



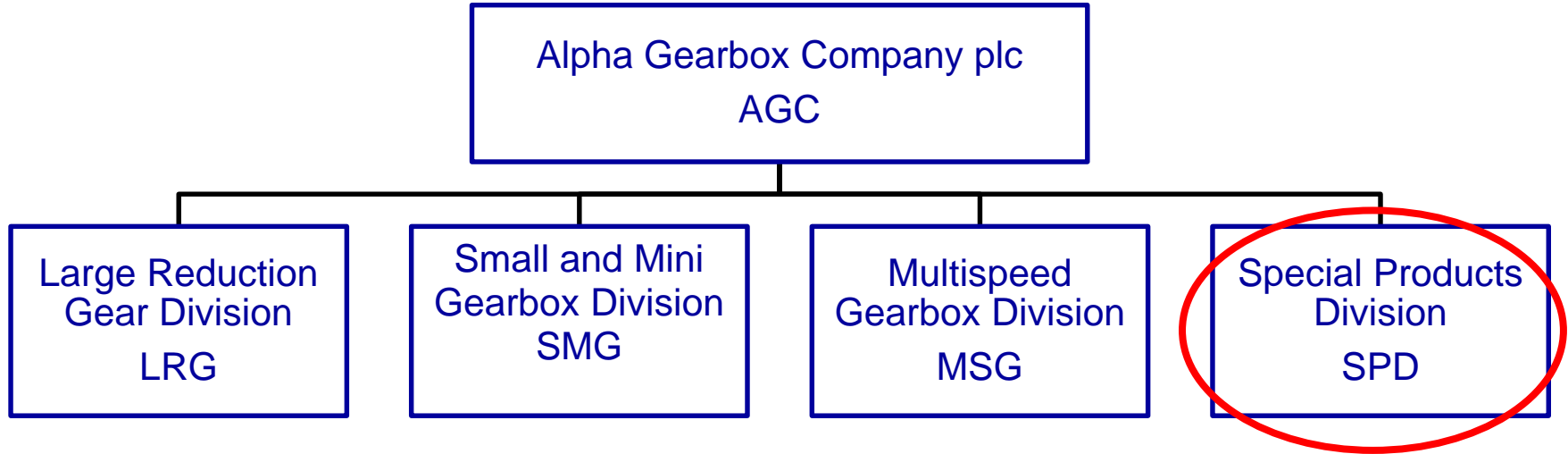
University of
Nottingham

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**Department of Mechanical, Materials &
Manufacturing Engineering
Design, Manufacture and Project
MMME 2044**

