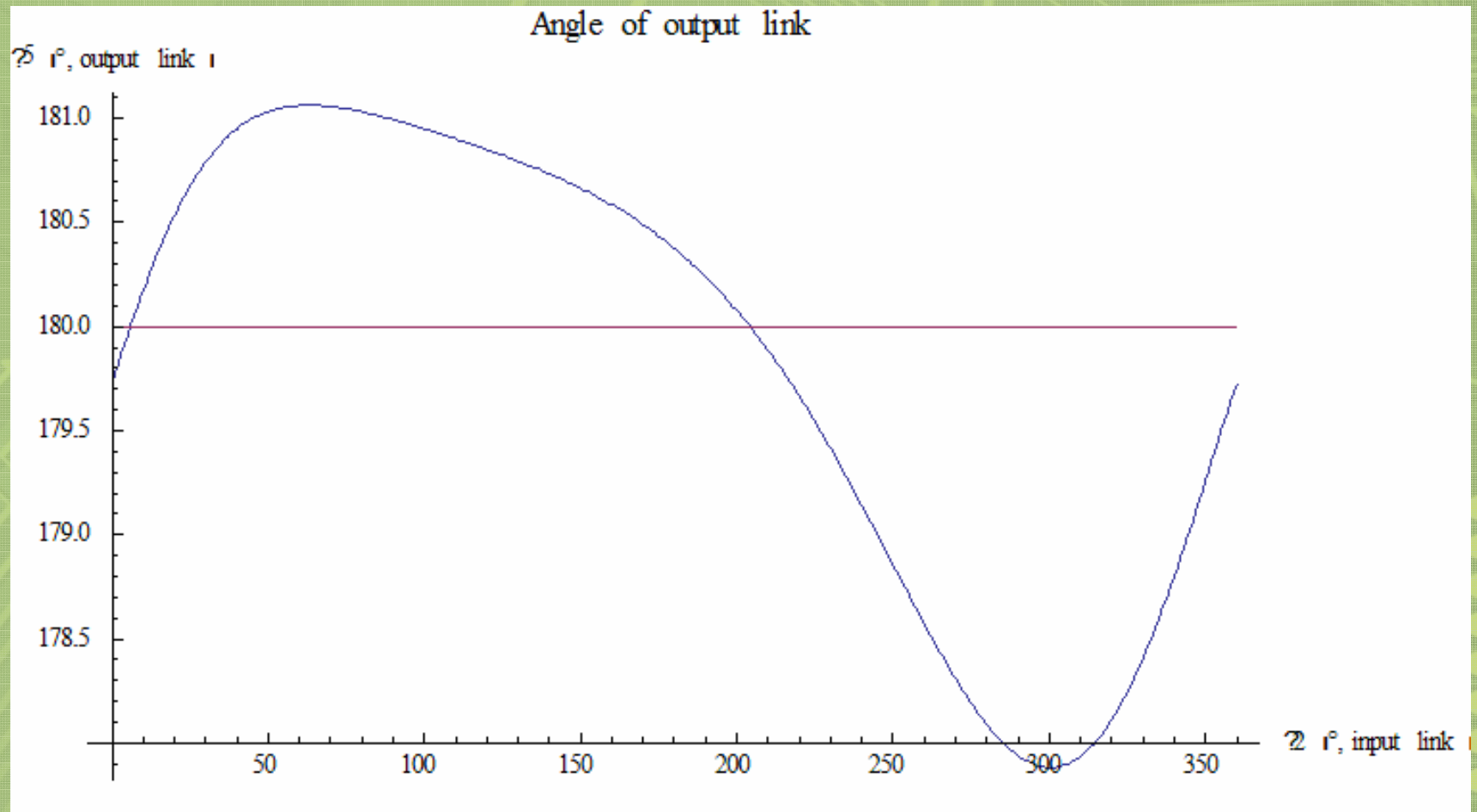


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Analysis: Final Path

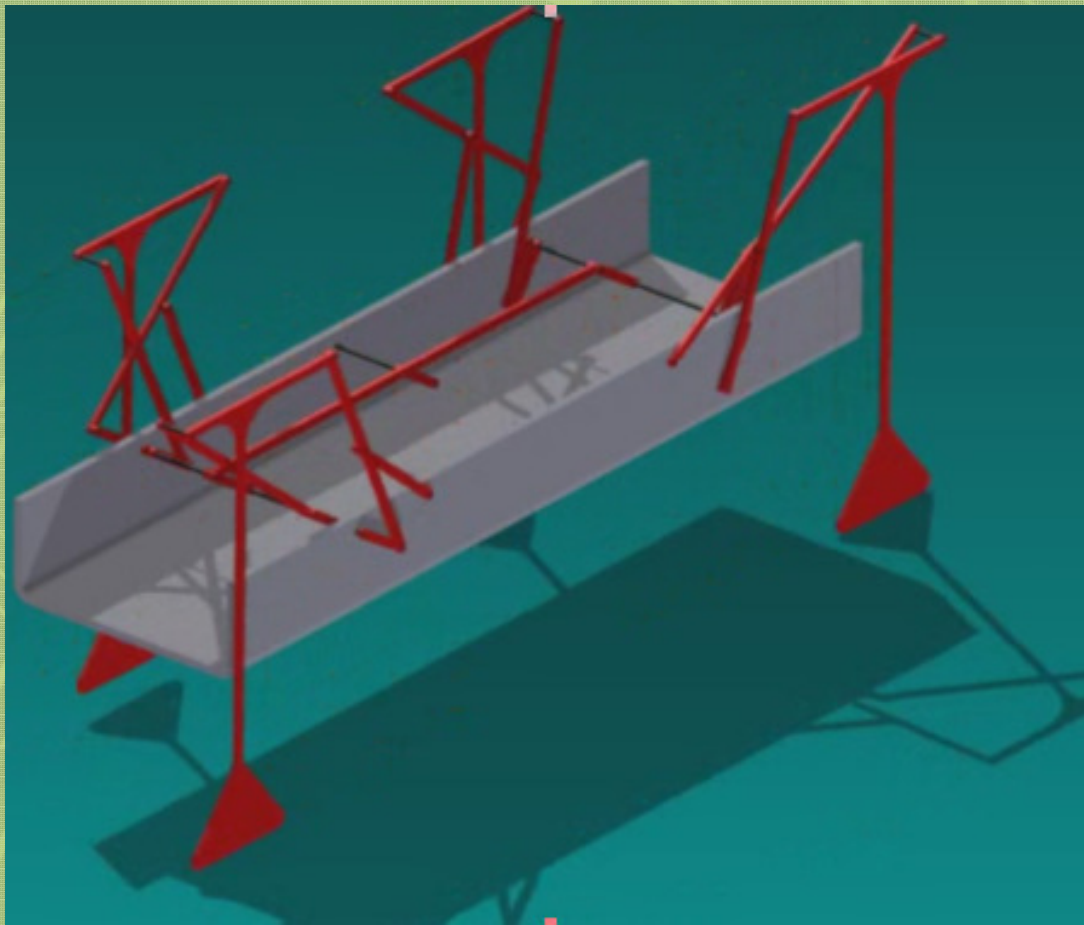


Analysis



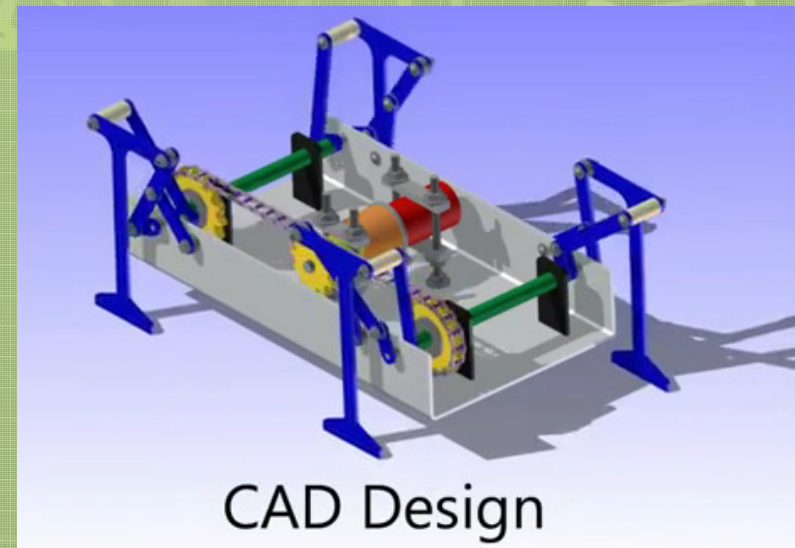
Analysis

- Proof of concept CAD confirmed that the mechanism was feasible



Design of Prototype

- Low-carbon steel
 - Plasma-cut linkages
 - Bend sheet metal body
- Washers, vinyl tubing, and machine screws
- Three bicycle sprockets
- Steel bar stock
- 18V electric drill motor
- Threaded shafts for chain tensioning

