

Mechanism Feasibility Design Task

Dr. James Gopsill

Contents

1. Before Easter
2. Submission

Before Easter

Introduced you to:

- Types of gear and their application
- Design of a multi-stage spur/helical gear set

Where you should be at:

- Evaluated a spur and helical gear ratios
- Selected one to carry forward
- Created gearbox arrangement in CAD

Product Design Specification

Concept Design

Concept Selection

Stage-Gate

Deployment Modelling

Motor, Gear Ratio & Damping Selection

Gearbox Design

Submission

This Week - Submission

- Report
 - LaTeX Template Provided
- Simulink A3 Hand-In
- Gearbox Assembly Drawing
- Look back over the exercise

Feasibility Design Report

Design & Manufacture 2 Submission

Feasibility Design Report

Joe Bloggs (XXXXX), John Doe (XXXXX)

January 11, 2017

Abstract

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift - not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

1 INTRODUCTION

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2 PRODUCT DESIGN SPECIFICATION

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3 CONCEPT GENERATION

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Page 1

Report

Why 15 pages?

- Consistent marking
 - 1 hour per report.
 - 30 mins reading.
 - 30 mins marking, feedback, assessing assembly drawing & Simulink model
 - 71 groups -> 71 hours -> 8.9 days of marking
- Typical reading for comprehension 200 words per minute -> 6,000 words
- 500 words a page on average -> 12 pages
- Important to be clear and concise in your report
- Time scales match industry and the time managers permit to review reports

The Reviewer

- Your boss
- A respected engineer
- Very busy
- Tight-time constraints
- Clear concise reporting
- Wants to know the feasibility of this idea and is it worth pursuing?



Adrian Newey

https://s1.cdn.autoevolution.com/images/news/adrian-newey-receives-segrave-trophy-33526_1.jpg

Report

Introduction (~1 page)

- Provides the context of the problem you're trying to solve
- Assume that we're a reviewer who has no idea of the project
 - Layout the business case
 - Quantify where possible
- Workflow of the design process you have undertaken
- Lays out the structure of the report

Introduction
Product Design Specification
Concept Design
Concept Selection
Deployment Modelling
Motor, Gear Ratio & Damping Selection
Gearbox Design
Solution Specification
Conclusion & Future Work

Report

Product Design Specification (~1.5/2 pages)

- Discussion of how the specification was generated
- Table of specifications
 - Can be updated since the stage-gate submission
- Be as exhaustive as possible
 - 1 page is sufficient
- Check your stage-gate feedback
- Reference material you have used to build it

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Concept Design (~2 pages)

- Three concepts
- Description of each one
- Key Features
- Hand Calculations
 - Estimate of mass
 - Area enclosed by the mechanism
 - ...?
- Present each one in a consistent manner. No Bias.

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


Solution Specification

Conclusion & Future Work

Report

Concept Selection (~1 page)

- Controlled convergence
 - Use your PDS for the comparison criteria!
- Final concept selection
- Rationale behind the final decision

Criteria	 Concept 1	 Concept 2	 Concept 3	 Concept 4	 Concept 5	 Concept 6
Ease of use		+	+	-	-	S
Aesthetic appeal		-	+	+	-	-
Manufacturability		+	+	-	+	-
Low weight		+	-	+	-	+
Energy efficiency		S	+	-	+	+
Safety		-	+	S	-	-
2 ⁺		3	5	2	2	4
2 ⁻		2	1	3	4	1
2S		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

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Deployment Modelling (~3 pages)

- Boundary Calculation
 - Purpose
 - Free-body diagram
 - Assumptions
 - Results
- Simulink Model
 - Overview of the Model – What does simulink enable us to do?
 - Selected Solver (Why is Runge-Kutta a suitable choice?)
 - Assumptions
 - Motor & Gearbox Model Description
 - Mechanism Model Description

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Motor, Gear Ratio & Damping Selection (~3 pages)

- Outline your cases
 - **Motors investigated**
 - Gear Ratios
 - Level of Damping
- Table describing these cases.

