Mechanism Feasibility Design Task

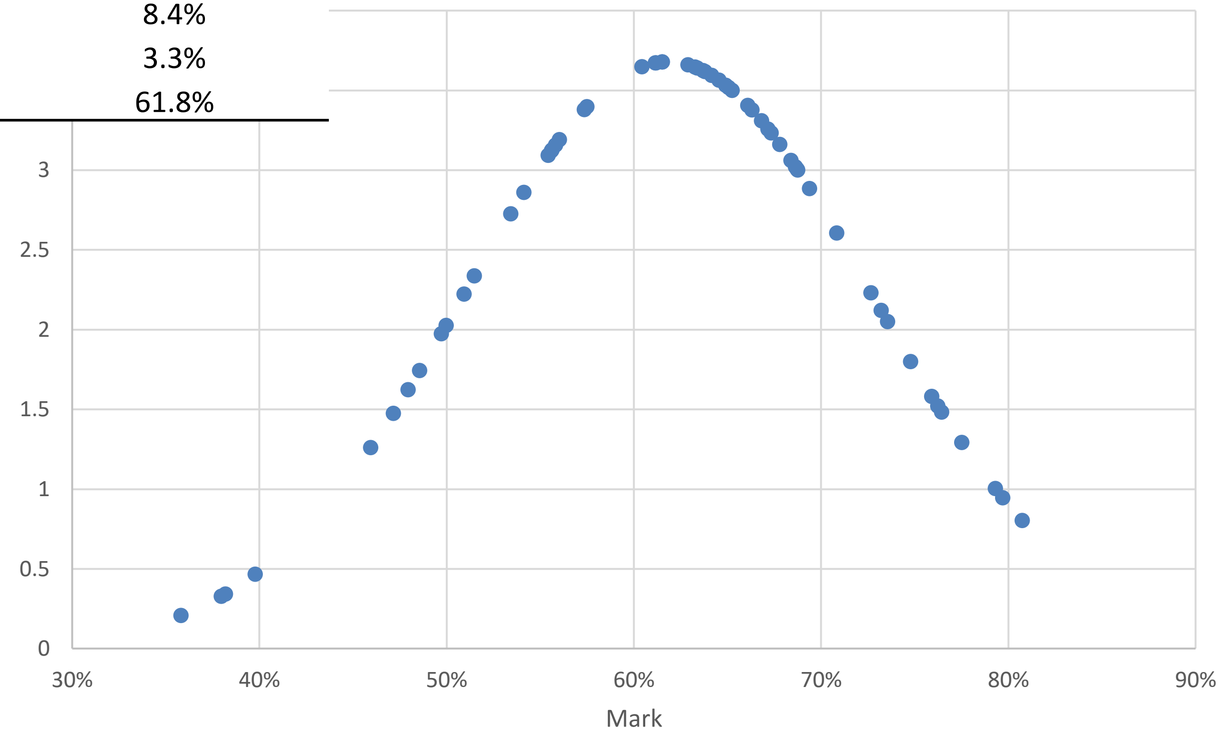
Dr. James Gopsill

Contents

Machine Design: Shaft Design Feedback

Dr Chris Snider

	Student Score
Initial PDS and diagrams	4.8%
Design Report and Final PDS	24.3%
Calculation Report	14.9%
GA drawing of shaft	6.1%
Detailed drawing of shaft	8.4%
Report (content and presentation)	3.3%
Total	61.8%



Design Section	
PDS	
Thoroughness of specifications	65.8%
Target values	74.6%
Assessment performed / considered	69.5%
Flow Diagram / Process Description	
Completeness	68.4%
Clarity	84.7%
Design Report	
Arrangement choice	68.9%
Shaft refinement process	54.2%
Bearing selection process	75.1%
Sprocket and chain selection process	70.1%
Fixings - bearings	57.6%
Fixings - sprocket	55.9%
Fixings - spool	56.5%
Materials selection	54.8%
Safety factors	70.1%
Component assembly	48.6%
Maintenance	50.8%
Manufacture	48.0%
Operation	42.4%
Assumptions made	61.6%
Discretionary	57.3%
Totals	60.8%

