Mechanism Feasibility Design Task

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   - Pendulum
   - Fix it in position
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6. This Week

But First!

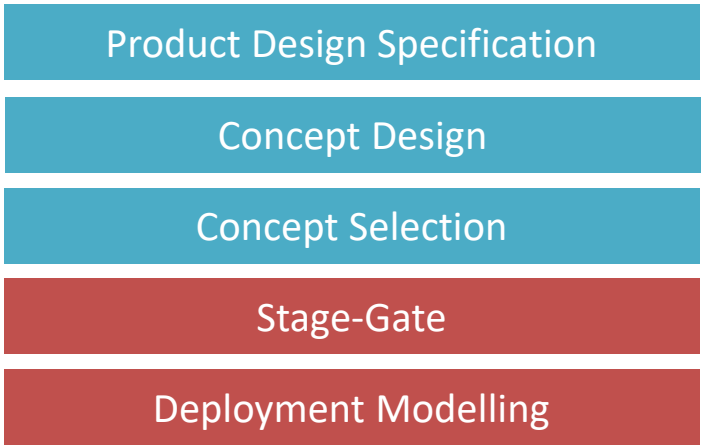
Points of Clarification

- Soft-top roof – lecture 2
- No sliding pins (time constraints) – lecture 2
- Unable to get Linkage on the University PCs this year
- Your criteria is your PDS

Criteria	Concept 1	Concept 2	Concept 3	Concept 4	Concept 5	Concept 6
Ease of use	DATUM	+	+	-	-	S
Aesthetic appeal		-	+	+	-	-
Manufacturability		+	+	-	+	+
Low weight		+	-	+	-	+
Energy efficiency		S	+	-	+	+
Safety		-	+	S	-	+
Σ+		3	5	2	2	4
Σ-		2	1	3	4	1
ΣS		1	0	1	0	1
Net Score	0	1	4	-1	-2	3
Rank	4	3	1	5	6	2
Continue or combine?	Combine	Combine	Yes	No	No	Yes

YOUR PDS!!

Last Week



We looked at:

- Product Design Specifications Techniques
- Concept Generation Techniques
- Concept Selection Techniques

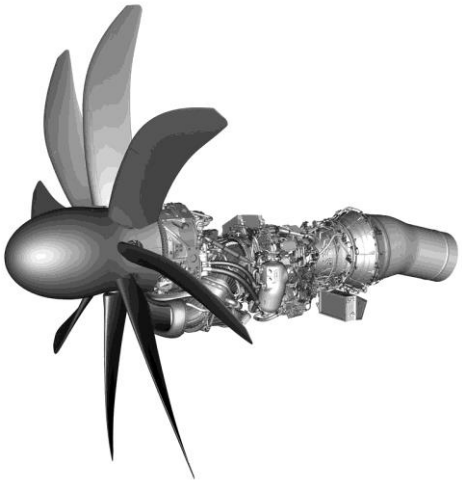
Where we should be:

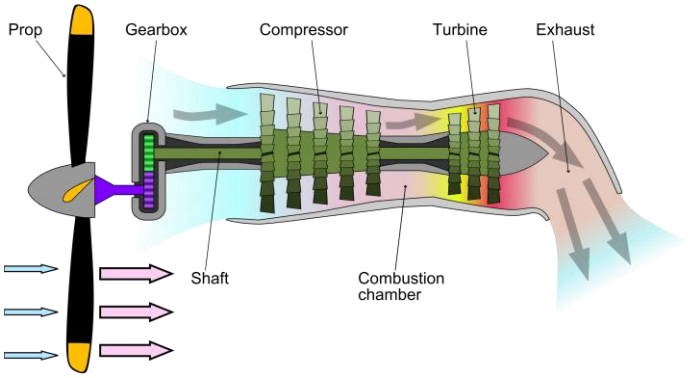
- Formed Product Design Specification
- Generated Concept Designs
- Started to Select a Concept to Carry Forward
- Ready for the Stage-Gate Submission

Systems Modelling

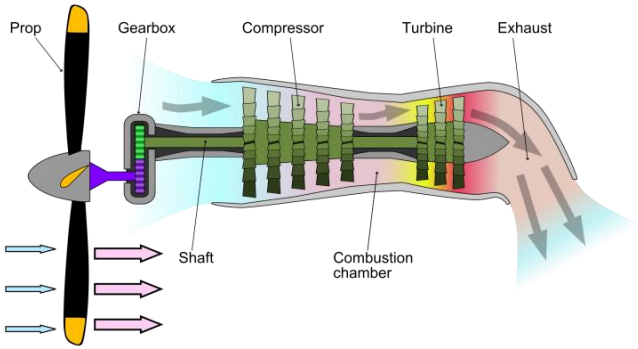
Systems Modelling

The development of models that simulate complex engineering systems that often span multiple engineering disciplines





Systems Modelling (illustration)