Case No.	Motor	Gear Ratio	Damping
1
2

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Motor, Gear Ratio & Damping Selection (~3 pages)

- What are you investigating?
 - Energy used
 - Smoothness of motion
 - Motor working within its operating window
 - ...? (Investigate a maximum of three)
- And how will you investigate them?
 - What are the calculations?
 - How will you use the model results?
 - E.g. Area under the curve

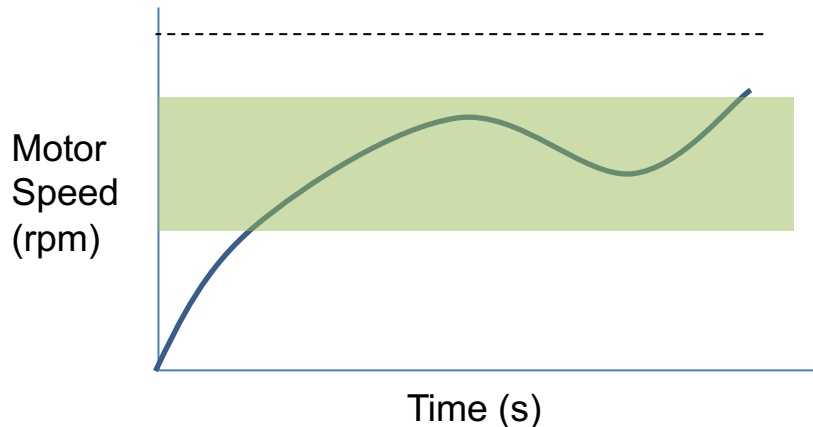
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Motor, Gear Ratio & Damping Selection (~3 pages)

For example: Motor working within its operating window

- Plot Motor Speed or Torque over time with graph showing the ideal window of operation and the limits of operation



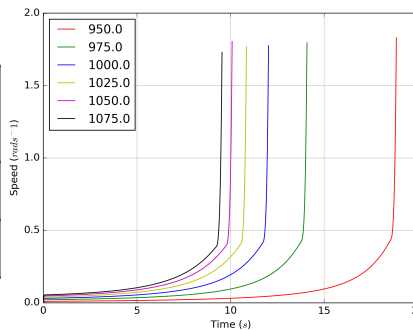
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Report

Motor, Gear Ratio & Damping Selection (~3 pages)

- Show the results
 - Graphs that help with your investigation
 - Also, we would like **Mechanism Speed vs Time** and **Motor Torque vs Time** from all of you!
 - Table highlighting key values for each case so you can compare them

Case No.	Deployment Time	Energy Required	Smoothness of Motion
1
2



- Introduction
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- Concept Selection
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- Motor, Gear Ratio & Damping Selection
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Report

Motor, Gear Ratio & Damping Selection (~3 pages)

- Discuss the results and record your rationale behind the final selection of motor, gear ratio and damping

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Gearbox Design (~3 pages)

- Introduce Gearbox Design Process
- Produce Gearbox Options
- Discussion and Rationale behind Final Gearbox
- Similar layout to previous section
- Your opportunity to show us that you can structure a section in the report

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Solution Specification (~1 page)

- This should be a table showing the final values from your analysis against the requirements in your PDS
- Compare final feasible design solution against PDS

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Report

Conclusion & Future Work (~1 page)

- Summarise the work that has been performed
- Highlight the key achievements & results from the work
- Discuss the next steps that need to be taken

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General Report Writing

- All major sections should introduce themselves
- All major sections should have a summary/concluding paragraph
- Figure Captions
- Table Captions
- Page Numbers
- Referencing
- Graphs
 - Axes labels
 - Legends
 - No titles (the caption is the title)
 - Make them legible!
- Tables
 - Minimise use of vertical separators
 - Keep values to same s.f. or d.p.