- PDS very good

- Flow diagram or process description very good too

- Selection processes OK – well described and justified for the most part

- Safety factors generally good

- Fixings:
  - Lots of detail given, generally OK in what was chosen
  - Keyways can't be square at the ends
  - Use shaft steps!
  - Be consistent – circlips or locking rings, not both
  - Floating bearings need location at the extent of their motion

- Assembly / manufacture / maintenance was often a bit of an afterthought

- Assumptions were often unjustified

Calculation Section	
Process, Design Decisions and Iteration	
Fundamentals calculated	96.6%
Cable mass and length	54.2%
Axial load	66.1%
Material UTS and UYS, SYS	84.7%
FBDs	60.5%
Reactions, moments	70.1%
Shear, bending, torsional stress	63.3%
Principal stresses and max shear	59.9%
Safety factors	69.5%
Stress concentration factors	53.7%
Shaft dimensions and stresses	59.3%
Component diameters	65.0%
Worst cases	37.3%
Discretionary	57.1%
Totals	59.6%

- Most people did well in most areas.
- Issues in presentation of information, rather than the analysis itself
- We didn't just want to see equations, we wanted to see how you used them and how this informed your design process
- Stress concentrations often just showed the graph, but didn't show calculations

Worst case scenarios / analysis scenarios:

- Why were you doing your analysis the way you were?
- Cable wound or unwound? Point loads or UDLs? Cable in the middle or at the end?
- This was usually not discussed in much detail

Sub-assembly drawing	
Can be CAD or hand-drawn	
Area	
Sectioning	37.3%
Dimensions	59.3%
Titles and labelling	93.2%
Views and layout	59.9%
Parts List	65.4%
Discretionary	55.6%
Totals	60.9%

Detailed Drawing of Shaft	
Can be CAD or hand-drawn	
Area	
Scale	57.6%
Selected views	81.4%
Chamfers	50.8%
Lines - centre and section	66.1%
Surface finish	83.1%
Shaft steps	66.1%
Tolerances	45.8%
Titles and labelling	89.8%
Defaults	46.9%
Layout and Clarity	62.1%
Dimensions - Completeness	61.0%
Dimensions - Layout	59.3%
Detail views / Sections	47.5%
Discretionary	51.0%
Totals	56.0%

Lost the most marks:

- Do NOT hatch rotationally symmetric components cut along longitudinal axis unless absolutely necessary
- Scales should be standard (2:1, 4:1, 5:1, 10:1, 20:1, 50:1)
- Missing chamfers, centrelines, tolerances, surface finish
- Default values – surface finish, tolerance, machining
- Dimensions
  - Should all come from a datum face to avoid tolerance build-up
  - Should not sit inside the part
- Missing detail views that would help with small details
- Detail views should be well labelled, lined up, in order
- Should show fixings for all components in detail
- Should show overall sizes, critical dimensions (i.e. distance between mounting points)
- Parts list OK – part name, part number, quantity, material, code (if applicable). Balloons should be lined up and in order where possible

Report (Presentation)			
Award marks for report structure and layout only. The above c			
Area			
Referencing			74.6%
Titles and labelling			74.6%
Figures			66.1%
Quality of English			67.5%
Structure			61.0%
Discretionary			62.0%
Totals			65.9%

Good overall

Some issues in structure and inter-linking – tying together the analysis and its implications for the design and the process that you followed.

Design section benefits from images as examples – don't describe the bearing, show us a picture of it!

Steps are a good thing!

