What is a good actuator?
Alternative Mechanisms for Powered Ankle Prostheses ??

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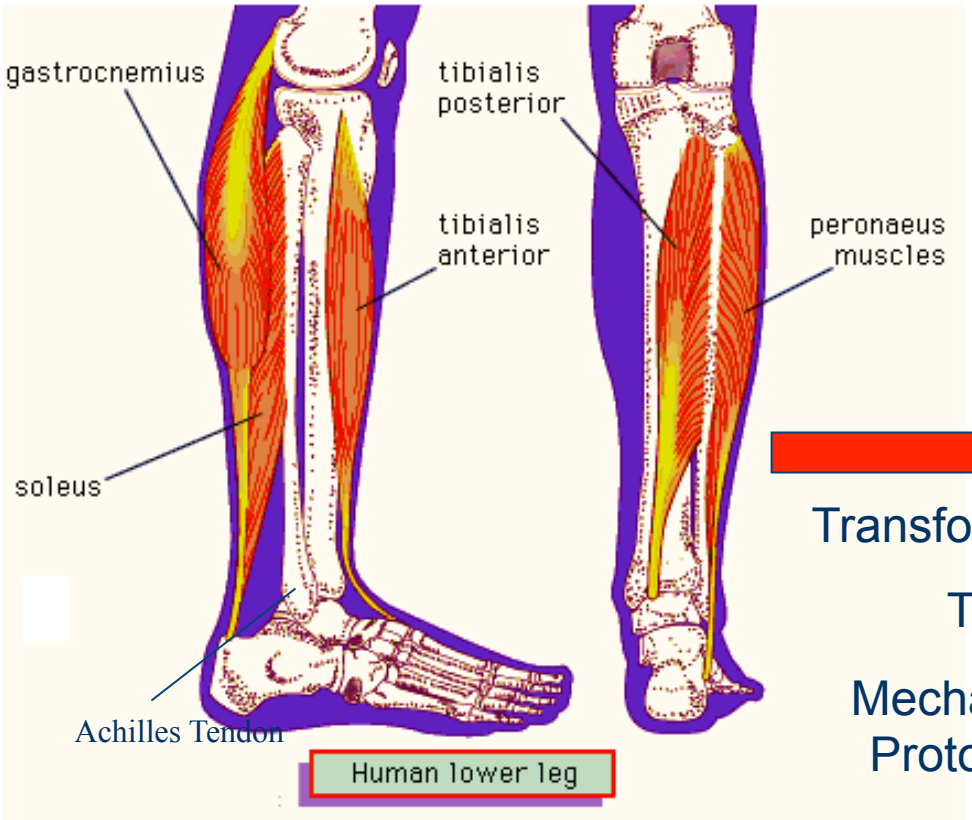
from Biology to Mechanics