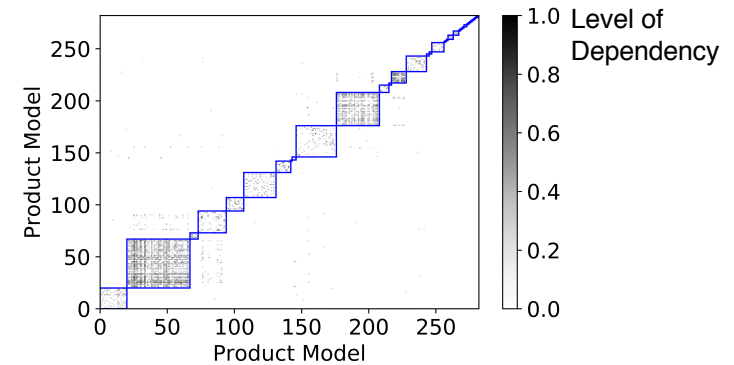


Figure 1: The design structure matrix for a formula student car

Table 1: Material extrusion details for test pieces

Beam	Value (mm)
Reference	
Honeycomb	4289.4
Optimised	
Three-Point Bend Test	4251.2 (-0.9%)
Off-Centre Three-Point Bend Test	4224.6 (-1.5%)
Four-Point Bend Test	4285.6 (+0.09%)
Inverted Four-Point Bend Test	4234.3 (-1.3%)
Statistics	
Mean	4257.0
Standard Deviation	26.3

LaTeX Packages and Helpful Pages

- Referencing `\usepackage{natbib}`
 - https://www.sharelatex.com/learn/Bibliography_management_with_natbib
 - Use `\bibliographystyle{plain}`
- Tables
 - <https://en.wikibooks.org/wiki/LaTeX/Tables>
- Figure and Table Cross-referencing `\label{}` & `\ref{}`
 - https://en.wikibooks.org/wiki/LaTeX/Labels_and_Cross-referencing
- Figures `\usepackage{graphicx}`
 - Save figures as eps or high-dpi (>300) pngs from MatLab
- Subfigures `\usepackage{subfig}`
 - http://www.peteryu.ca/tutorials/publishing/latex_captions_old
- Wrap figures `\usepackage{wrapfig}`
 - https://www.sharelatex.com/learn/Wrapping_text_around_figures

MatLab

- Useful Functions

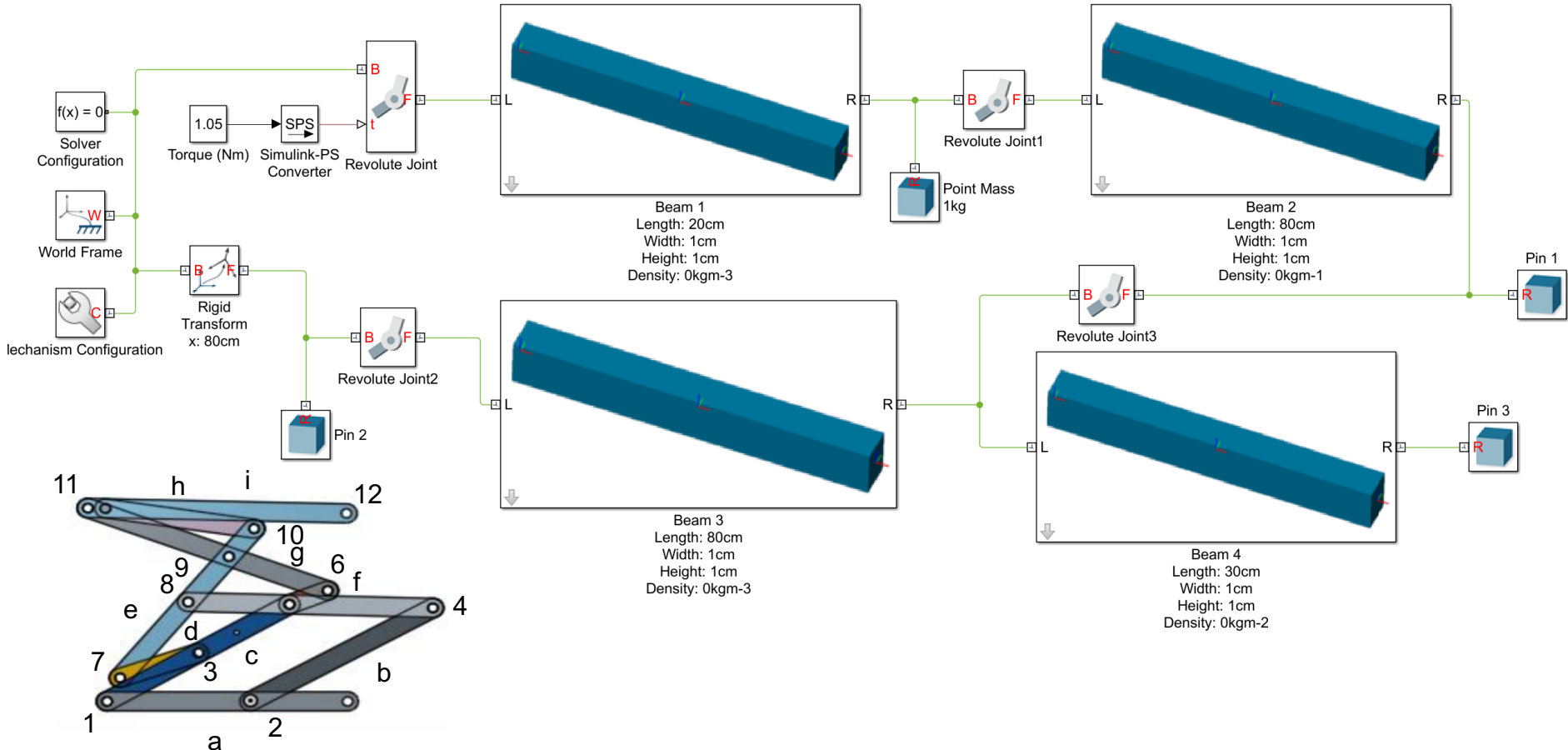
- hold on – to enable multiple lines to be plotted
- xlabel("") - <https://uk.mathworks.com/help/matlab/ref/xlabel.html>
- ylabel("") - <https://uk.mathworks.com/help/matlab/ref/ylabel.html>
- legend("") - <http://uk.mathworks.com/help/matlab/ref/legend.html>
- X and Y Ticks - https://uk.mathworks.com/help/matlab/creating_plots/change-tick-marks-and-tick-labels-of-graph-1.html
- All have options to alter fontsize, weights and linestyles
- And even add LaTeX maths symbols - https://uk.mathworks.com/help/matlab/creating_plots/text-with-mathematical-expressions-using-latex.html