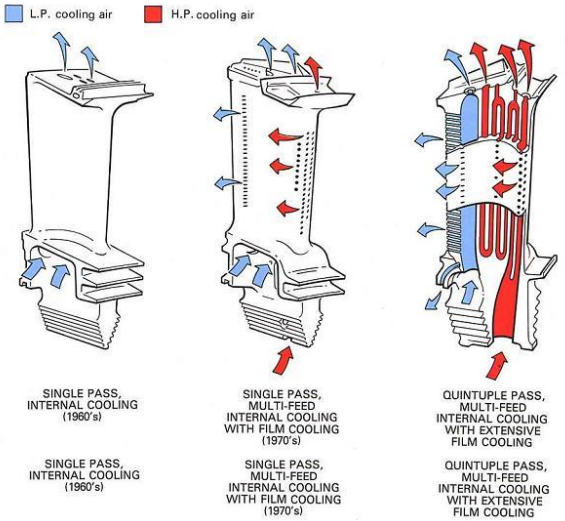
Systems Modelling

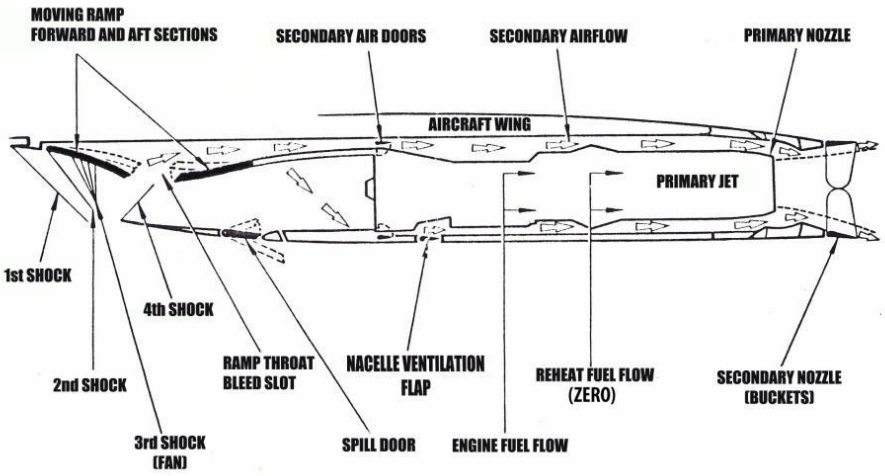
Not forgetting!

- Fuel system
- Cooling system
- Lubrication system
- Engine start system

Other Jet Engines

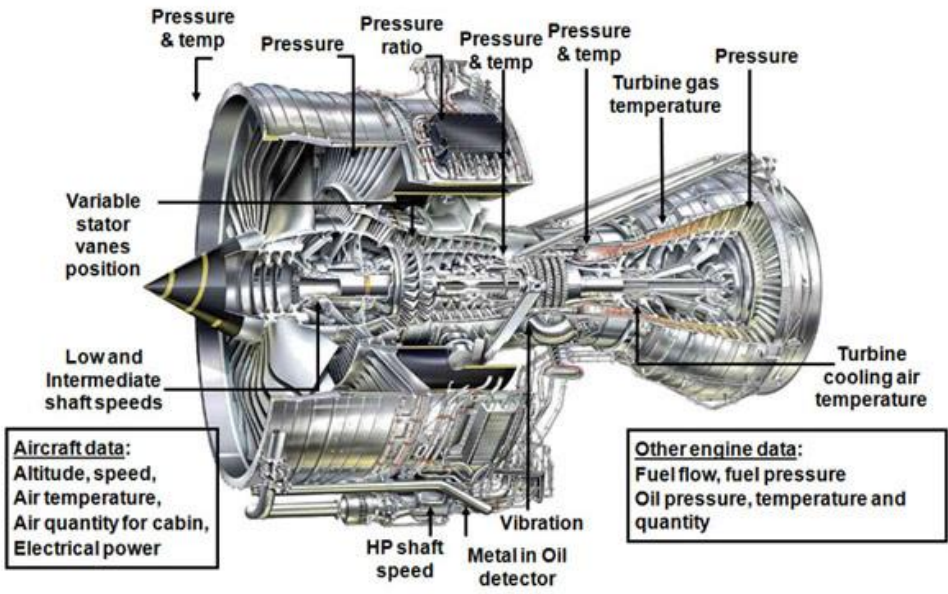
- Varying intake
- Reheat





Systems Modelling (Why?)

- Global optimisation of the products design
- Performance analysis
- Sensitivity analysis
- Product health monitoring
- Diagnosis of product issues
- Pass-off tests



Convertible Roof as a System

Electro-mechanical system

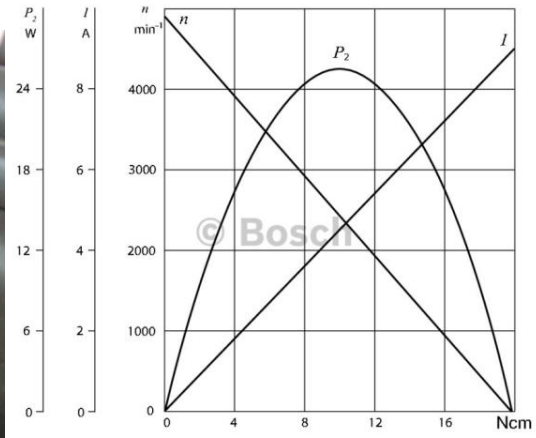
1. Electric Motor
2. Worm Gear
3. Multi-Stage Gearbox
4. Connecting Rod
5. Multi-Bar Mechanism

(Illustration)

Convertible Roof as a System

Energy transfer through the system

- Power to the motor provides initial torque
- Torque travels through the gear box where the gear ratio will change the amount of torque delivered
- Which then drives the mechanism against gravity (initially)



Convertible Roof as a System

https://www.youtube.com/watch?v=UqcKYFU6VIg

Boundary Calculations

Boundary Calculations (Why?)

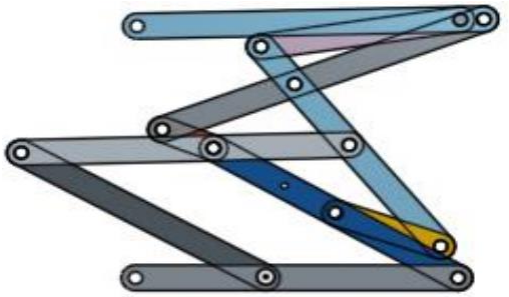
- Help us determine initial conditions for our models
- Provide a sanity check for our models
- Provides evidence for our initial component selection

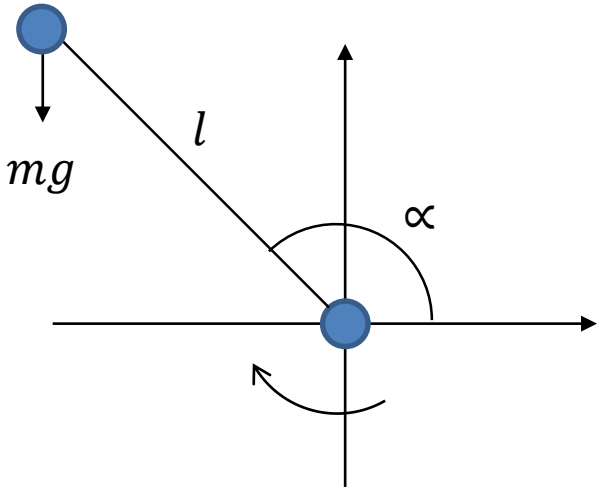
Boundary Calculations

What are our boundary conditions and what do we need to know?

