



UNIVERSITY OF
BATH

ME20025 Machine Design Assignment



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4E 3.46

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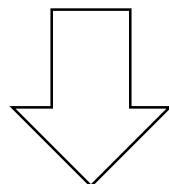
Dr. Joseph Flynn (Joe)

- Lecturer in Manufacturing Engineering
- Researching metal additive manufacturing technologies (3D Printing)
- Teaching Design 4, Design Optimisation Project (IDE) and Computer Integrated Manufacturing (3rd Year)
- Wearer of excellent socks...

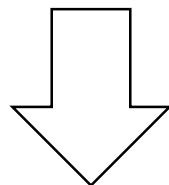


Unit Breakdown

Machine Design
Assignment

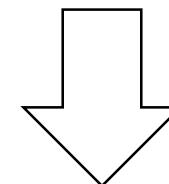


Weeks 19 – 25

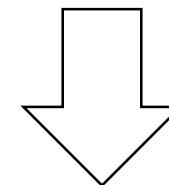


Worth 64% of the unit

Technical Feasibility
Study Assignment



Week 26, onwards



Worth 36% of the unit

Today's Lecture

- How is the assignment run?
- What is a machine?
- How do you design one?
- What is the assignment?



How is the assignment run?

It is run in (different) pairs

- Please organise yourselves into pairs
 - These **pairs must be different** from the Mechanism Design
 - You both need to **sign up to a group on Moodle**
-

Machine Design: Project & Lecture Information



Group Sign-up

Please sign-up for an available group number with your partner. Students must not work with their Mechanism Design partner from last semester.



[Assignment Brief - 2019/20](#)



[Lecture Slides](#)