- Lots seemed to be aiming for a constant diameter
- Steps give a locating surface with high accuracy – how do you get your fixings in the right place?
- Not much effort to machine
- Constant diameter can make assembly difficult or impossible

Linking analysis with design process

- Often kept separate
- We want to see the values you have achieved in the design report as part of your rationale, and then flick to the calculations to see how you reached those values

Evidence of iteration using analysis and stresses was often poorly described

Last Week

Introduced you to:

- Systems Modelling in Simulink
- Modelling a Pendulum

Where you should be at:

- Boundary Calculation
- Modelled Pendulum
- Powering a Single Mass by a Motor

Product Design Specification

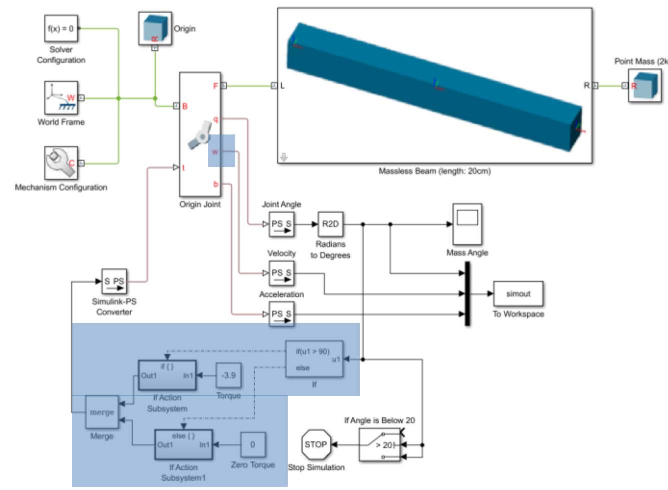
Concept Design

Concept Selection

Stage-Gate

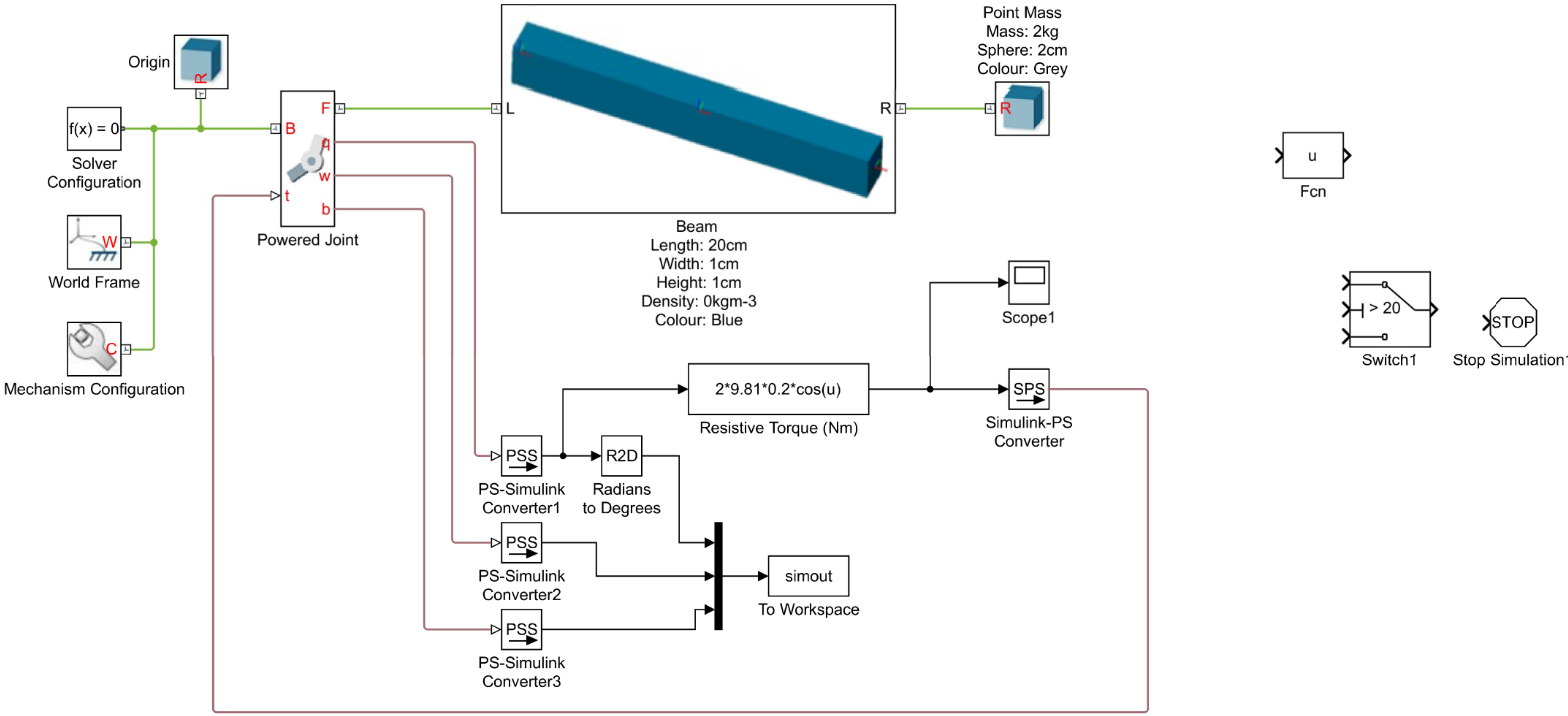
Deployment Modelling

Motor & Gear Ratio Selection

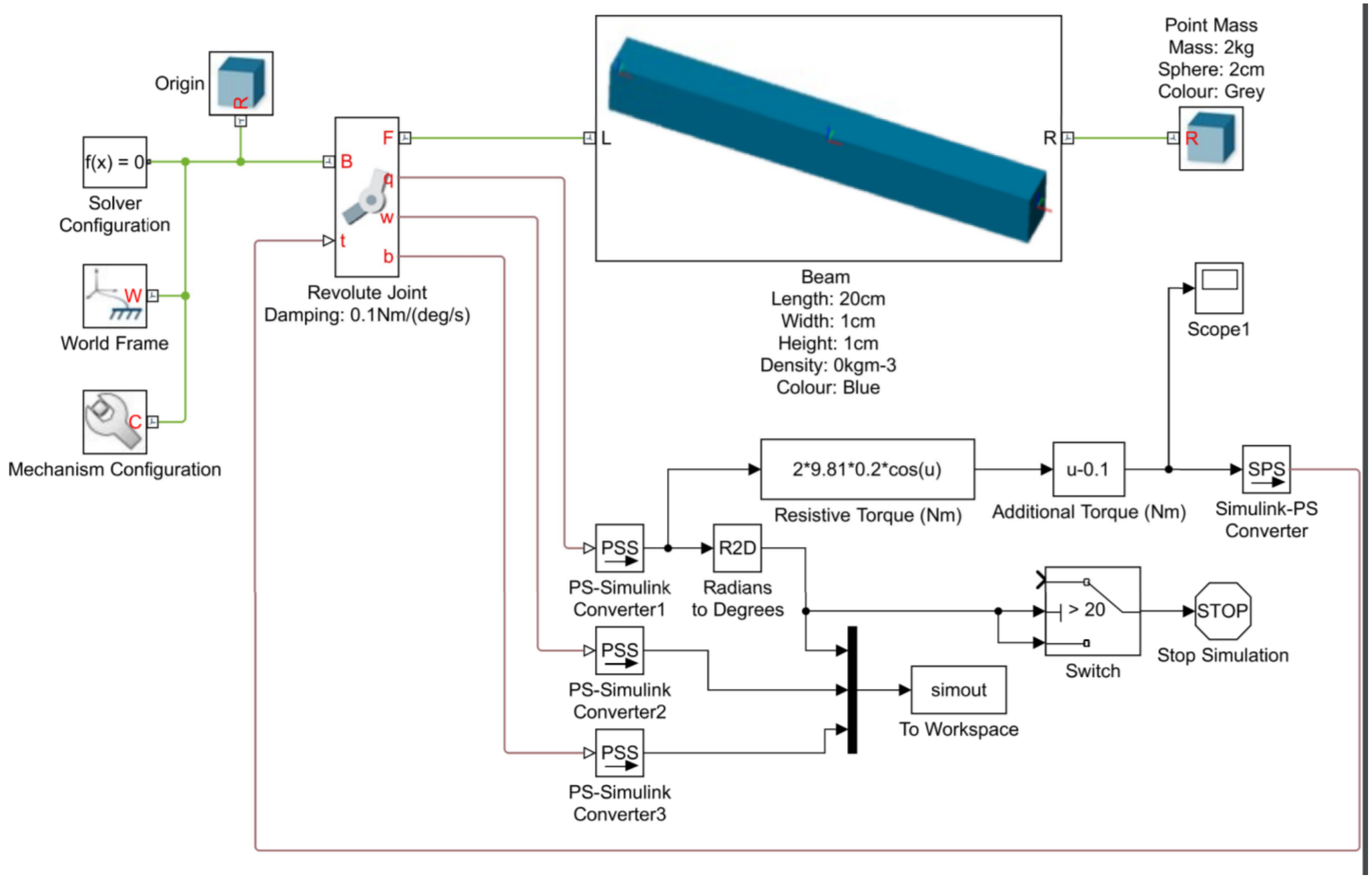


Happy to Continue?