Individual Design Study
Two Speed Gearbox Actuator
Professor G E Kirk

The Company



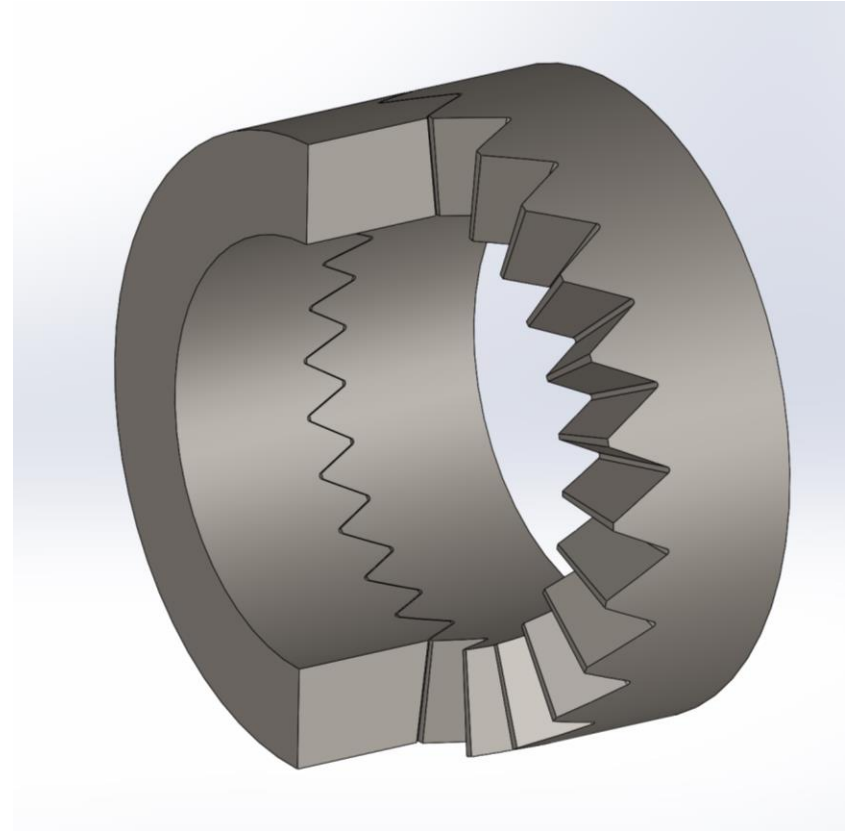
The task

- MSG are developing a new Two Speed Gearbox, 1:1 and 2:1, with numerous applications from electric cars to marine craft.
- It has the novel application of a Hirth Clutch replacing the conventional Synchromesh or Dog Clutch arrangement.
- It is anticipated that this will be capable of transmitting higher powers in a smaller space.
- However, the Hirth Clutch needs a constant axial load to maintain engagement when transmitting torque.
- This requires a new Actuator which SPD has been requested to design.
- It is your task to produce a Concept design for the Actuator.
- A meeting to launch the task has been held and a note recording the discussions issued.