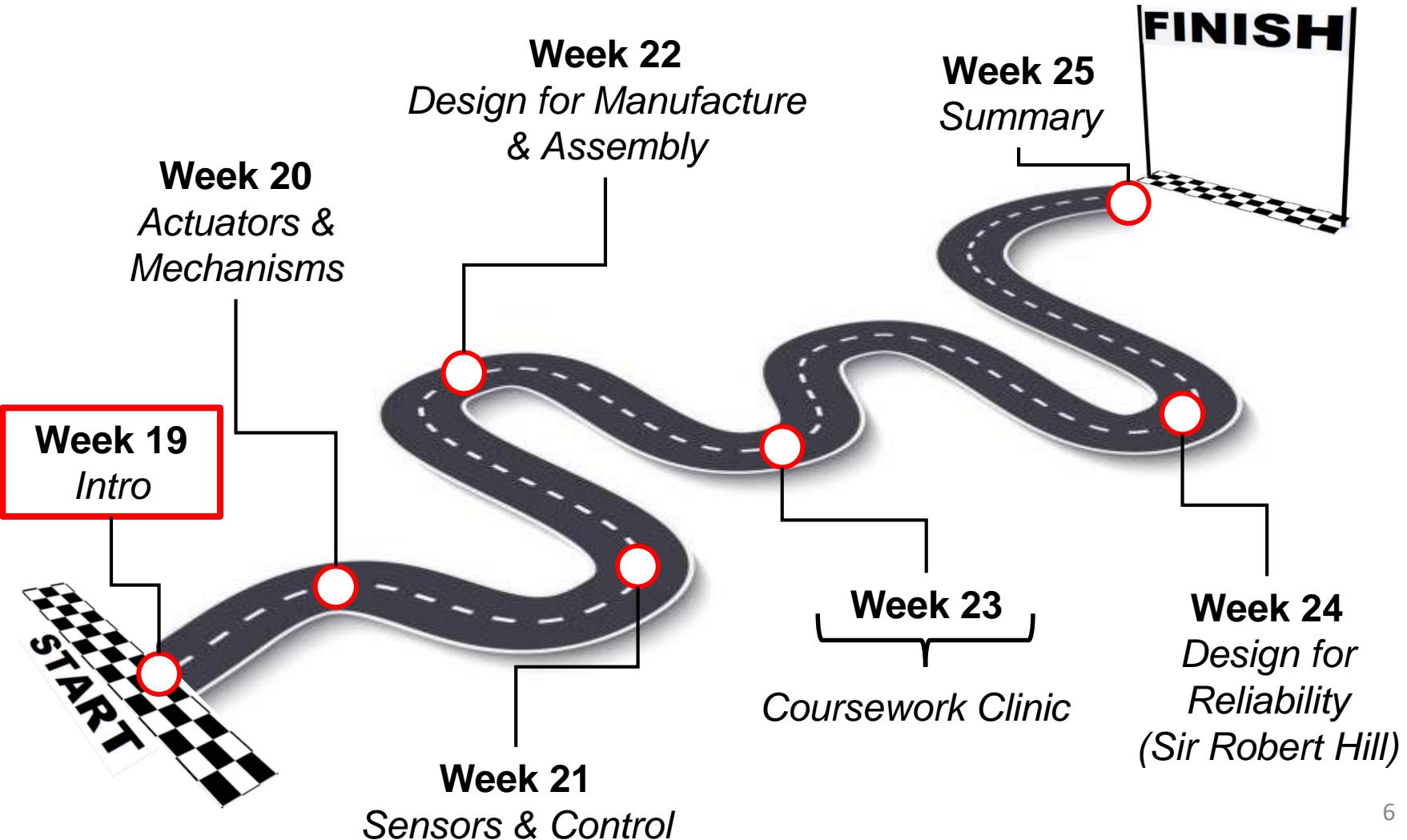


[Lecture Notes](#)