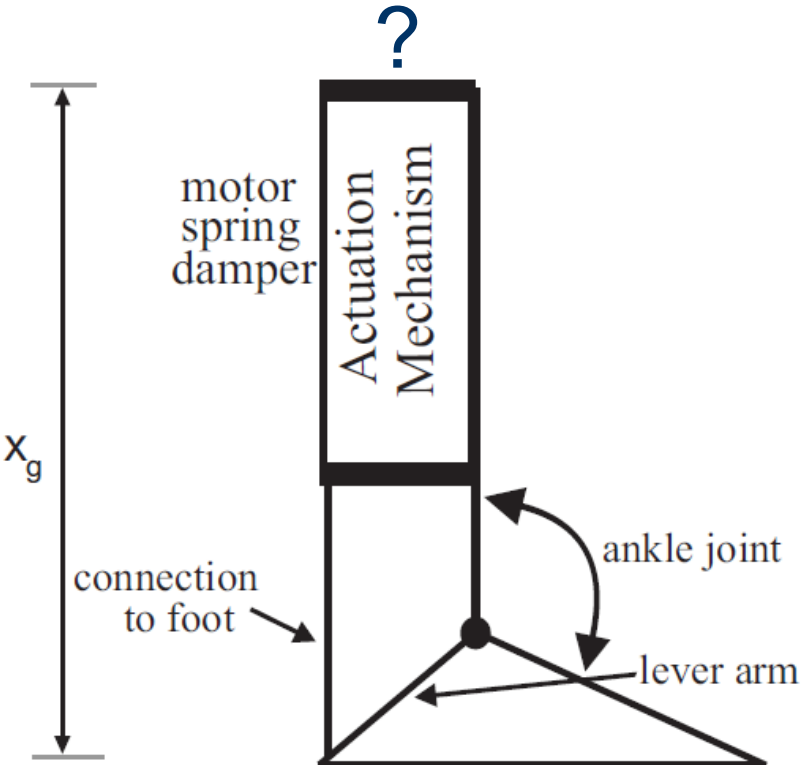


Biology

Transformatio

To

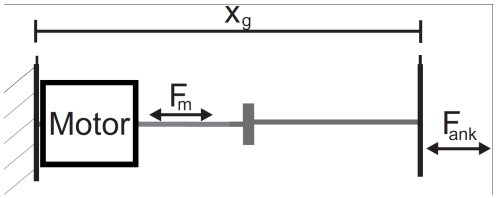
Mechanical Prototype

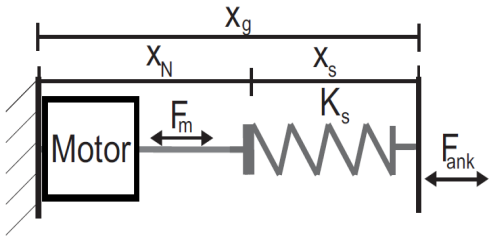


Objectives could be :

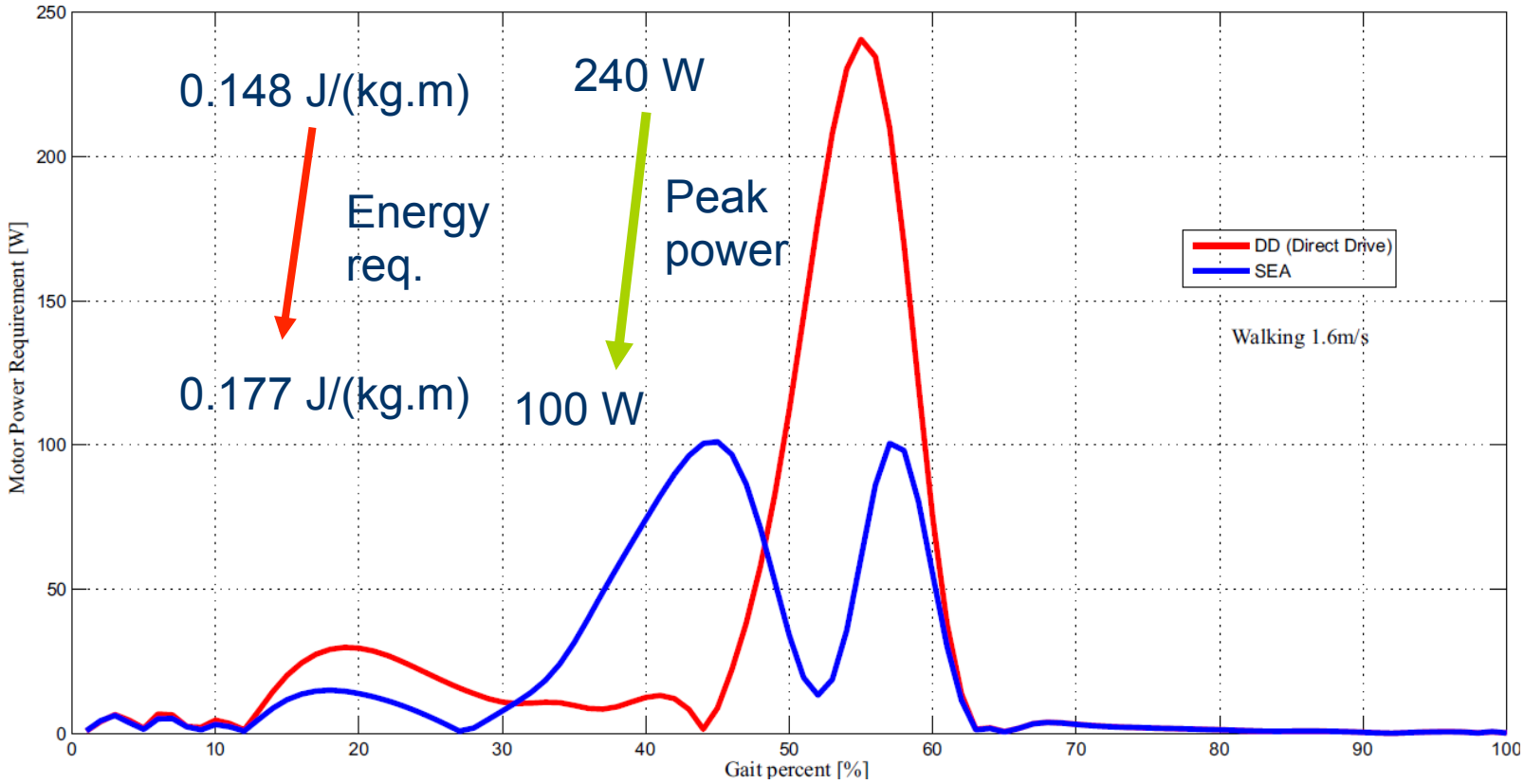
- Ability to reproduce movements like biological counterpart
- Power-energy /mass 
- Energy efficiency
- How well it interacts within network of joints (self organization, with low control effort)
- Adaptivity to uncertainties of terrains and surfaces
- ....