Boundary Calculations

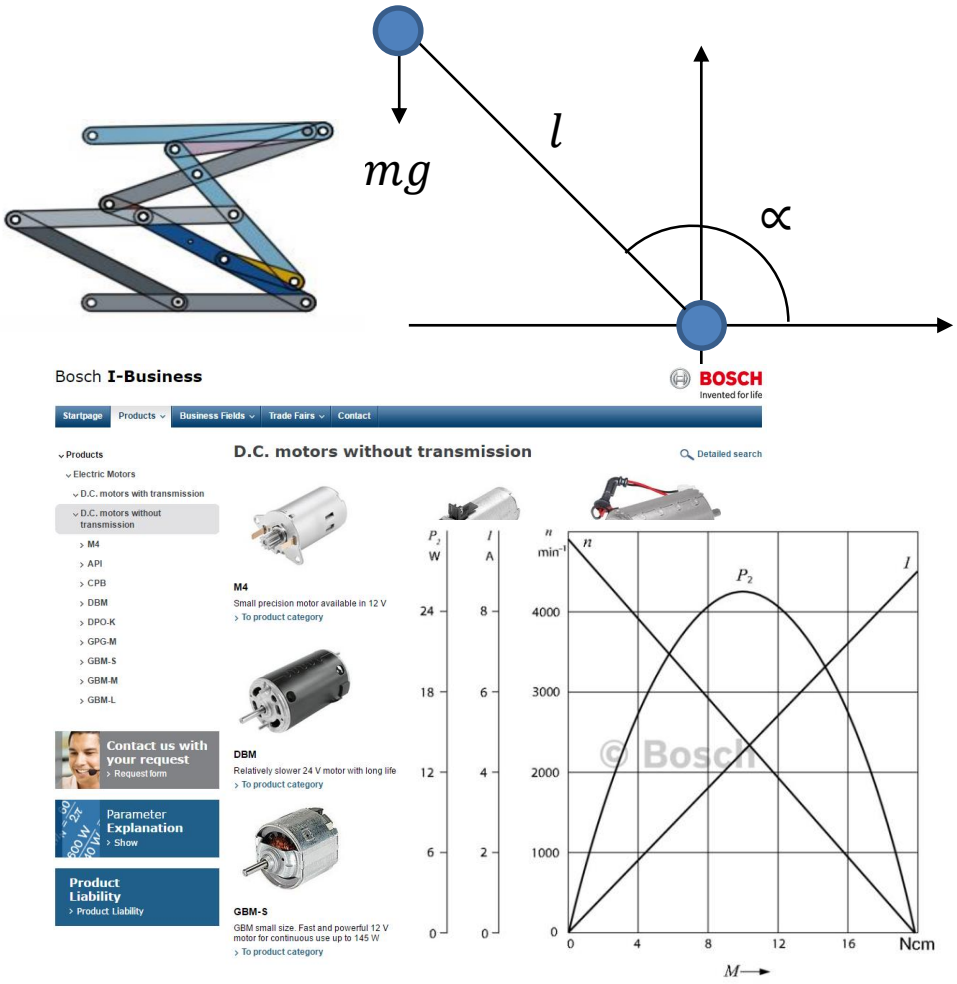
- What torque do you require to get the mechanism moving?
  - Assume a single mass
  - Think centre of mass





Boundary Calculations

- What torque do you require to get the mechanism moving?
  - Assume a single mass
  - Think centre of mass
- What motor and gear ratio is required to achieve this?
  - Select a motor from Bosch
  - Refer to your PDS when selecting the motor
  - Determine the gear ratio required
  - Note: you will need a gear ratio!
  - Record your rationale for your choice



http://www.bosch-ibusiness.com/boaaelmoocs/category/D.C.%20motors%20without%20transmission/114?locale=en_GB

Boundary Calculations

Design Report

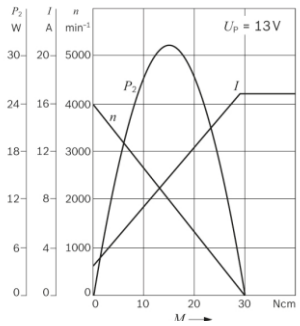
- Deployment Modelling (Boundary Calculations)
  - How did you calculate the torque required?
  - What were your assumptions?
  - From this information and your PDS, how did you determine the initial gear ratio & motor

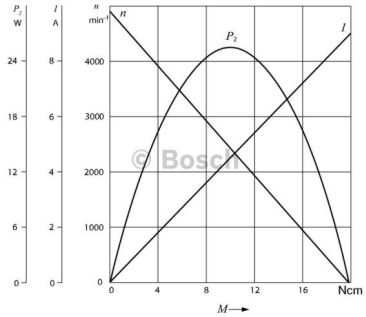
Modelling the System

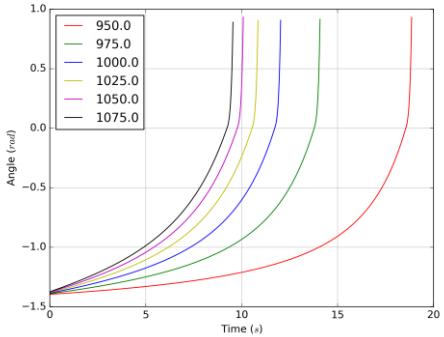
Modelling the System

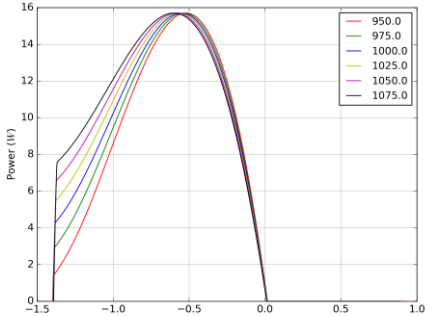
What do we want to know?