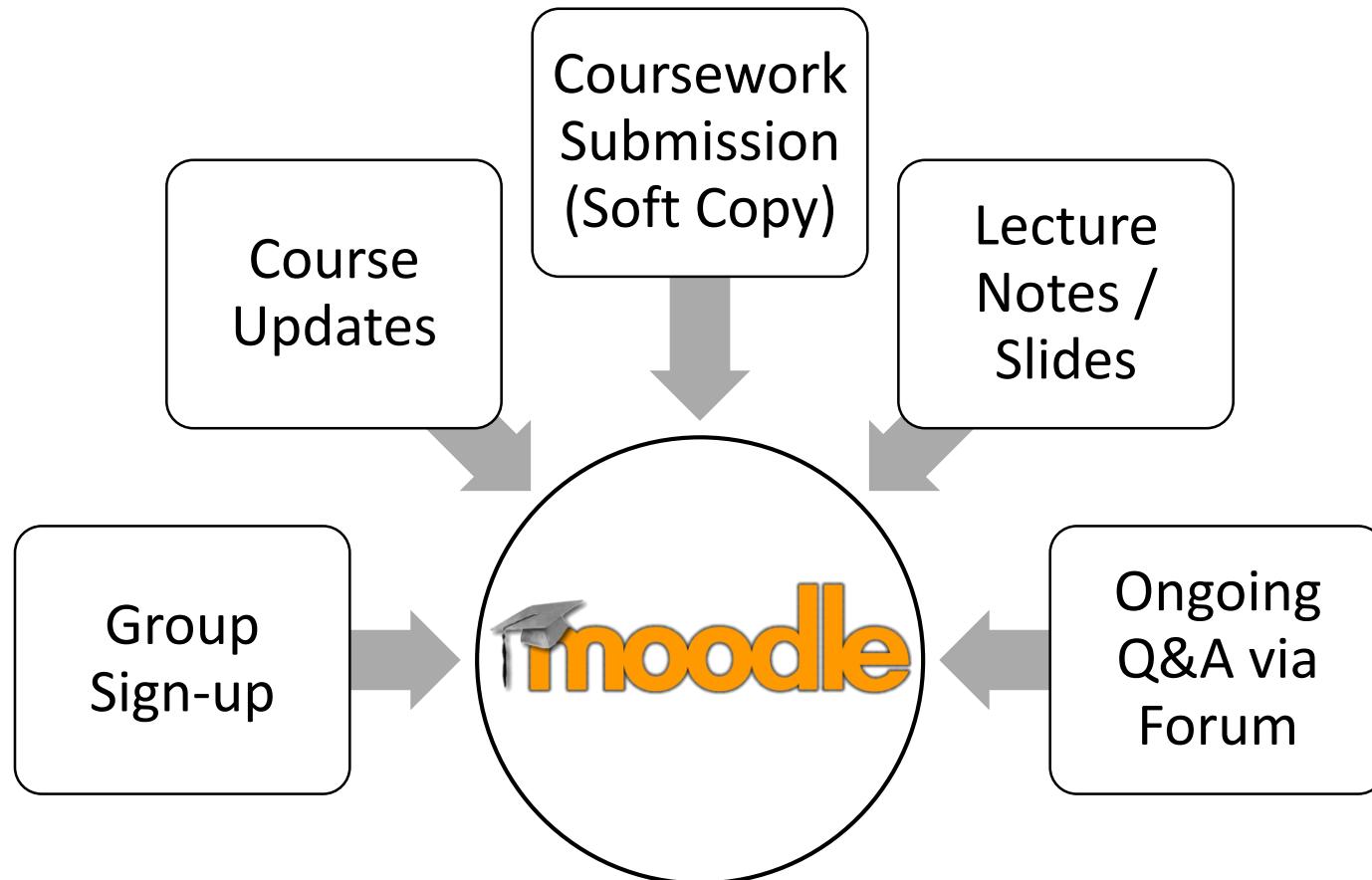


[Examples from Previous Years](#)

Course Schedule



Moodle is Important!

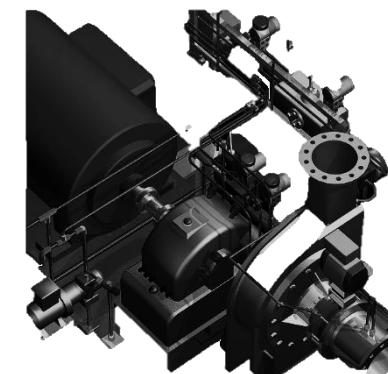
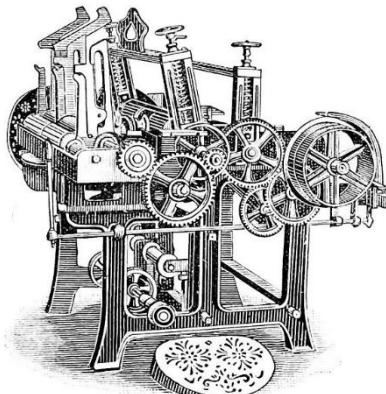


Assessments / Key Dates

Date	Name	Description	Weighting
18/02/2020	Stage Gate Review	Marks awarded in the studio session for the PDS, morphological design and concept sketches	5%
12/03/2020	Submit CAD Drawings	Submit soft copy (Moodle) and hard copy (UG Office) of your assembly and subassembly drawings for your machine. Think of this as a design freeze.	N/A
19/03/2020	Submit Final Report	Final report describing the detailed design of your machines	95%

Intended Learning Outcomes

1. **Provide** an awareness of actuator, sensing and safety/reliability technologies and theories
2. **Practice** design thinking, rationale capture and build upon feedback from the Mechanism Design
3. **Understand** the machine design process, including technical and economic considerations
4. **Develop** skills in modelling complex assemblies using CAD
5. **Apply** standard design methods to the generation of machine concepts
6. **Generate** feasible machine design concepts that exhibit elements of 'Design for X' and analysis-led component selection



Ground Rules for Students

Students are expected to...

- Design a machine
- **Use Autodesk Inventor**
- Attend lectures and tutorial sessions
- Work in **different pairs** to Mechanism Design (sign-up on Moodle)
- Ask questions on the Moodle Forum
- Keep up with the programme
- Work together and take equal responsibility
- Think about how they can apply the lecture content within their submissions
- **Treat this exercise as an opportunity to be creative**

Ground Rules for Assignment Leader

As the leader of this assignment, I commit to...

