Designing and understanding mathematical models and feedback controls

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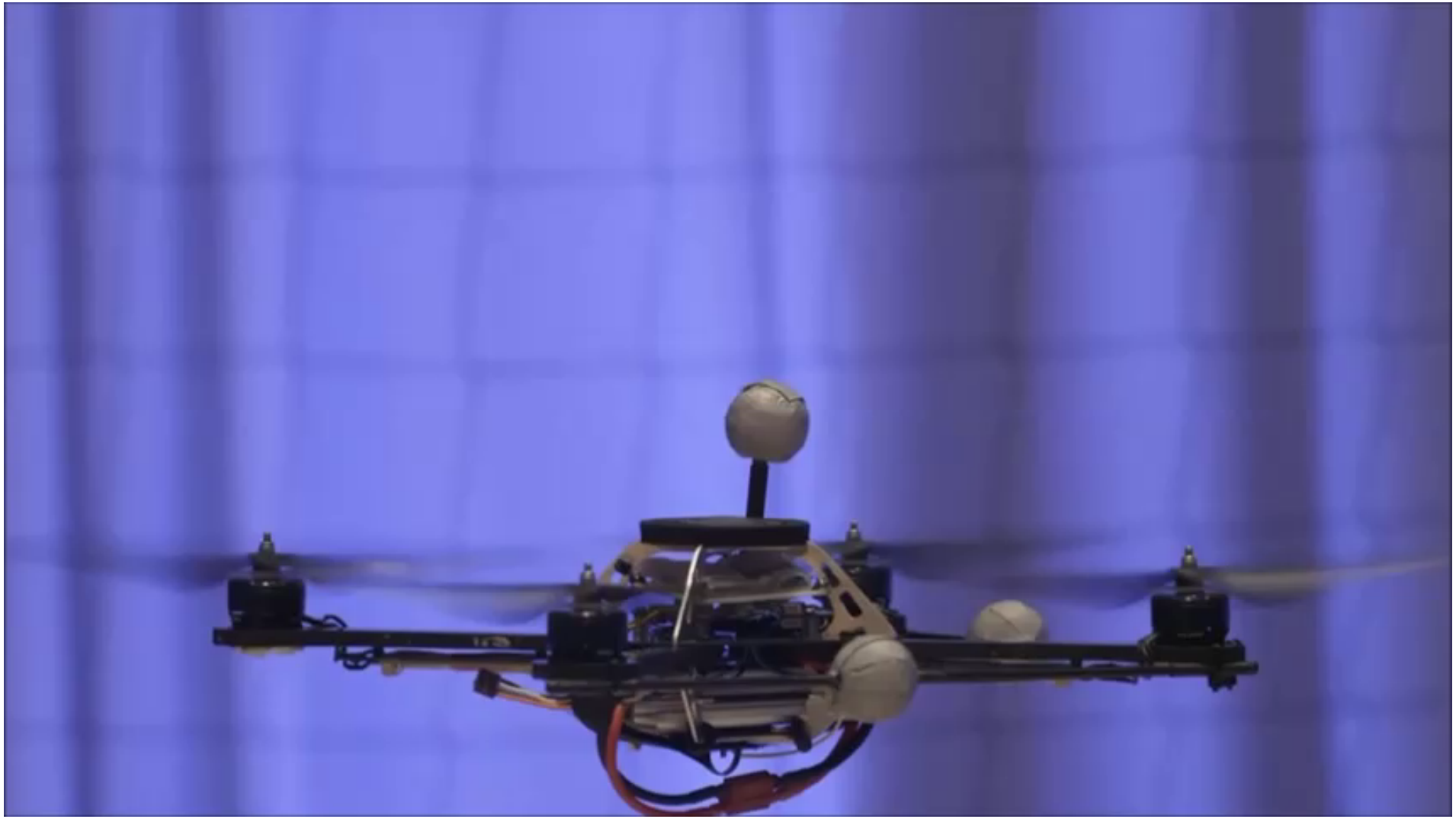
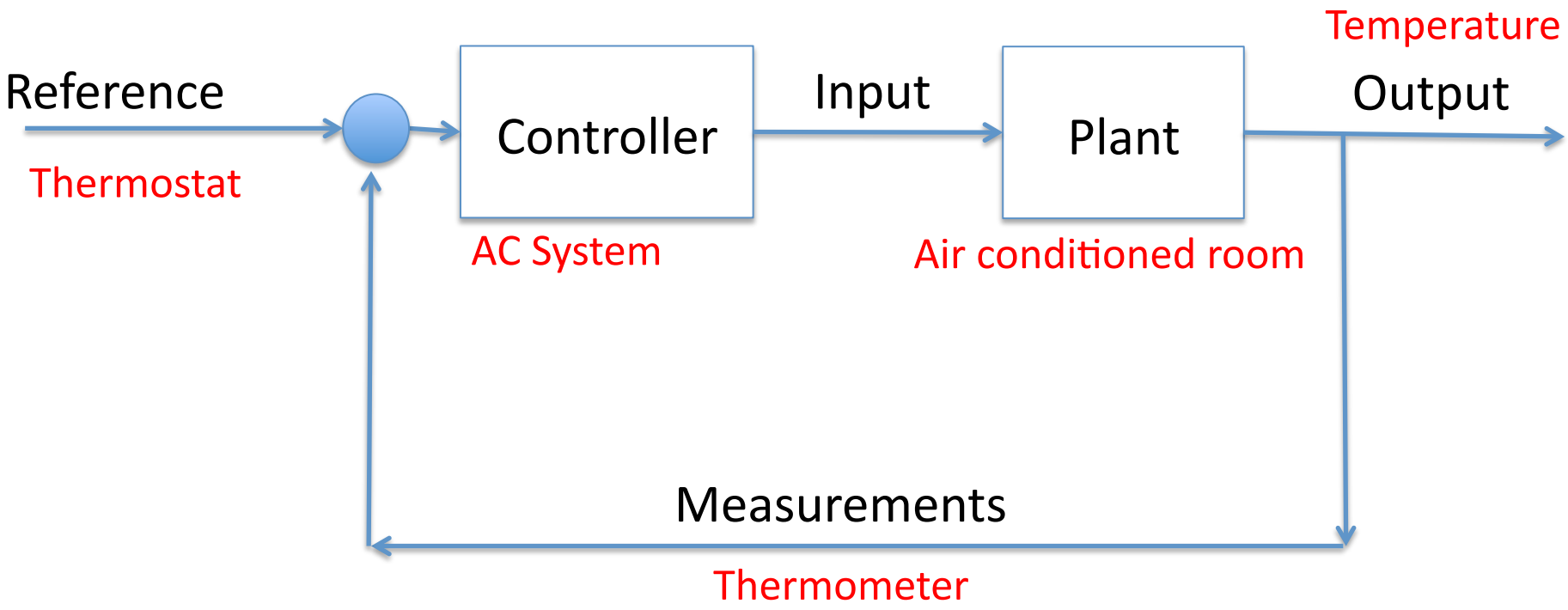
Will the glass fall?