Questions?

Simulink A3 Model

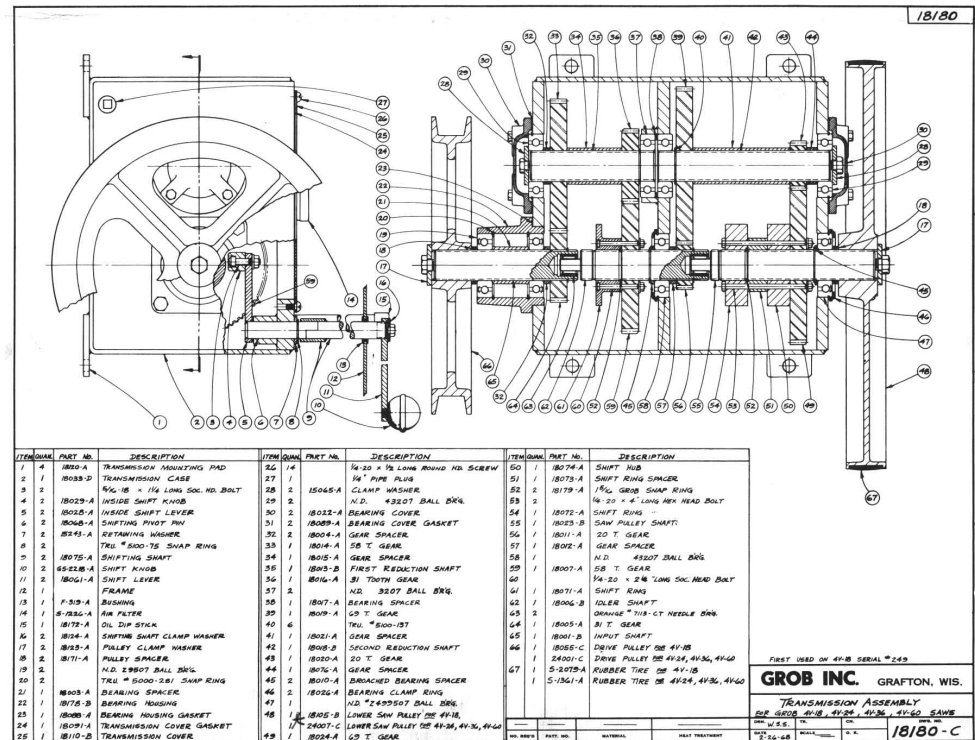
- Blocks clearly labelled
- Minimise overlapping lines
- Mapped to mechanism
- Get it reviewed by your peers and in class