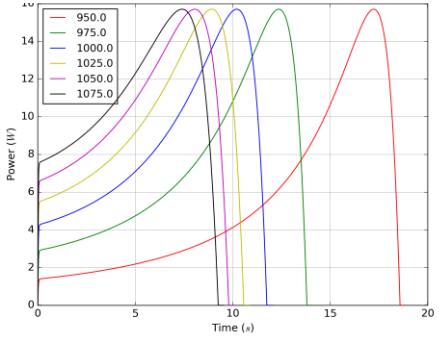
- Energy required to deploy the roof
- Time to deploy the roof
- To help us determine the final Motor, Gear Ratio and Damping values

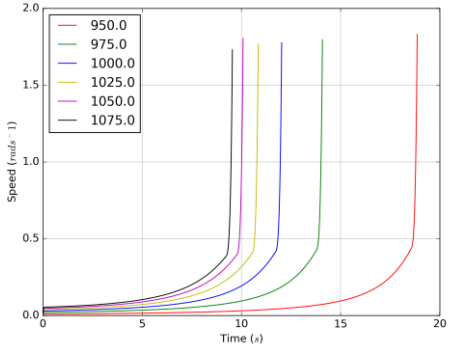








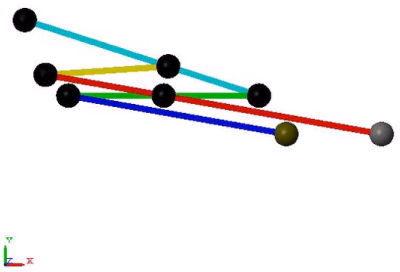




Modelling the System

What is changing over time?

- Torque provided by the motor
- Force due to gravity
- Inertia of the mechanism
- Mechanism
  - Acceleration
  - Velocity
  - Displacement



What remains constant?

- Gear ratio
- Mass of mechanism

Modelling the System

What assumptions are we making?

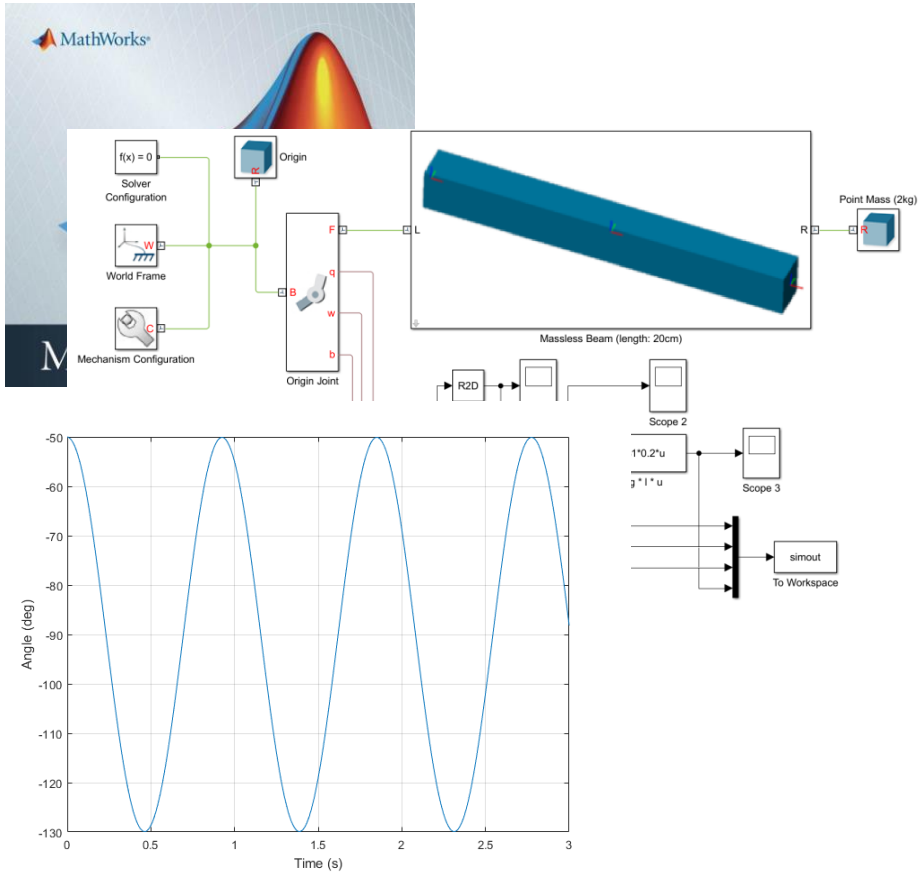
- Friction
- Air Resistance
- ?

If included, what effect would they have?

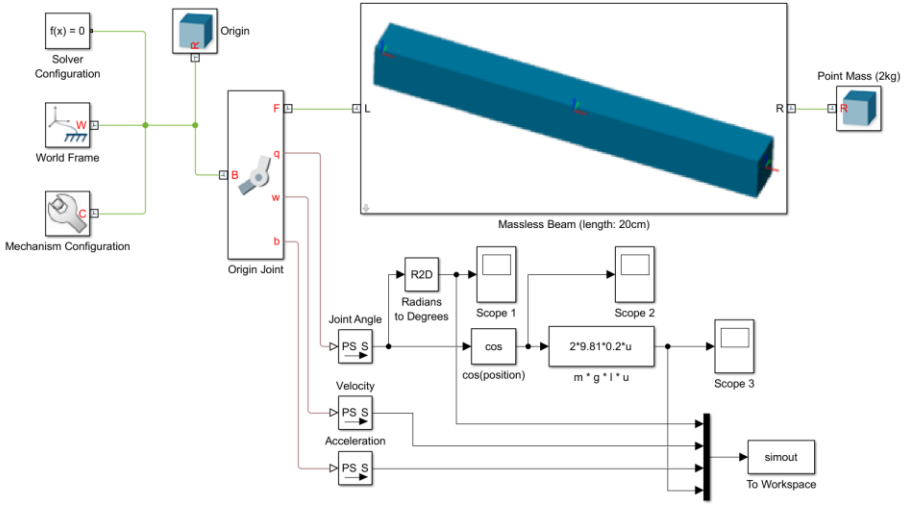
This is important to know so we can be analyse the results in the appropriate context. (Put this in your report)