The Astounding Athletic Power of Quadcopters | Raffaello D'Andrea | TED Talks
https://www.youtube.com/watch?v=w2itwFJCgFQ


TED
TED
(Applause)

How automation works



Our Plant is a Gantry Crane

Steps to Automation

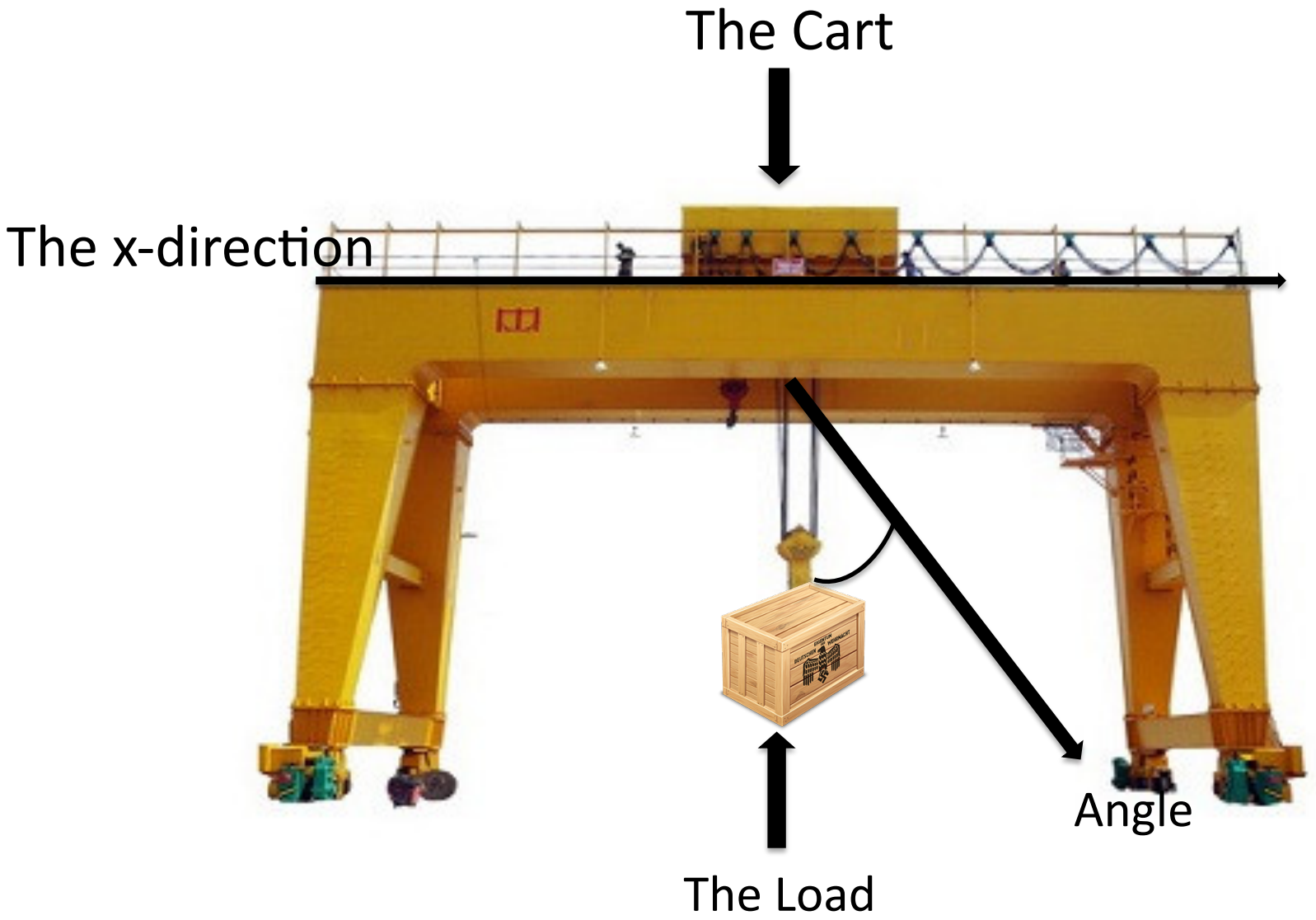
Applied Newton's laws of mechanics to our plant.

Formulated a mathematical model.

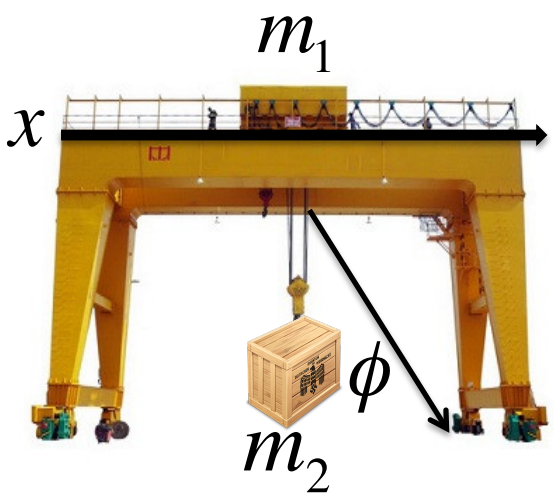
Designed control algorithm.

