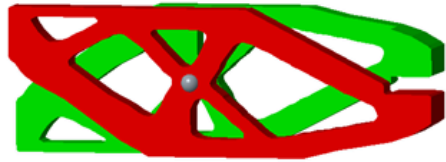


# Re-inventing the Wheel: Computational Synthesis of Compound Machines Using Design Optimization

Kai A. James

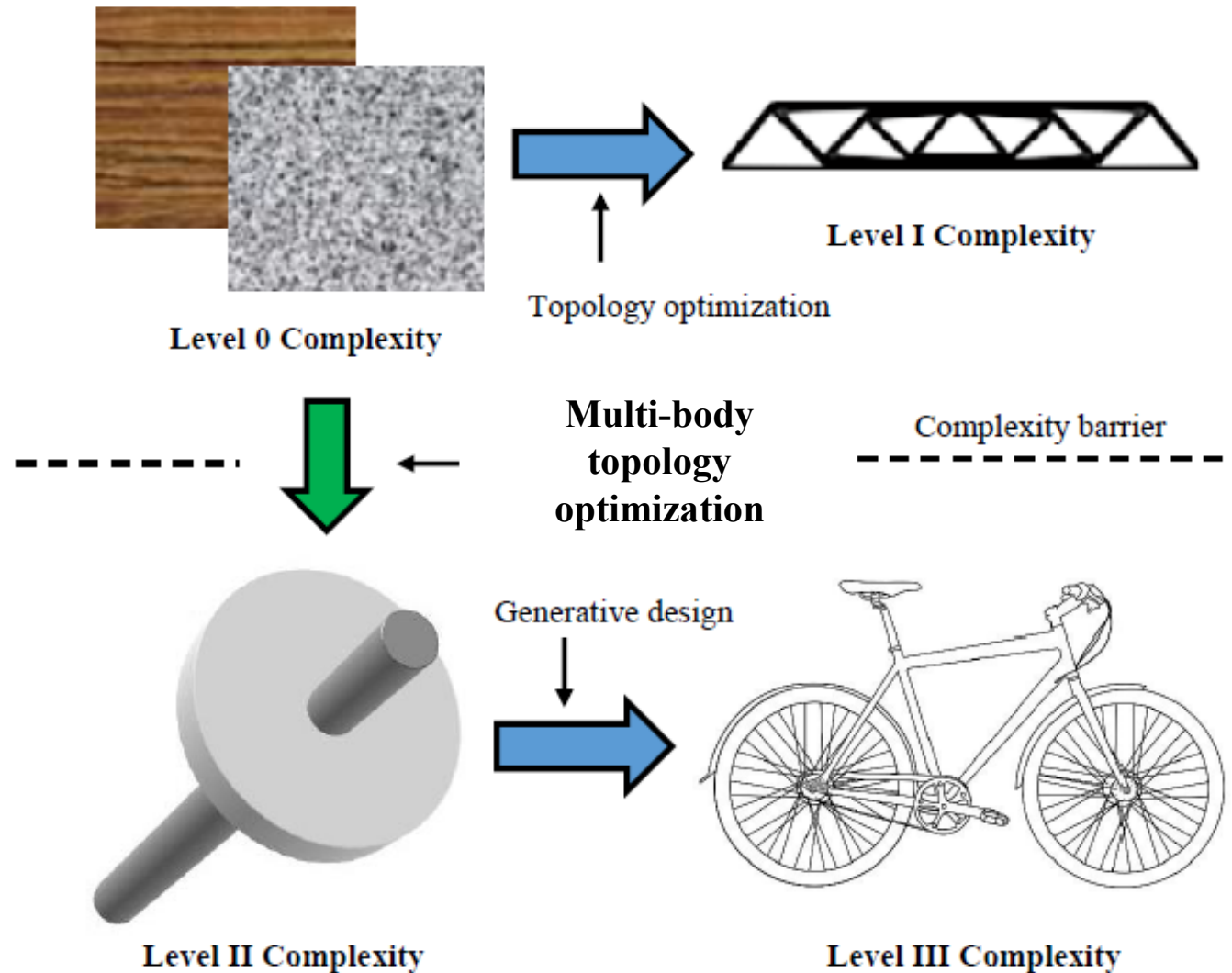