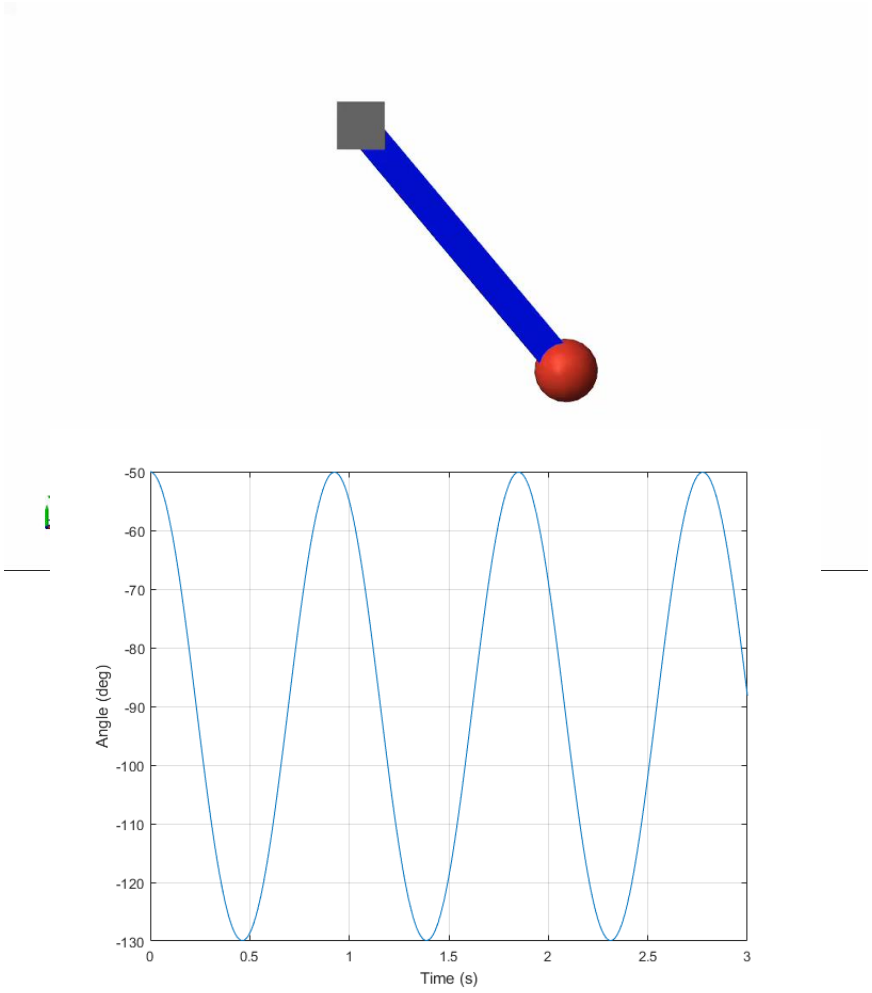
How are we going to model this?

- Simulink
- A block modelling language that is great for modelling systems.
- Blocks represent calculations that need to be performed.
- Handles the iterations and time domain for us
- We are going to use it to help us model the dynamics of a multi-bar mechanism