Validate controller design in
simulation followed by experiment

Gantry Crane



Mathematical Modeling



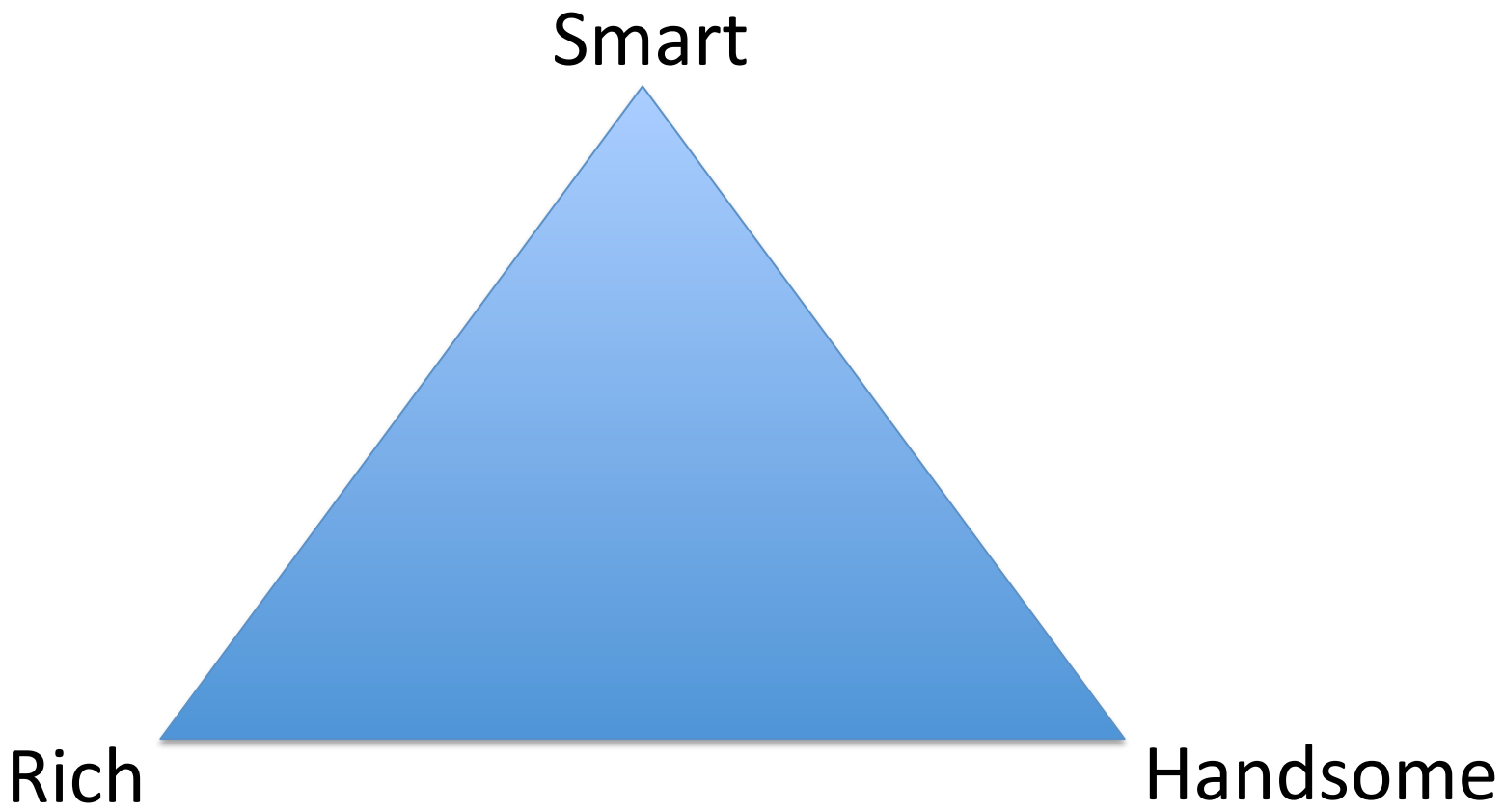
$$m\vec{a} = \sum_i F_i$$

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}}\right) - \frac{\partial L}{\partial q} = \sum_i F$$

$$L = T - V$$

$$\begin{bmatrix} m_1 + m_2 & m_1 l\cos\phi \\ m_1 l\cos\phi & m_1 l^2 \end{bmatrix} \begin{bmatrix} \ddot{x} \\ \ddot{\phi} \end{bmatrix} = \begin{bmatrix} u + m_1 l\,\dot{\phi}^2 \sin\phi \\ -m_1 g l \sin\phi \end{bmatrix}$$