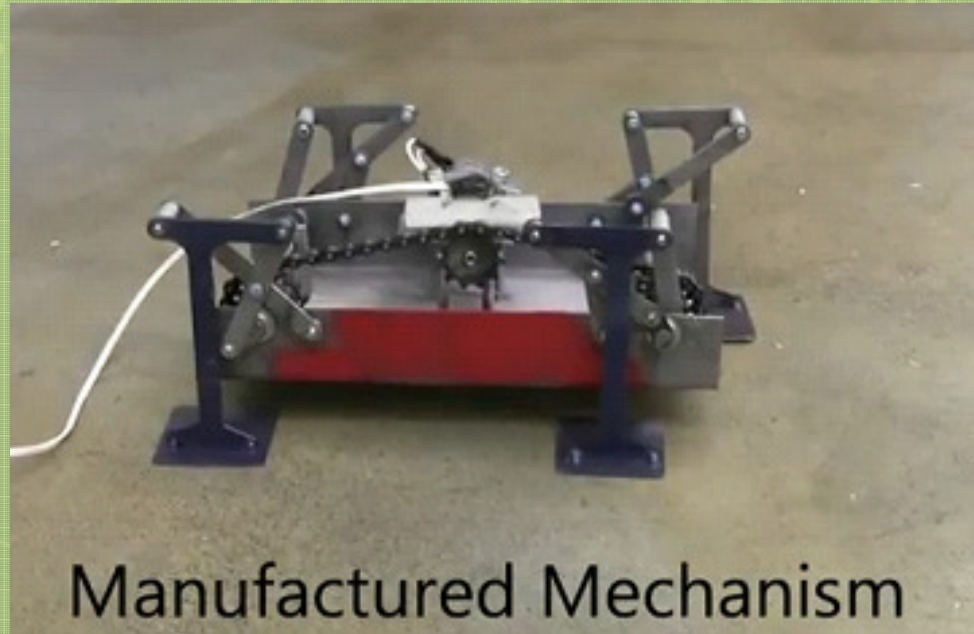


CAD Video

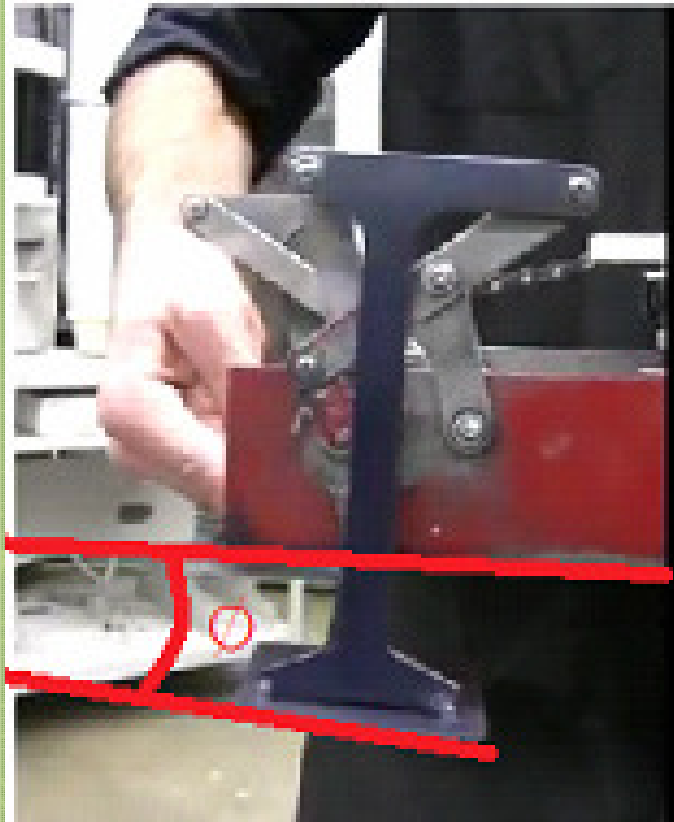
- <http://www.youtube.com/watch?v=XnWlYM9TIwI>

Discussion of Prototype

- Challenges:
 - Friction
 - Stability
 - Motor mount
 - Slack
 - Motor control
- Solutions:
 - Lubrication
 - Feet addition
 - Tighter motor mount
 - Loctite
 - PWM driver native to drill



Discussion of Prototype



$$\phi = \sim 8^\circ$$

Conclusion

- Overall, a success
- Path of the linkage deviated by a maximum 8° from the intended design
- Maximum vertical displacement of the feet $<0.25\text{in}$ (exp. 0.75in)
- Importance of aligning high-torque components
- Future improvements:
 - Keyed shafts and sprockets
 - Rivets and washers
 - Better motor mount