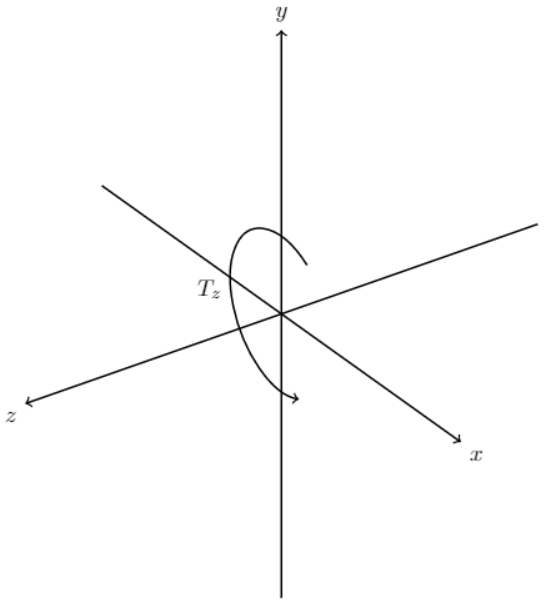


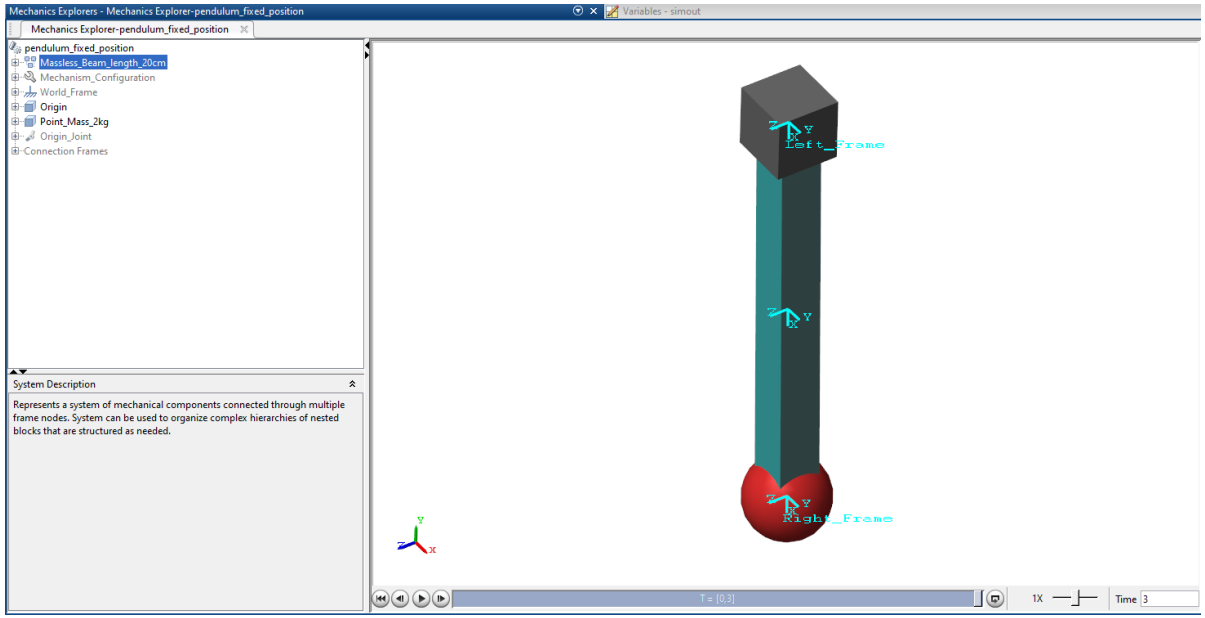
Demo - Pendulum





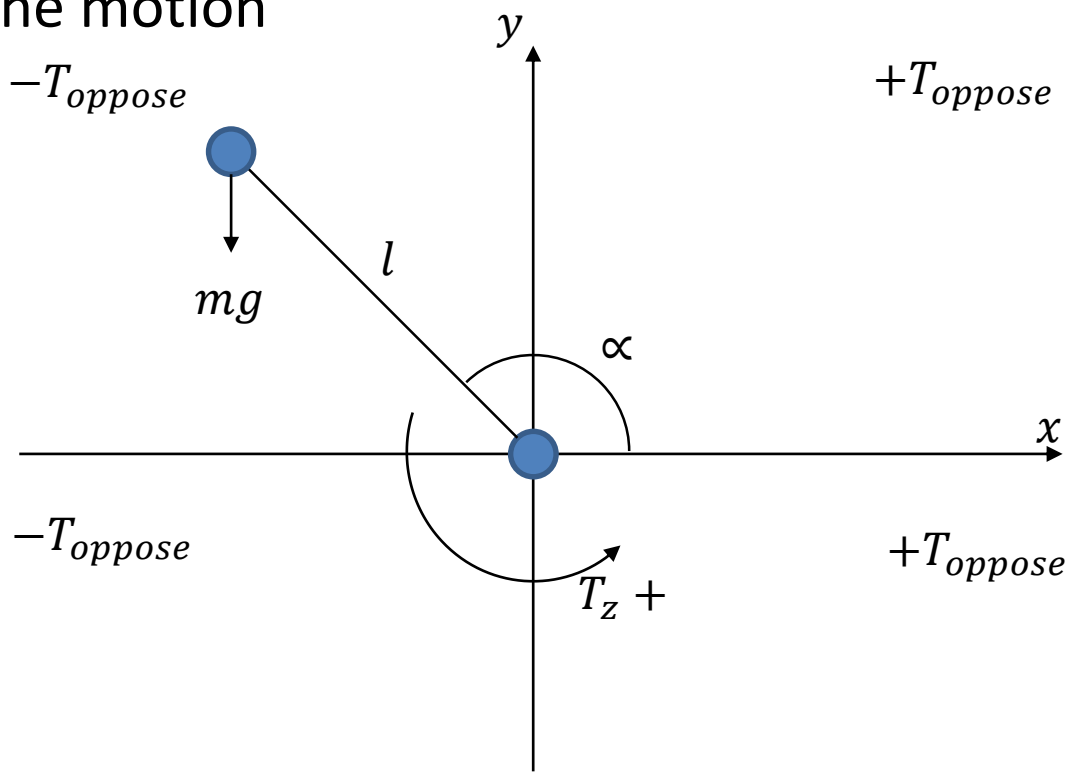
Co-ordinate System