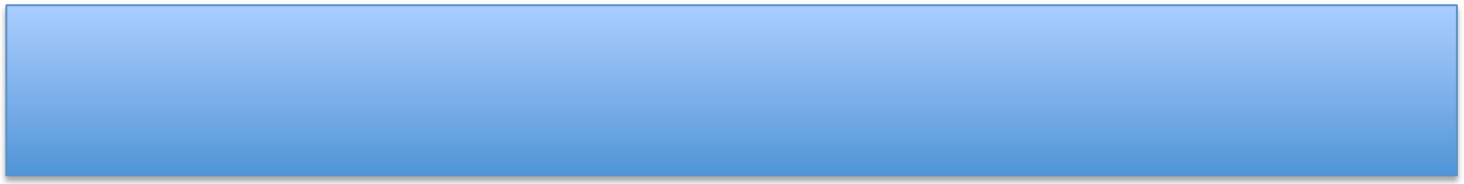
Control and Design Considerations



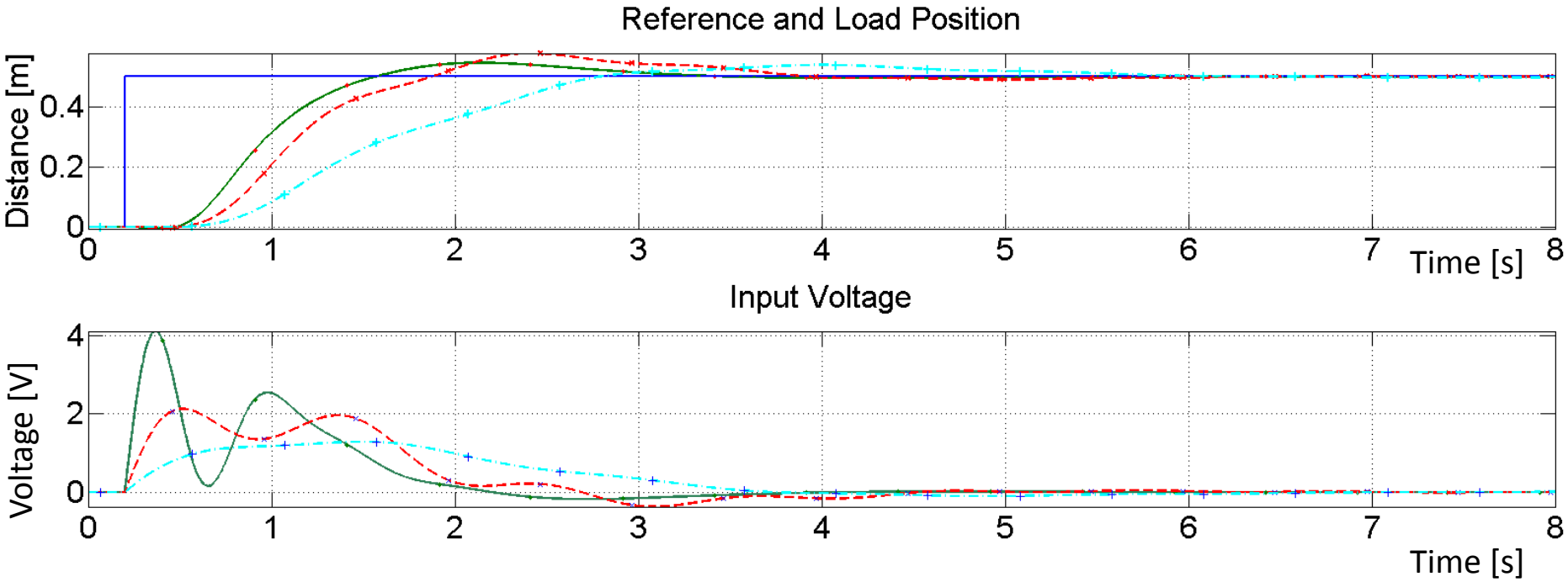
Control and Design Considerations

Speed

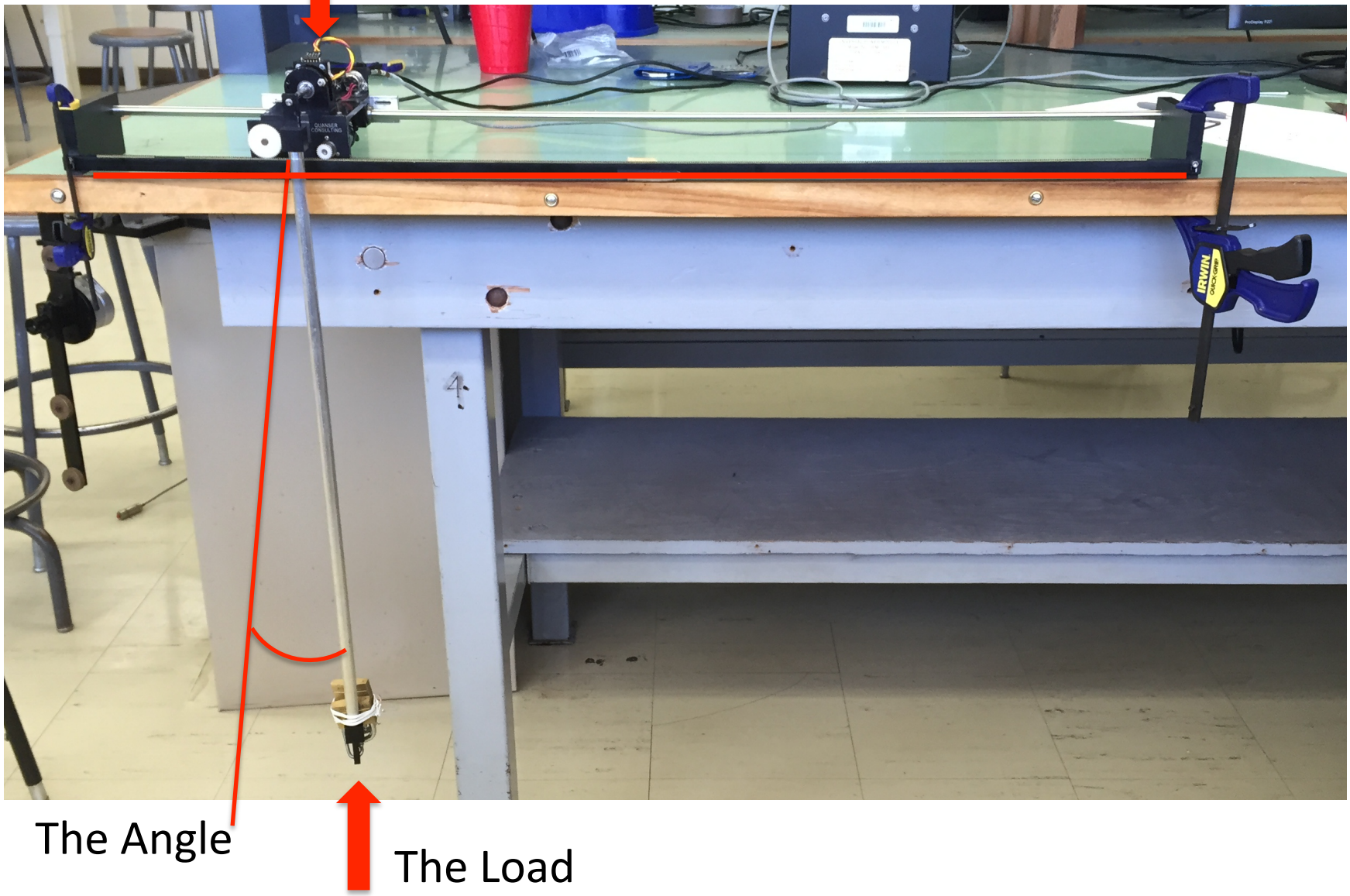
Energy Efficiency