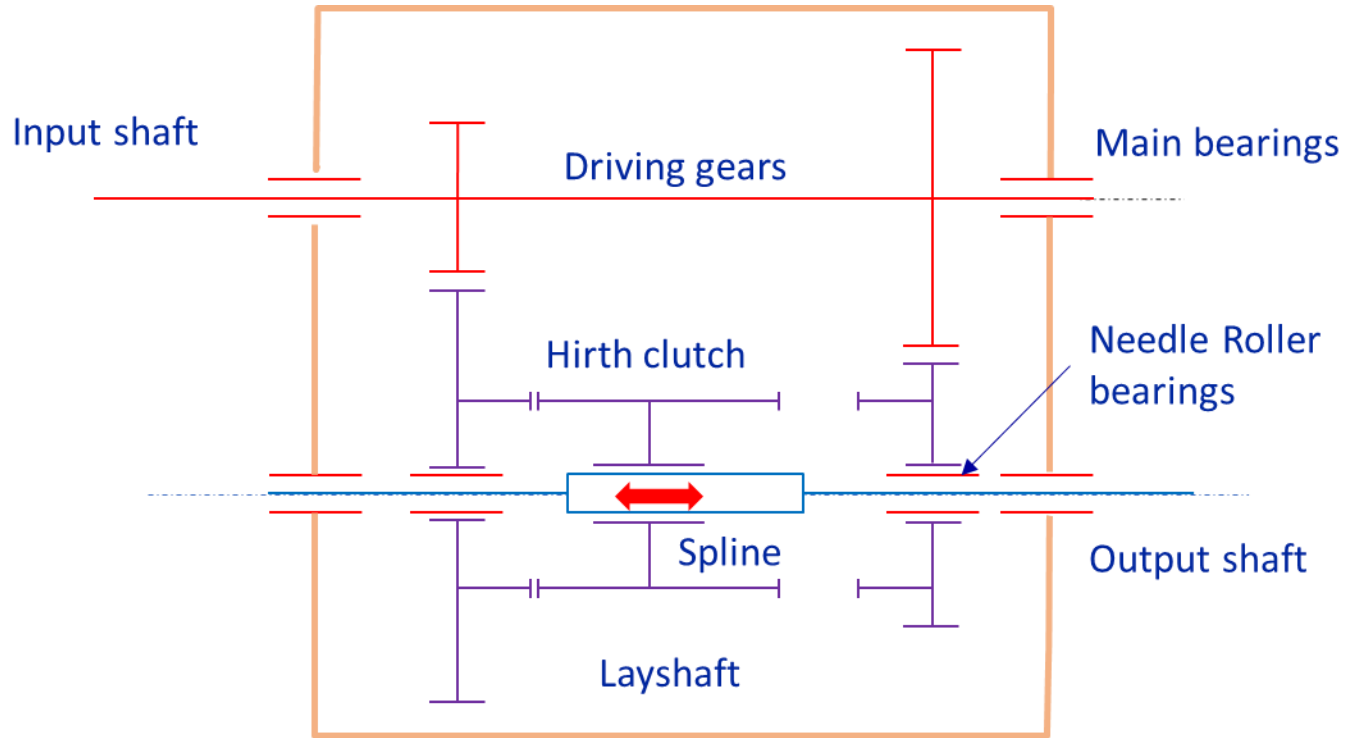


Hirth Coupling

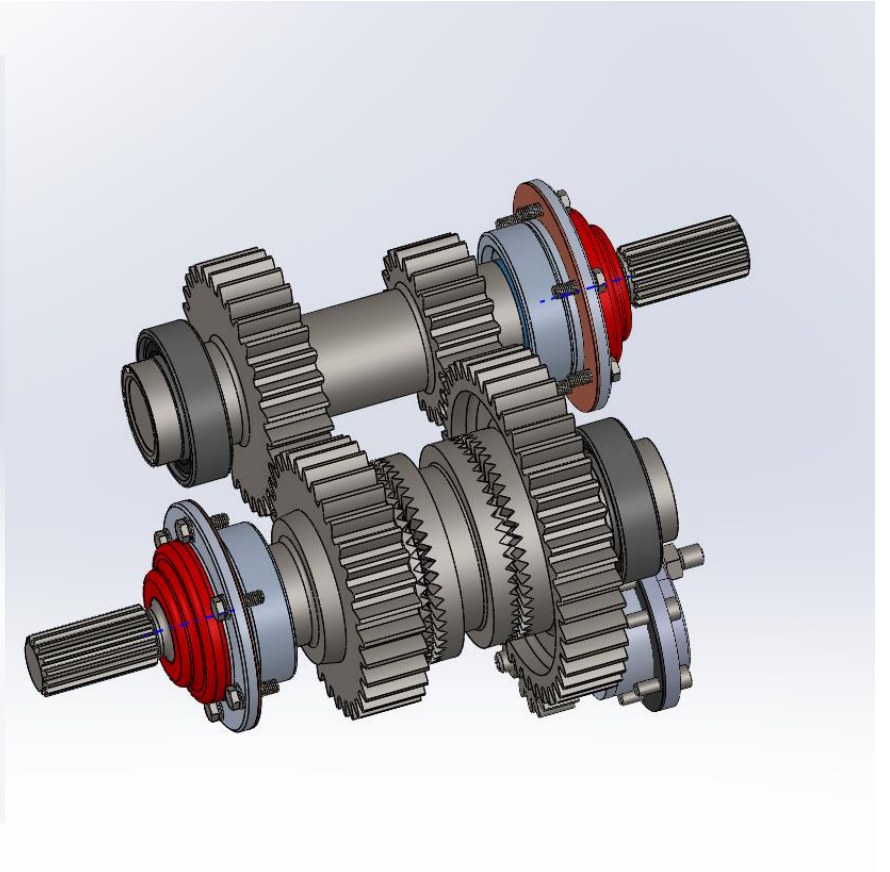
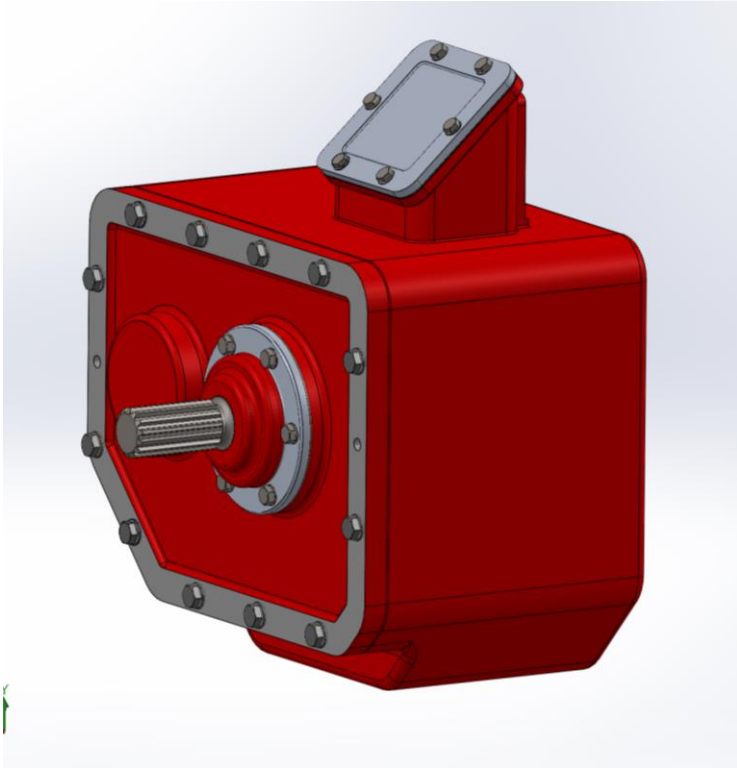
- Hirth Couplings consist of radial teeth formed by grooves in the end faces of a cylindrical shaft.
- The teeth are tapered, symmetrical serrations usually with angles of 60 and 90 degrees.
- A key feature of the coupling is that the load-bearing faces of the joint are tapered which by applying an axial load that eliminates backlash. This load can be by either bolting the shafts together or applying spring pressure from an external housing.
- This lack of backlash also reduces wear due to fretting.
- Advantages
 - Very high torque can be transmitted in a small diameter
 - There is no slip in the joint.
 - The joint is self-centering.
 - Fretting wear can be remedied by restoring the end load.
- Disadvantages
 - The manufacturing process is complex, time-consuming, and consequently expensive.