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Purdue University  
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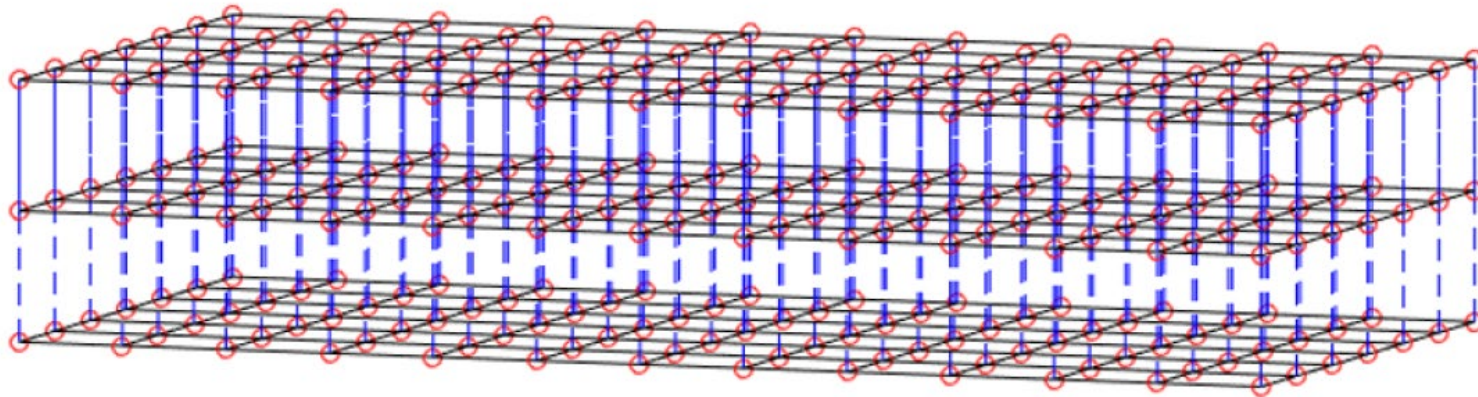
**CDiLAB**  
Computational • Design • Innovation • Lab