Simulink A3 Model (Example)



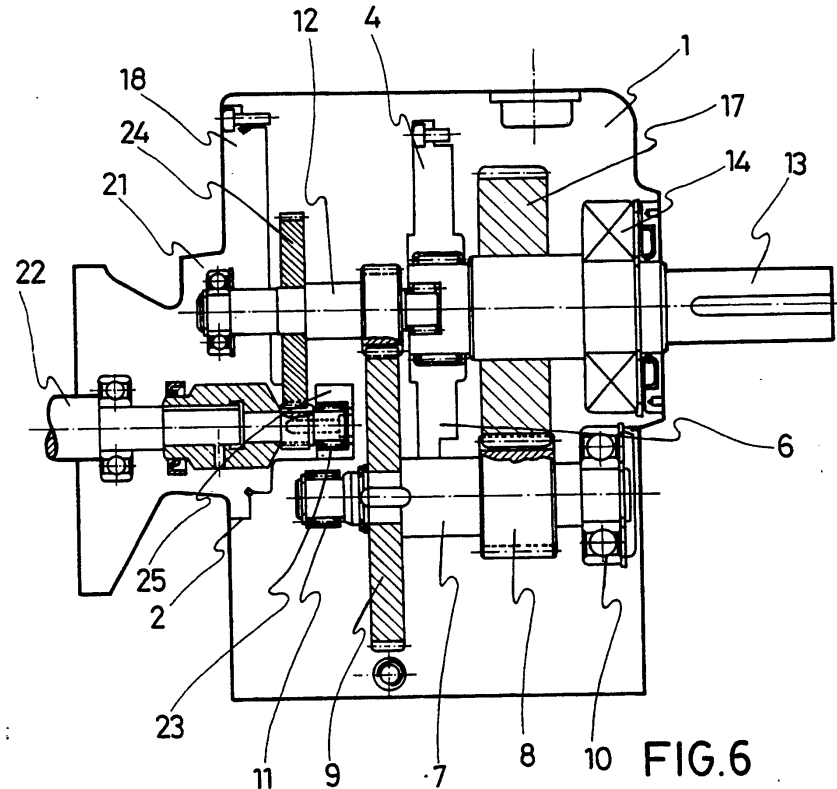
General Assembly of the Gearbox

- Page 14 of your 1st Year Design Notes
- Feedback from shaft design exercise
 - Parts List
 - General Dimensions
 - Clarity
 - Section Views



General Assembly of the Gearbox

- Page 14 of your 1st Year Design Notes
- Feedback from shaft design exercise
 - Parts List
 - General Dimensions
 - Clarity
 - Section Views
- Show us in class!



Feedback & Marks

- Feedback will be released after the exams
- Focus on the exams
- Marks will be released alongside the exam results on SAFE

Questions?

Look how far you've come!

- Familiarised yourself with a uncertain/unconstrained design problem
- Market research
- Created a number of concepts
- Formed a PDS
- Did some initial calculations to evaluate your designs
- Controlled convergence
- Systems Modelling
- Boundary Calculations
- Assumptions
- Simulink Modelling
- Set out a number of cases to explore the design space
- Plotted results and selected a motor, gear ratio and damping
- Evaluated two types of gear box
- Selected a feasible gearbox design
- Created a report detailing the process

Next Week

- Final Tutorial Session
 - Need to hand-in your construction kits!
 - Will be checking them in
- Last chance to get feedback on the submission
- No Lecture
- Submission on blackboard and a hard copy submitted to the school office

Q & A