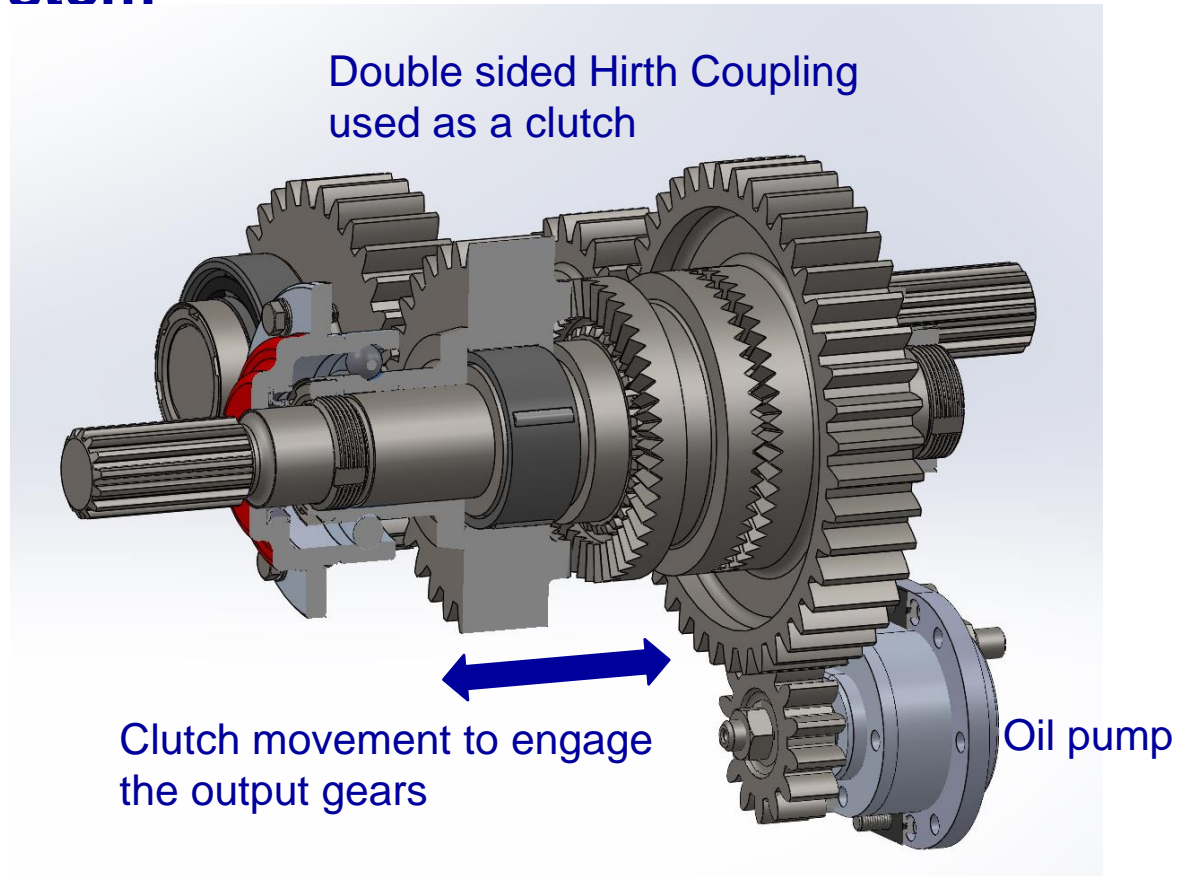
Diagrammatic View of the Gearbox



The Two Speed Gearbox



The Gear System

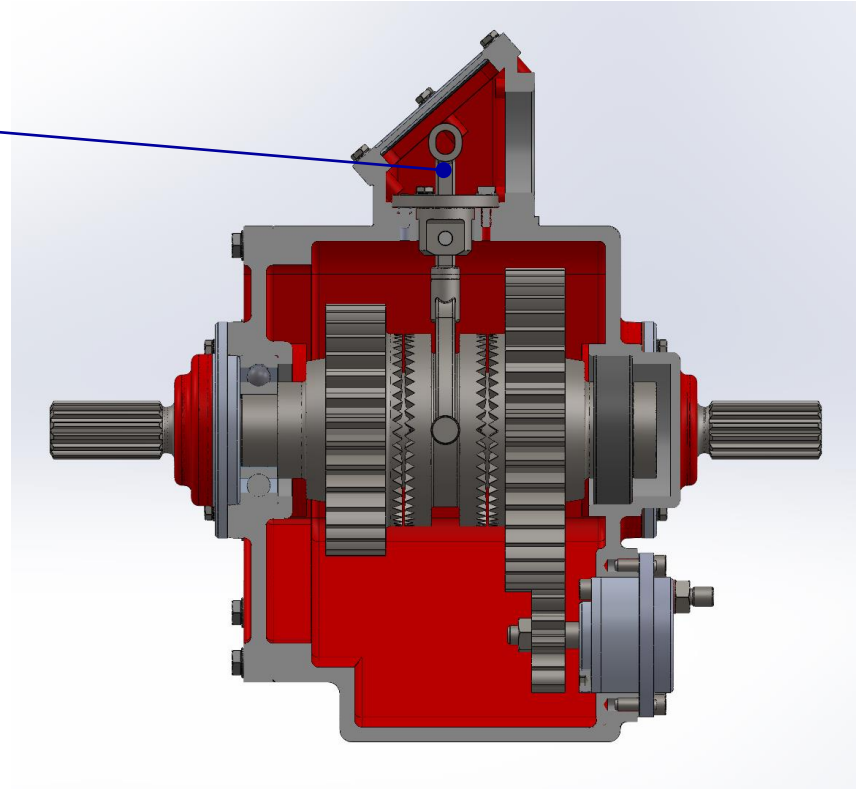


Gearbox Operation

- The input shaft is connected to the prime mover and has two gears.
- These gears are in constant mesh with two gears on the output shaft. These gears are mounted on needle roller bearings and so are free to rotate in engagement.
- A two sided Hirth Clutch is mounted between the two output gears on a spline which means it can move axially to engage either gear.
- With the Hirth Clutch in the centre there is no output power transmitted but the hydraulic pump is still driven providing hydraulic pressure. The clutch needs to be maintained in the neutral position by two opposing forces.
- Movement of the clutch in either direction will engage the Hirth teeth. So torque will then be transmitted from the input gear to its mating gear then through the Hirth clutch to the spline on the output shaft.

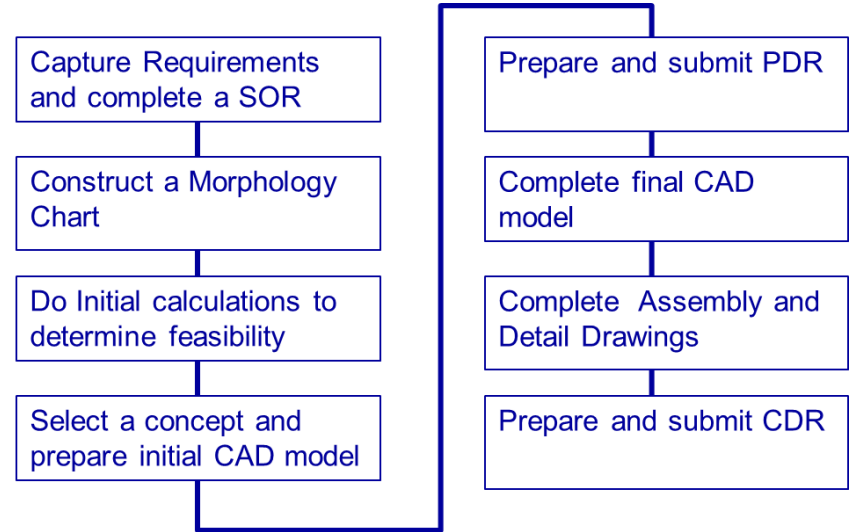
The Gearbox and Clutch

Clutch lever to move the Clutch from the neutral position shown to either gear.



Route map


- The task is to design the new actuating device to move the catch fork.
- There is an interface drawing MSG 101222
- There is a record of the meeting between SPD and MSG to define the task but a formal SOR is required as part of the task.
- A 'route map' is provided with 'anticipated' times, which are only guides to help plan the work.
- Iteration will be required so the times may not all be expended at one go.




Route Map

- This is a route map
- It is possible to create a work plan using this.