Stopping a simulation at a specific point



Stopping a simulation at a specific point



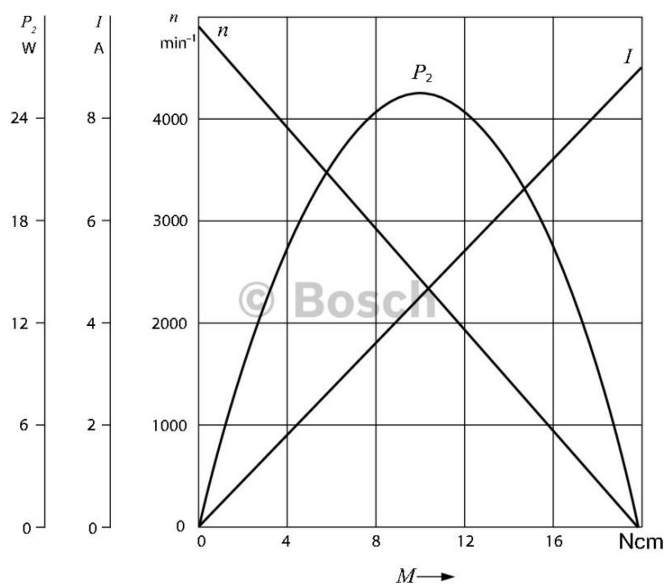
Damping

Linear Dampers

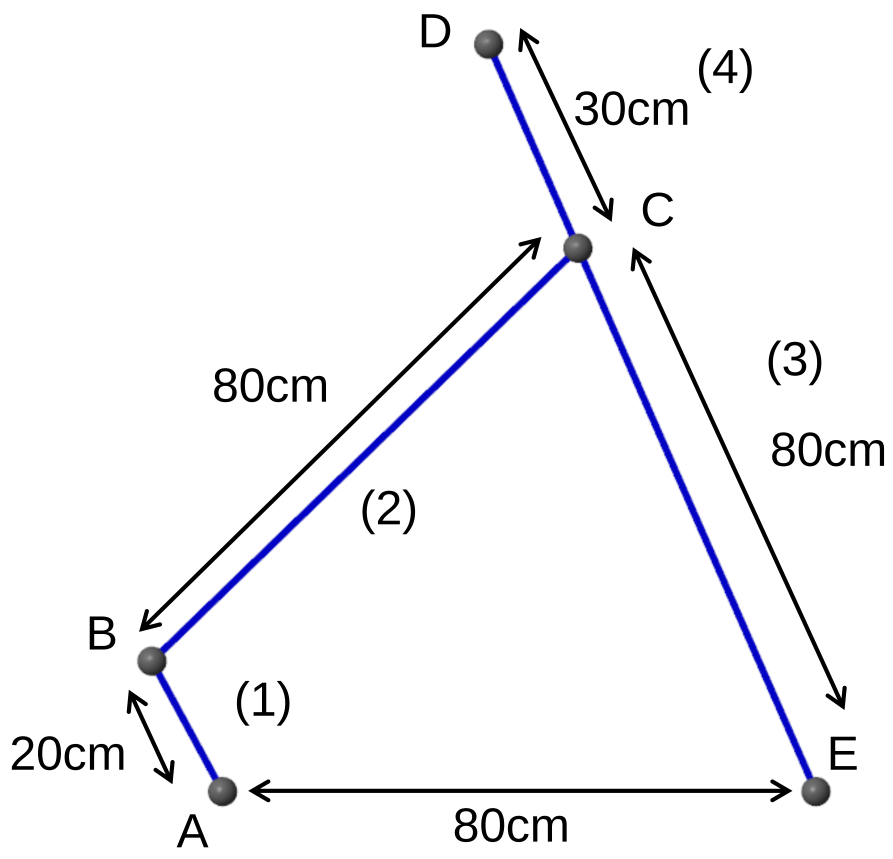
Rotational Dampers

Provide a smooth motion

- Prevent people trapping their fingers
- Safety if an element breaks
- Motor over-speeding