- Supplying you with notes / lecture slides on Moodle
(not printed, unless requested by individuals)
- Answering Moodle questions promptly
- Providing all lecture notes and slides ahead of each lecture
- Making additional resources available on Moodle to assist your learning
- Giving you clear guidance on what to submit
- Giving you clear guidance on how your assignments are marked

Traps to avoid

“You do all of the CAD, and I will write the report”

“Let’s leave it a week or two before we start.”

“... I thought you were submitting the hard copy, not me?!?!”

“Wow! The queue for printing is really long. Let’s both stand in the queue and miss the softcopy deadline too.”

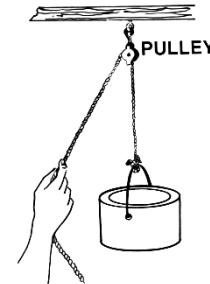
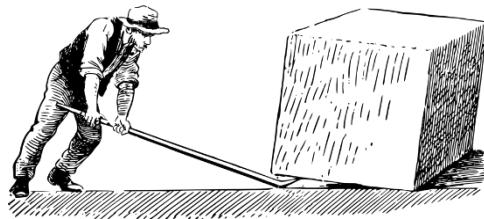
“... stop logging in at night and trying to ‘fix’ my CAD. I’m sick of waking up and finding that all of my CAD relationships are broken!”

“Dr Flynn, my partner has not been working on the project and I’ve decided to wait until the day before the deadline to tell you.”

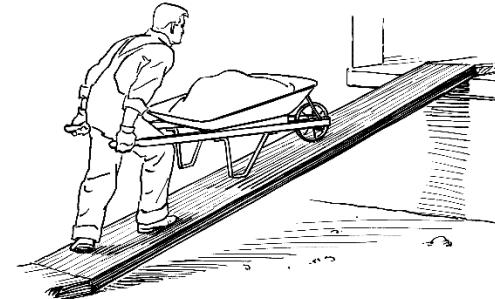
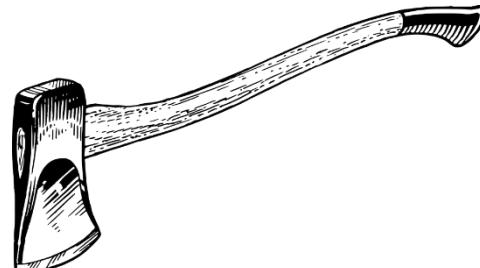
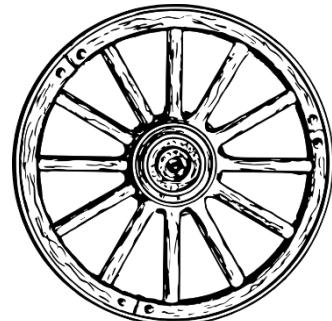
What is a machine?

What is a Machine?

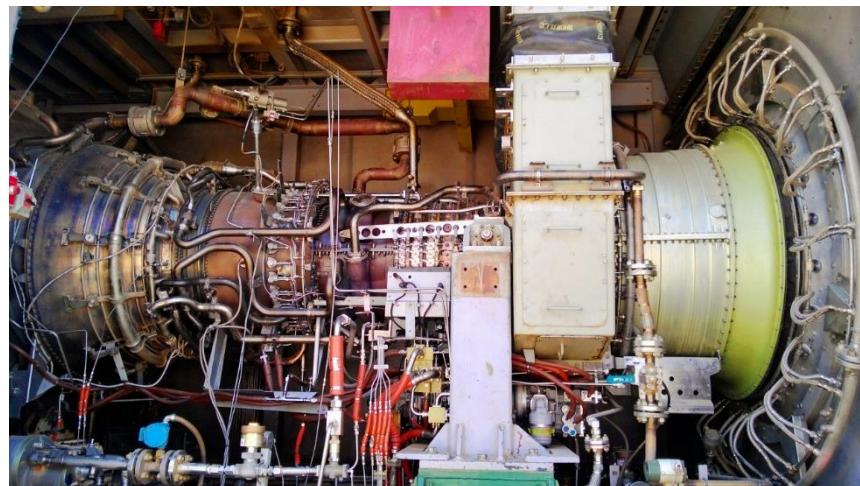
We begin with the notion of ‘simple machines’. These were systematised by Archimedes in Ancient Greece (~3rd Century BC) and included the **lever**, **pulley** and **screw**.