- Elapsed times and key mile stones.




 University of Nottingham Individual Design Project Guidelines <small>UK CHINA MALAYSIA</small>		
Project Two Speed Gearbox Student Tasks		Guide Hrs
Requirements (see Lecture MMME 1024 Requirements)		
· Capture the Requirements in a numbered tabular form.		4
· Include weighting factors.		
· Define Method of Compliance Demonstration (Calculation, Test or Observation)		
Generate Concepts (see MMME 1024 Concept Generation)		
· Define the Main Function and then the Enabling functions		4
· Create the means of satisfying the functions. (See Engineering Features and http://507movements.com)		
· Create a Morphology Chart		
· Create Concepts by reference to the Morphology Chart. (Neat sketches , Stick Diagrams)		
Evaluation Concepts (see MMME 1024 Evaluation)		
· Preliminary calculations of Concept Critical Features		4
1. The force and means of restraining the clutch in the neutral position		
2. The force and means of applying the Hirth Clutch axial load		
· Very preliminary product risk assessment, (what could go wrong, if anything?)		
Chose the Final Concept (see MMME 1024 Concept Selection)		
· Decision Matrix		2
· Create a preliminary CAD model with key dimensions.		6
PDR Report		
· Justify the choice of concept and show a high probability of satisfying the requirements		2
· Include ALL sketches		
Embodiment (see MMME 1024 Embodiment)		
· Complete CAD Model		10
· Create assembly drawings		4
· Create detail part drawings		6
· Complete calculations of the device		6
CDR Report		
· Complete the report. Include Requirements and all Charts		4
· Complete a Compliance Statement		2