Demo: Four-Bar Mechanism



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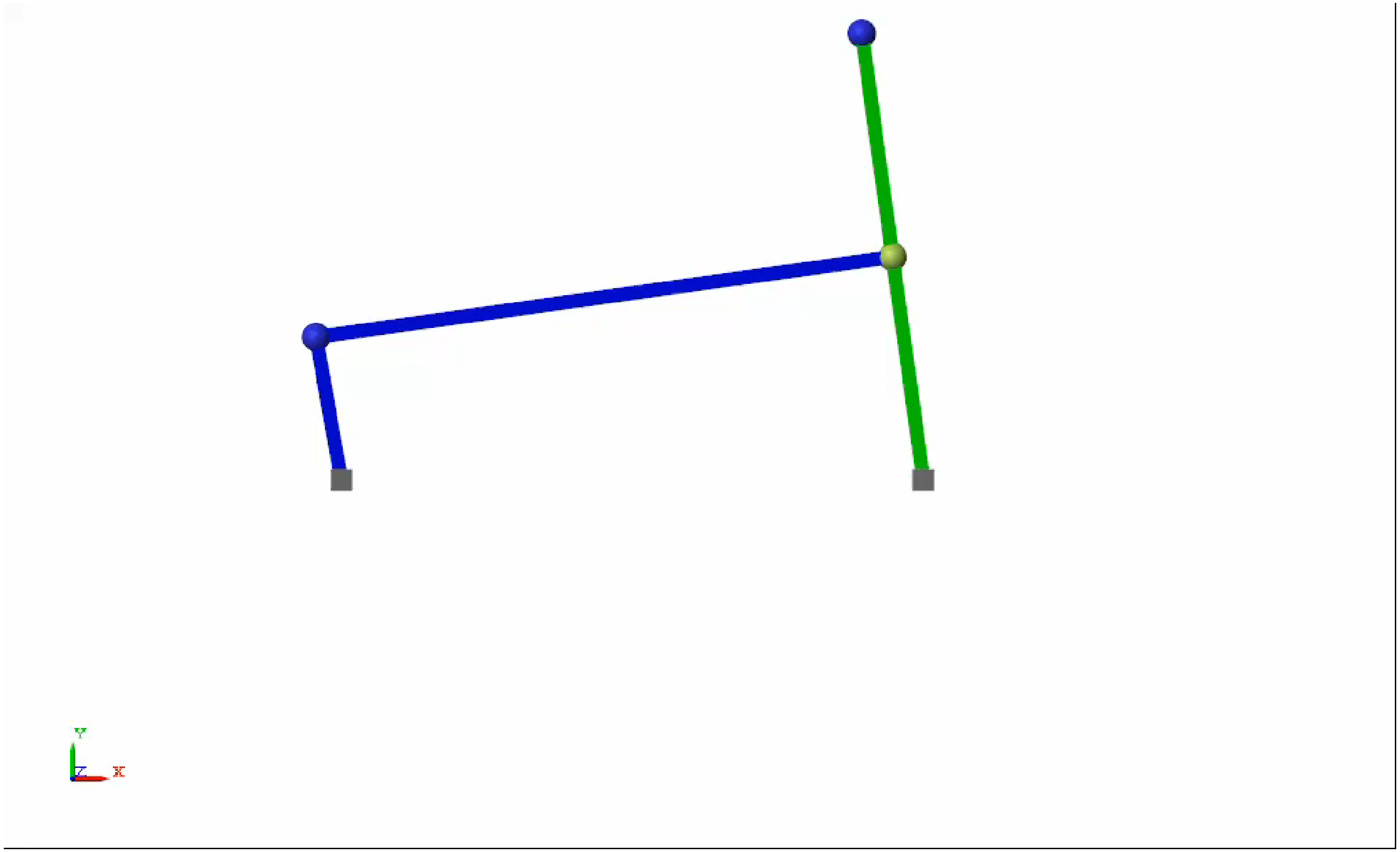