# Computational Design of Compound Machines



# A Multi-Layer Approach

- Multiple planar meshes are included in the computational domain
- Each coincident node is connected to other layers via a virtual elastic “link”
- Loads and boundary conditions applied to each layer as necessary



# Reinventing the wheel...

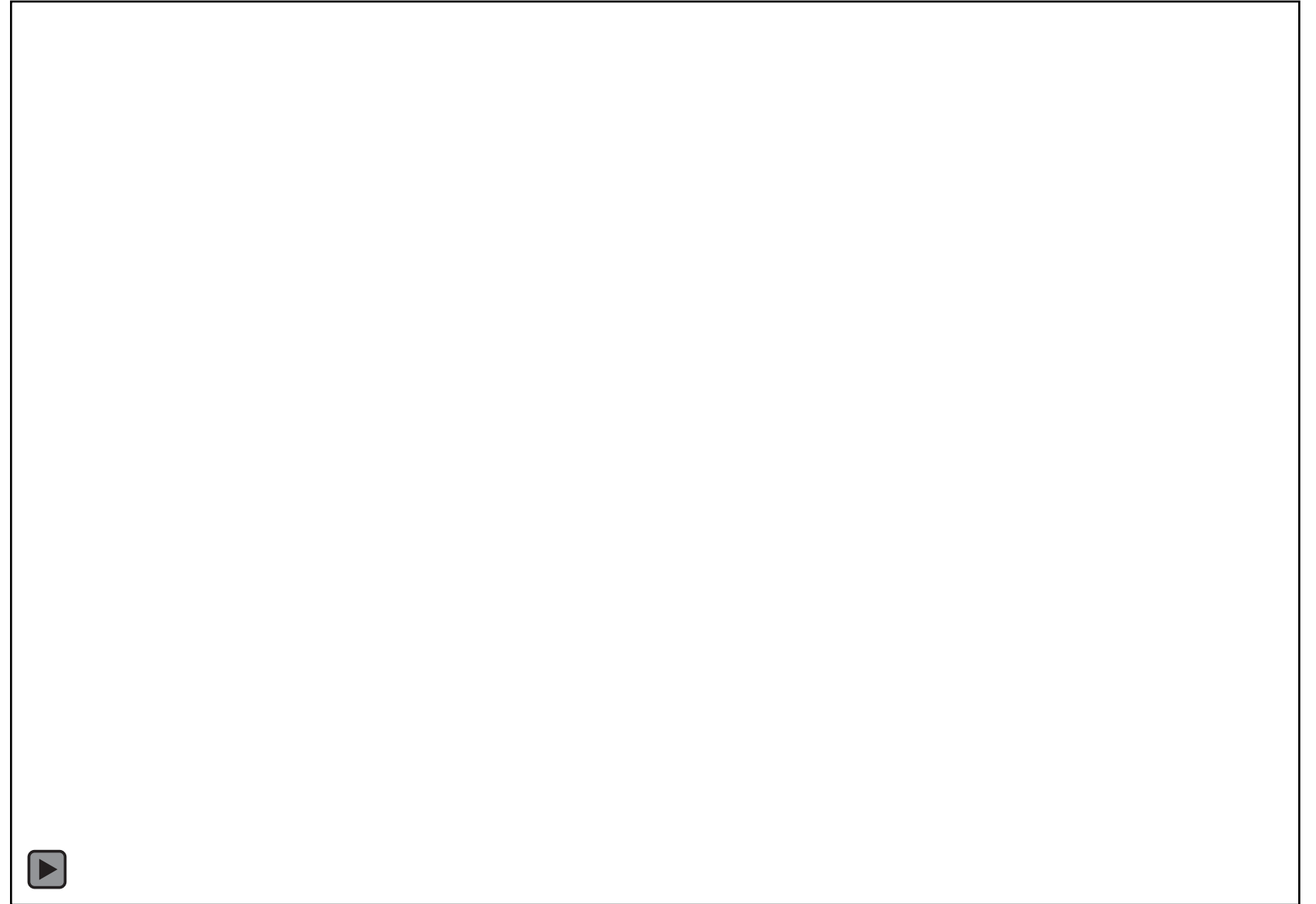
- Iconic and fundamental building block, central to mechanical design
- Free rotation **not found in nature**
- Can we *evolve* wheeled mechanisms through a gradient-based process?



# Why is a wheel round?

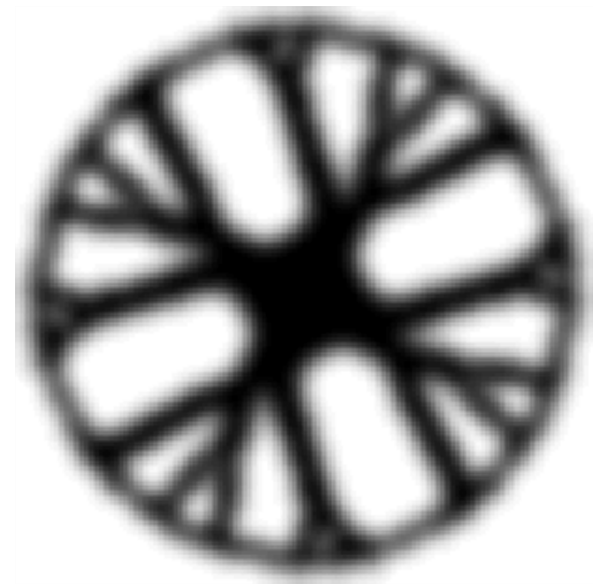


# Results



# Future Outlook

- Can we learn about the natural environment that led to the invention of the wheel?
- Can we learn about the *technological* environment?
- What would an optimal wheel look like ...
  - on a sinusoidal terrain?
  - in a non- uniform gravitational field?
- Can we use this framework to create novel design concepts?



# Thank you!