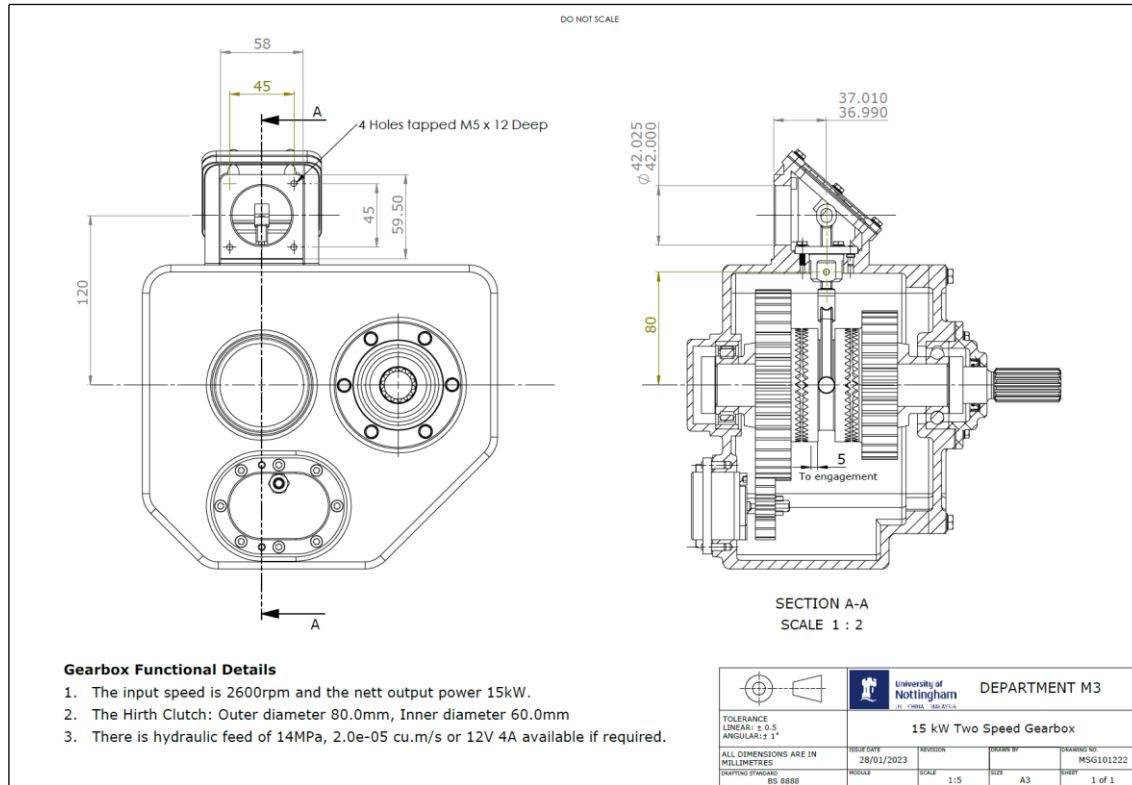
Proforma

 University of Nottingham <small>UK CHINA MALAYSIA</small>		Statement of Requirements - Actuating Device		
No	Customer(s)	Requirement	Method of Demonstrating Compliance	Rank
1		The device shall xxxxxxxxxxx		
2				
3				
4				
5				
6				



 University of Nottingham <small>UK CHINA MALAYSIA</small>		Morphology Chart - Actuating Device				
Main Function - To XXXXX						
Enabling Functions		Means				
1						
2						
3						
4						
5						
6						
7						

The Interface Drawing





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