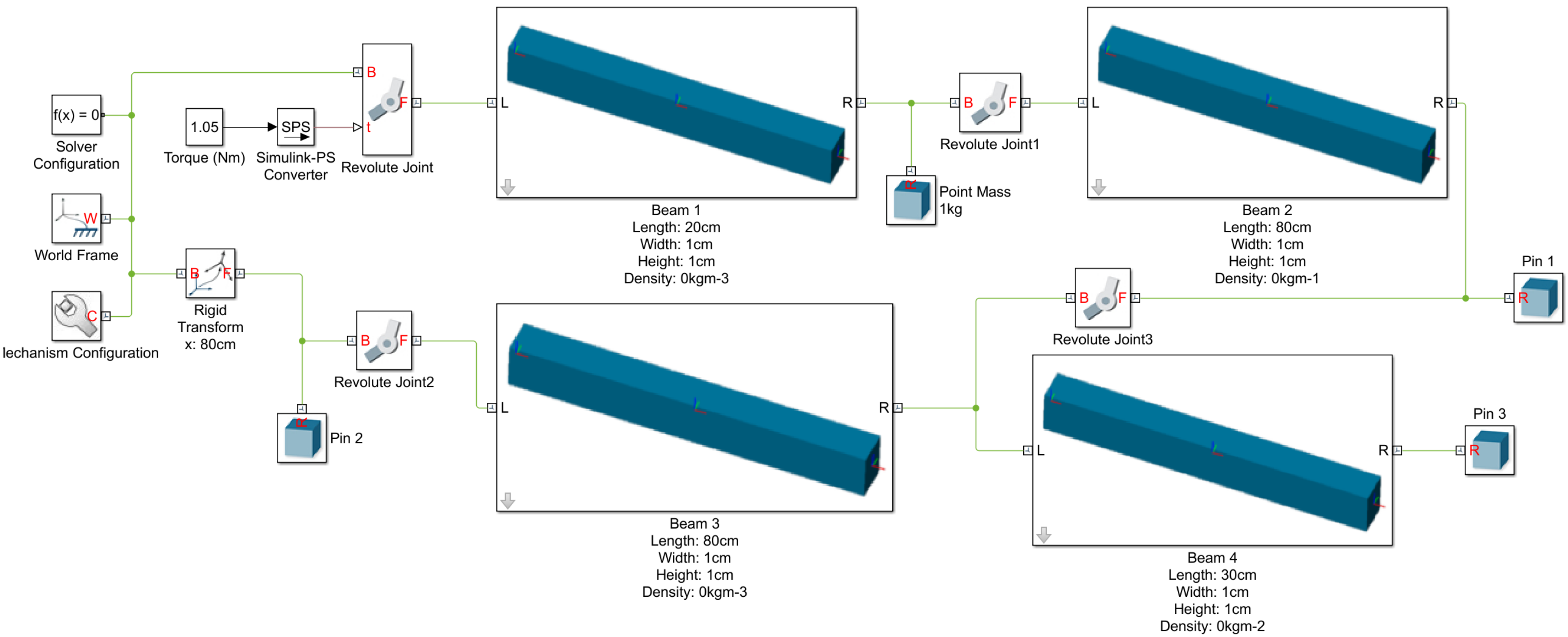
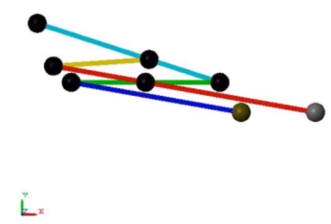