Involved Trade-offs

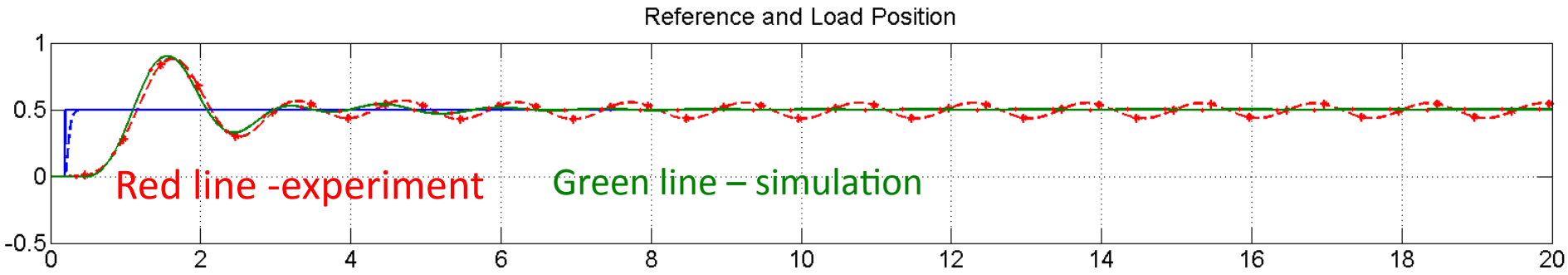


Experimental Set Up



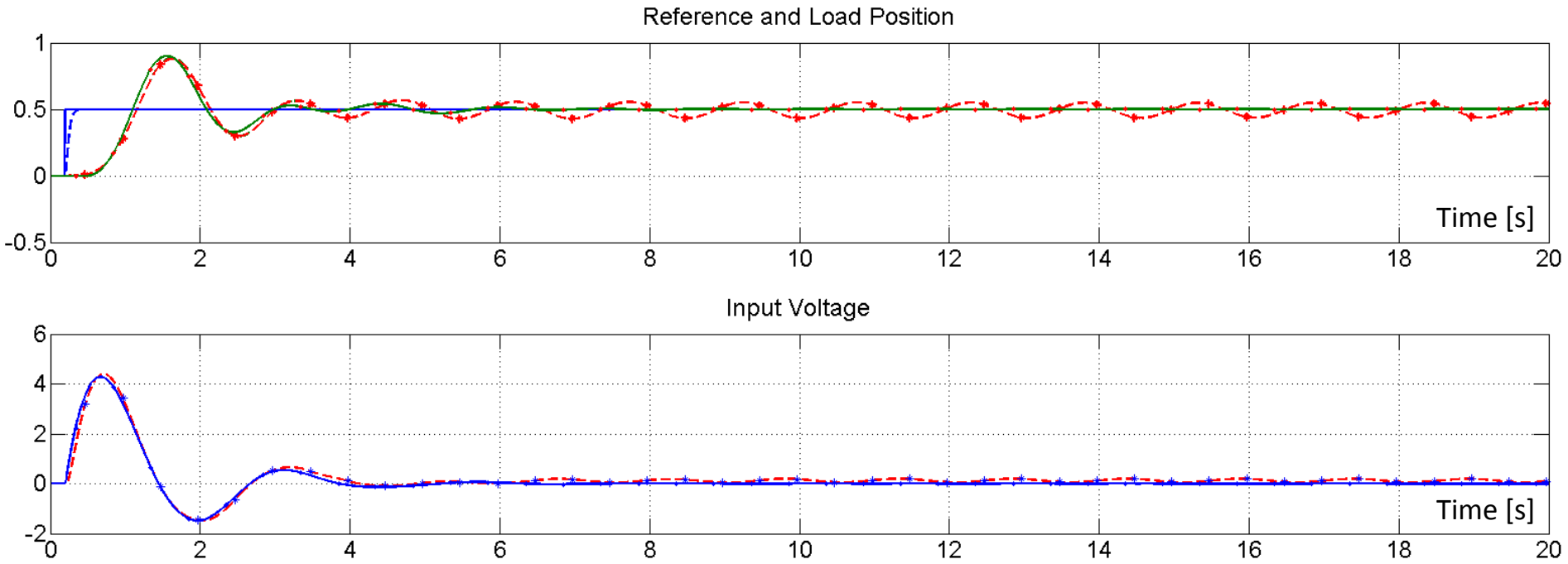
Initial experiment

Comparison: Simulation and Experiment




IRWIN

Successfully Designed a Mathematical Model



Thank You

Paul Gritt
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Jonathan Epperlein

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Wendy Ibsen
Jens-Uwe Kuhn