What is a good mechanical representation of the biological muscular structure?

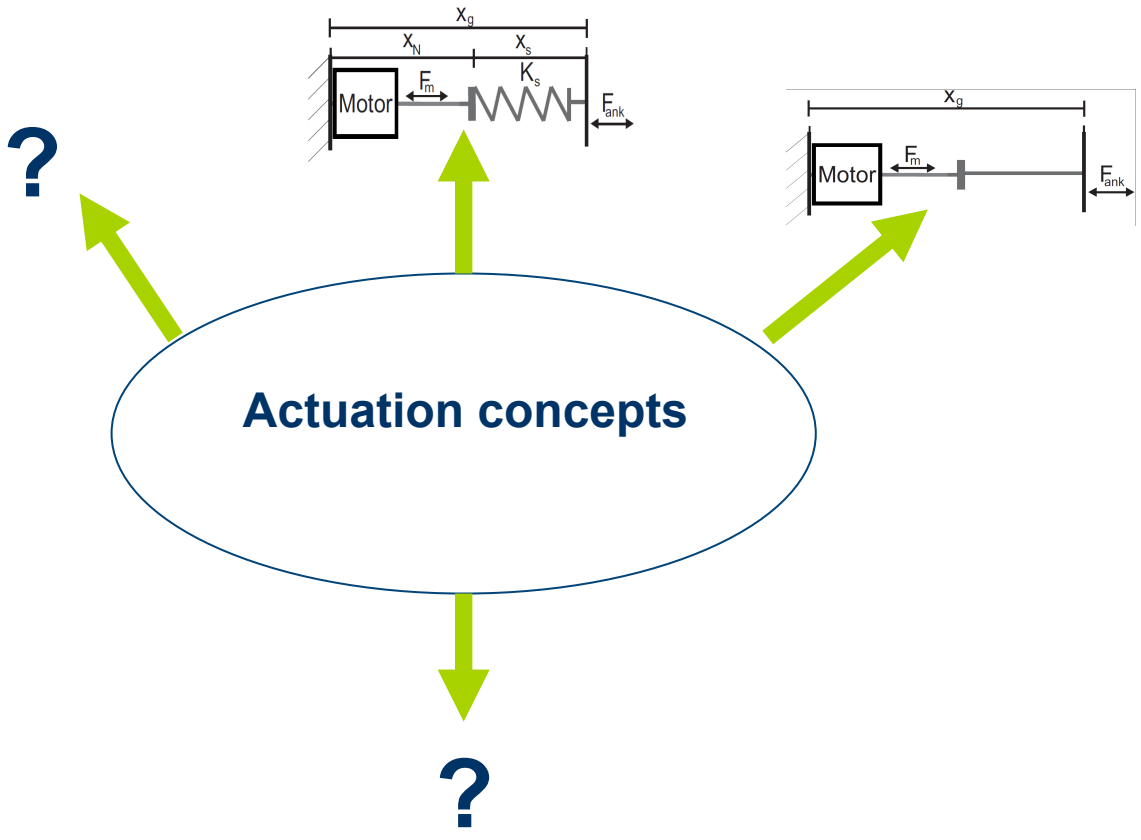




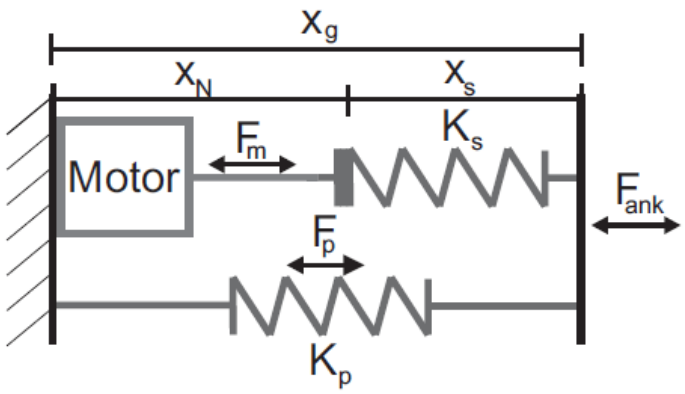
DD (Direct Drive) Vs. Series Elastic Actuator (SEA)



Could be other better alternative actuators??

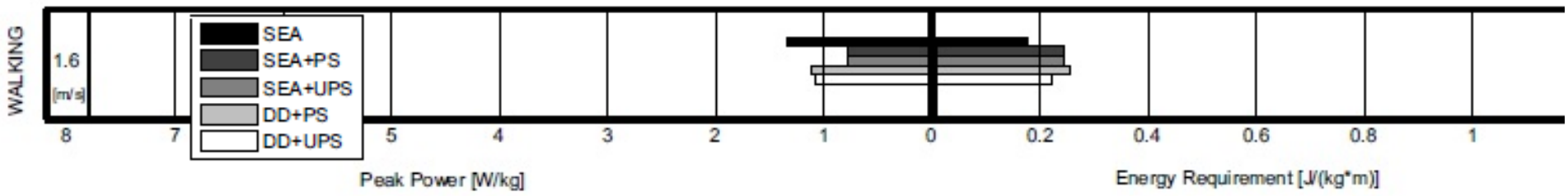


Parallel Elements adding to an SEA



SEA+PS (or UPS)

RESULT:



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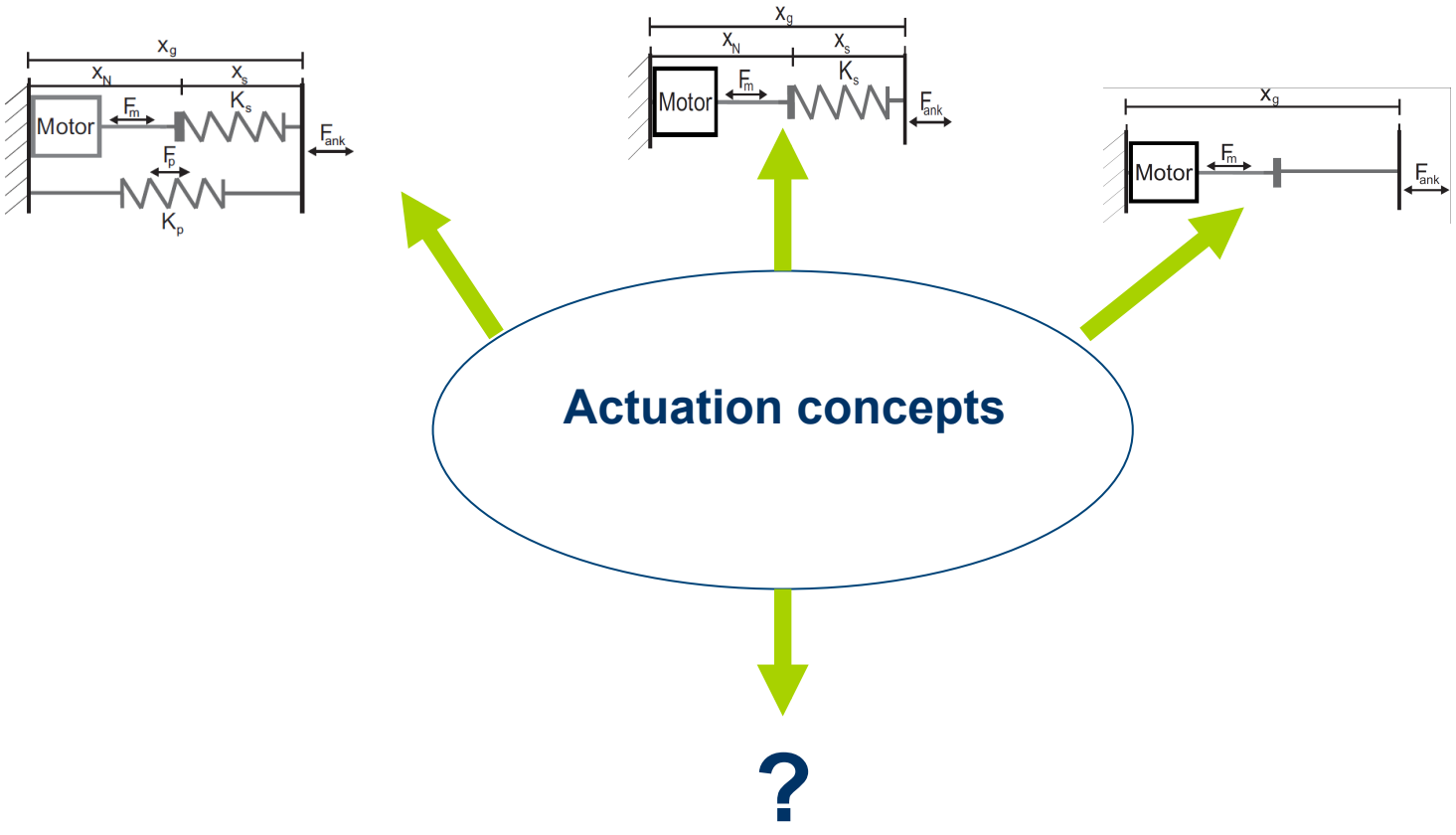
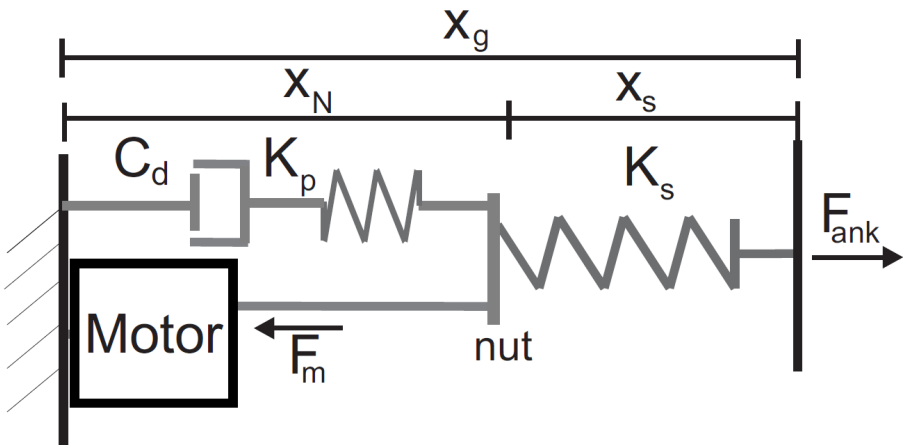


Parallel Elements (spring and damper) adding to an SEA



SE-PE+SD

Advantages

- Reduce motor force
- Capable of energy storage
- Energy and shock absorption

Disdvantages

- Phase dependency
- Required control policy
- Force-velocity-position dependency

Summary

- SEA actuator was very promising
- Still there is room for work because energy requirements should be reduced to get closer to biology

- Knowing these points, what is a good approach?

Outlook:

- Switchable parallel spring (Clutch)
- Unidirectional parallel Spring
- Adding Hill Type Properties to Motor (limitations with regard to Torque-velocity)
- Comparing with the case DC motor‘s properties are taken into account
- How Control Policy and Mechanical design interact with each other
- Unclutch the motor in some part of the gait
- Spring attached to the middle of another spring
- Tunable damper in series spring-parallel spring