Demo: Four-Bar Mechanism

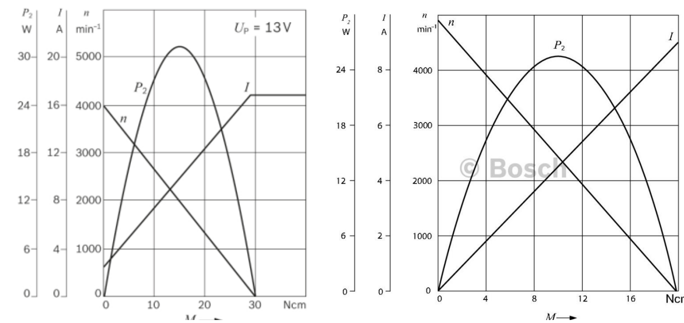


Designing Your Mechanism Model

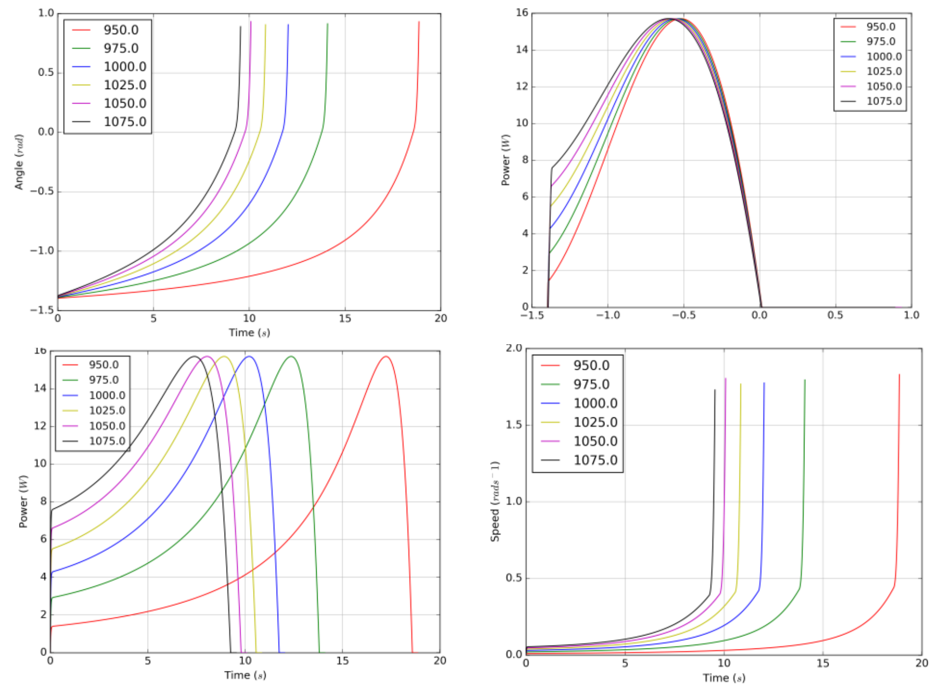
1. Build pendulum model powered by a motor & gearbox
2. Build a separate multi-bar mechanism of your model
3. Combine the two
4. Add damping to prevent the motor over-speeding
   - Otherwise place an IF statement to represent ‘disconnecting the motor’ from the mechanism at higher speeds



Why are we doing this again?



- To investigate various motor and gearbox ratio combinations
- Evaluate the energy required by the system to deploy
- Determine the damping required to keep the motor within its operating window



This Week

- Complete your mechanism model in Simulink
- Iterate a variety of motor, gear ratio & damping values
- Use this to support your decision on the appropriate motor, gear ratio and damping required