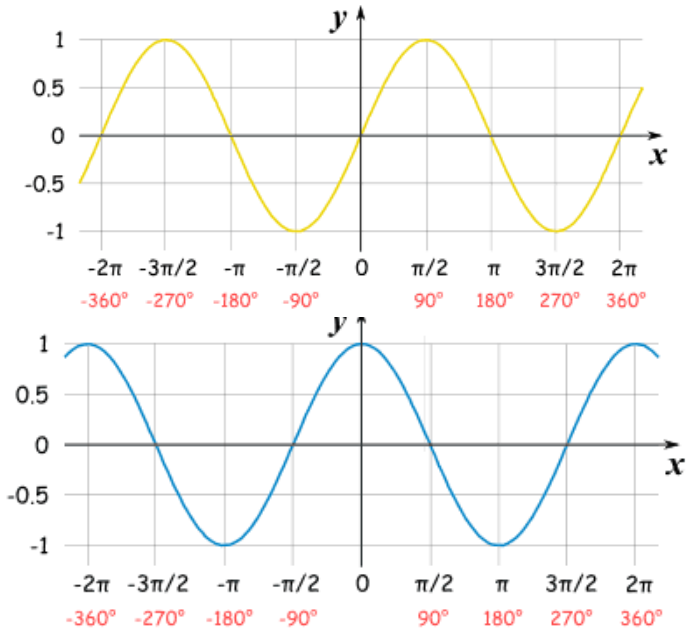




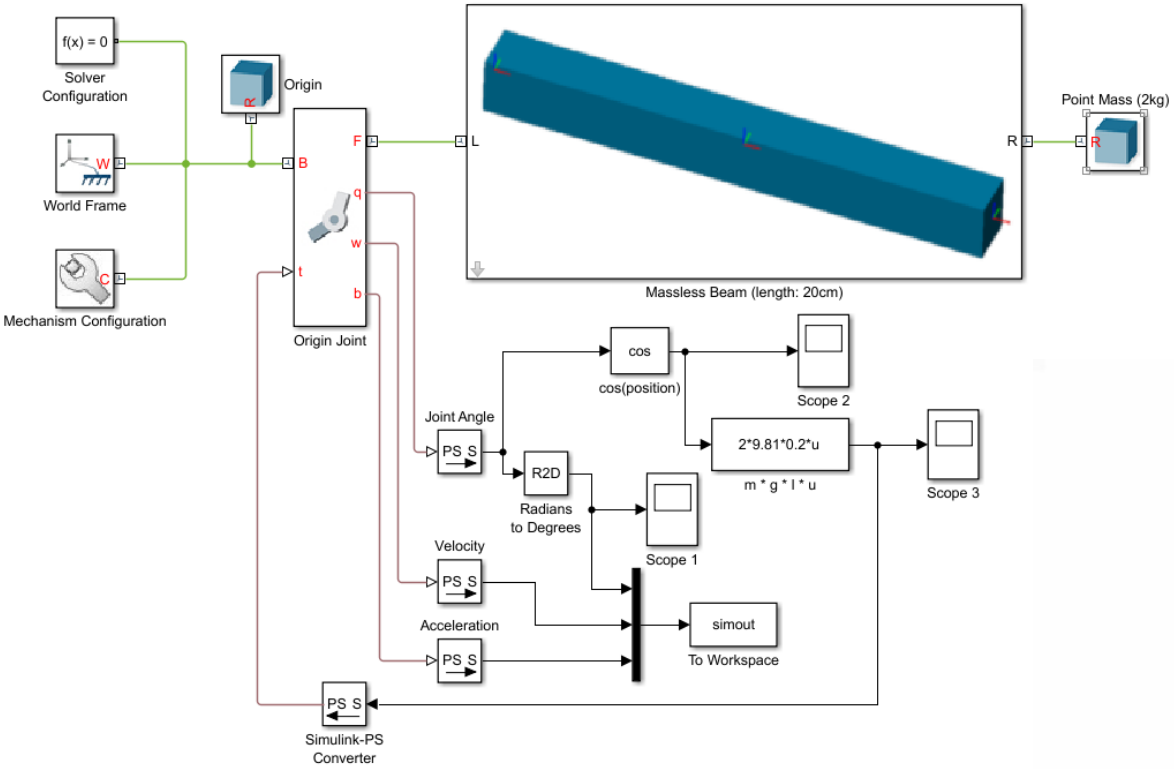
Fixing It Into Position

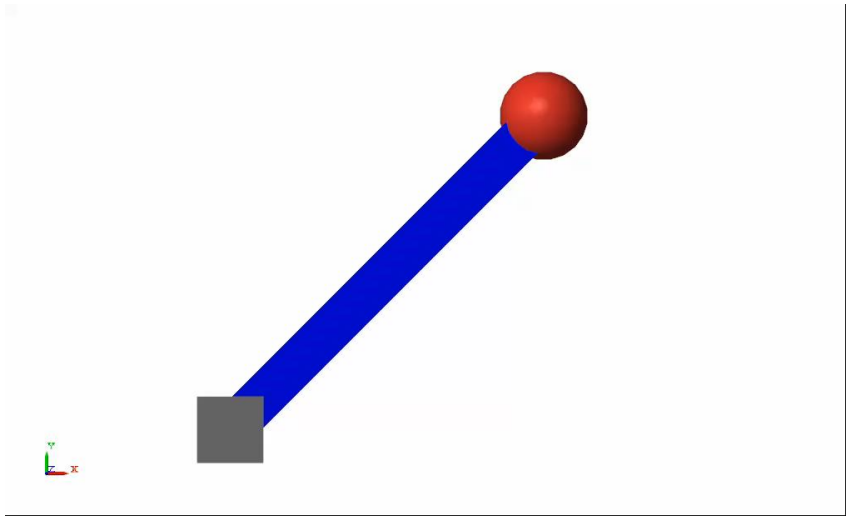
Calculate the torque required to oppose the motion



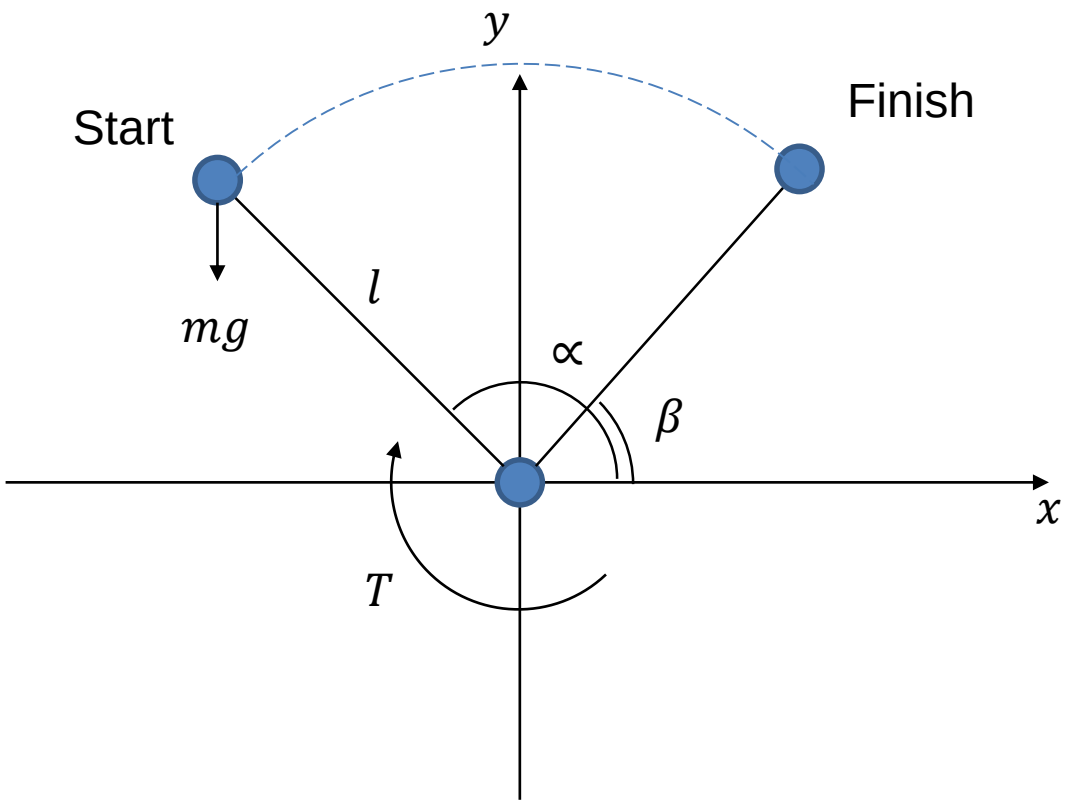


Fixing It Into Position



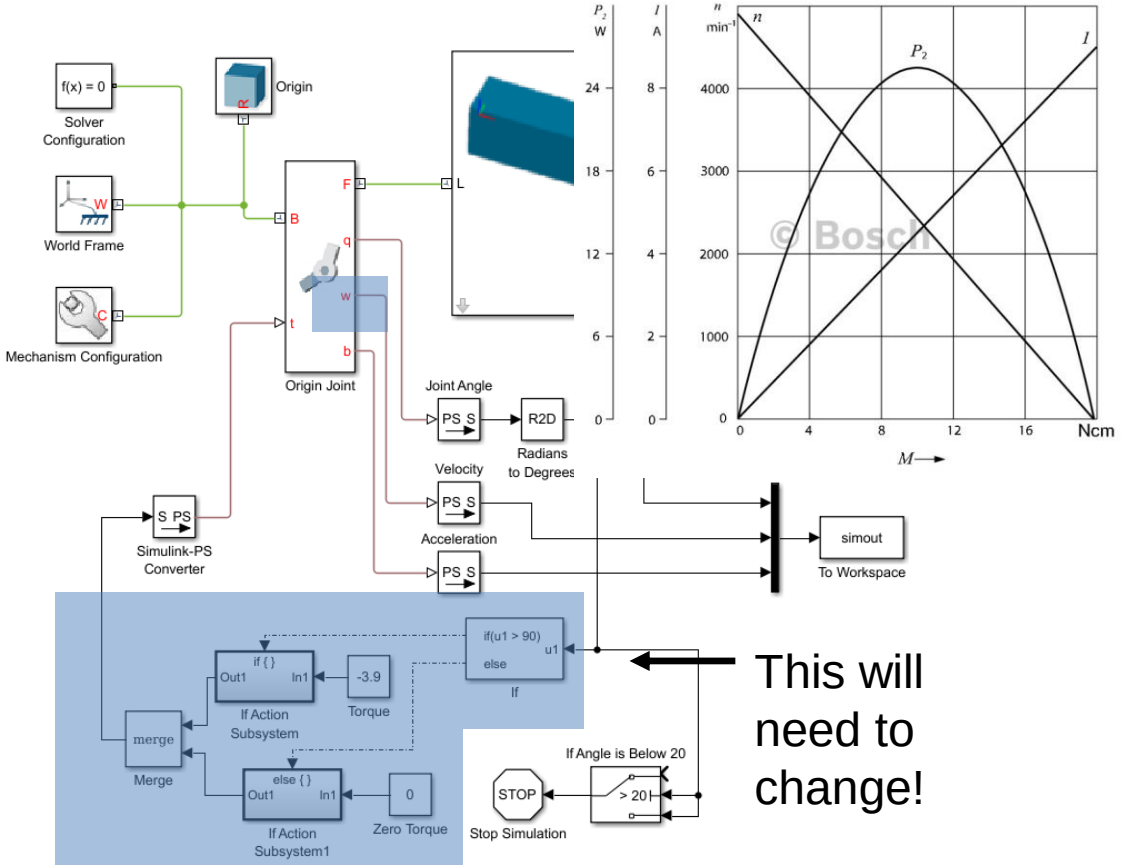


Deploying the Single Mass



Deploying the Single Mass using a Motor

- Motor Torque is a Function of Angular Velocity
  - Motor Curves from Bosch
  - Use Angular Velocity as the feedback
- The gear ratio will change the speed and motor
  - The motor will be running at a different speed to the mechanism
- Note: Next week we will look at damping so that we can keep the motor in its operating window!

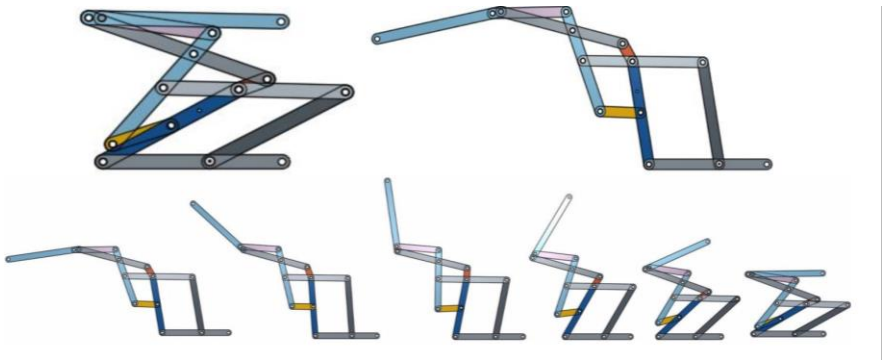


This will need to change!

Stage-gate: Submission

- Product Design Specification (Current Progress, A4 page)
- Chosen Concept Model
  - Images
  - Paragraph discussing main features
- Online Submission Blackboard
- 5% Pass/Fail Criteria

No.	Requirement	Must/Wish	Method of Assessment	Success Criteria	Will be assessed during the feasibility stage
1					
2					
3					
…					



This Week

- Boundary Condition Calculation
  - What torque is required to get your mechanism moving?
  - Assume a single mass
- Generate the Demo Models
  - Pendulum
  - Fixed Pendulum
  - Deployment Pendulum
  - Templates on the website
  - Model your single mass (from your boundary calculation!) moving from start to finish using the motor and gear ratio selected
- Next Week
  - Demo: Four-Bar Mechanism with Damping