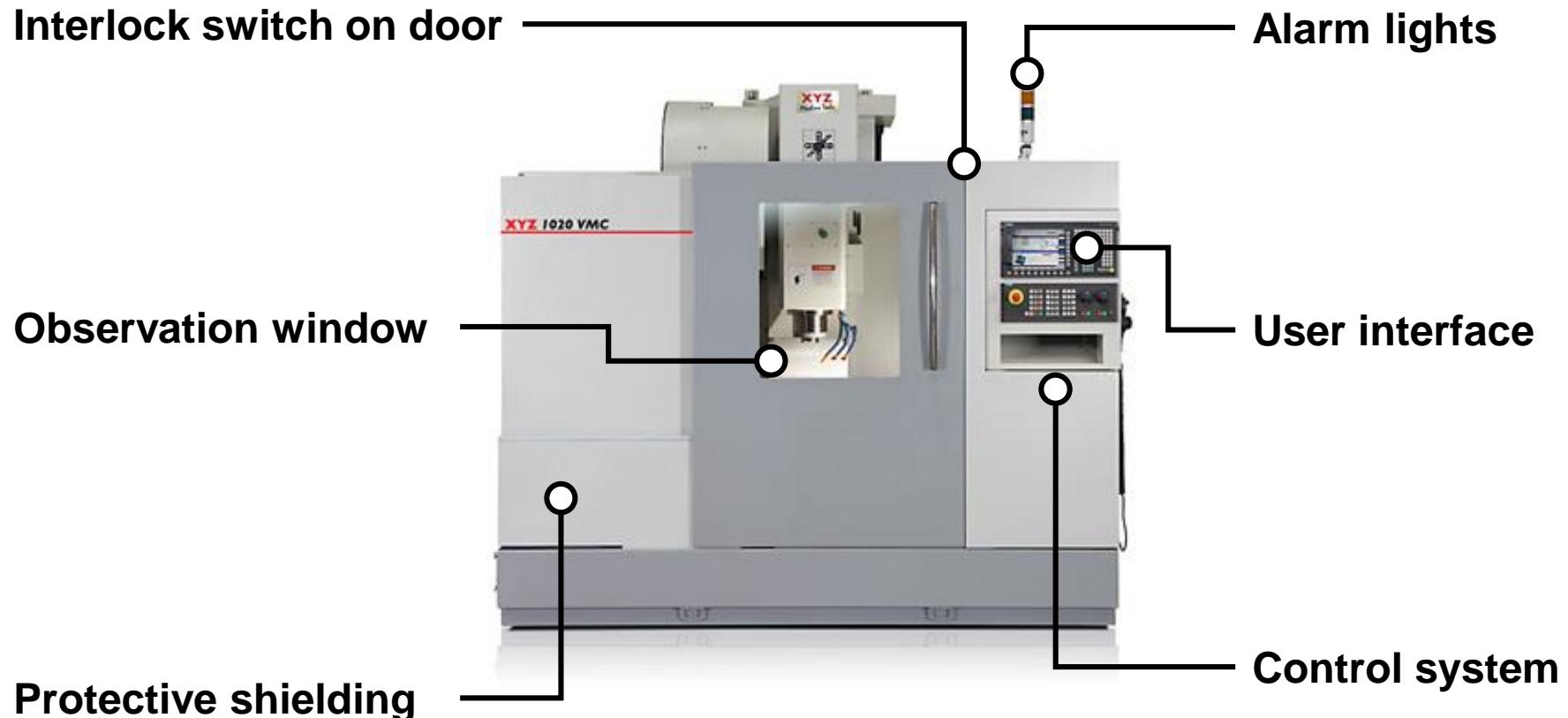
By the time of Heron of Alexandria (1st Century AD), the **wheel and axle**, and **wedge** had been added. It wasn’t until 1586 that Simon Stevin characterise the mechanical advantage of an **inclined plane**, thereby adding it as the sixth simple machine.



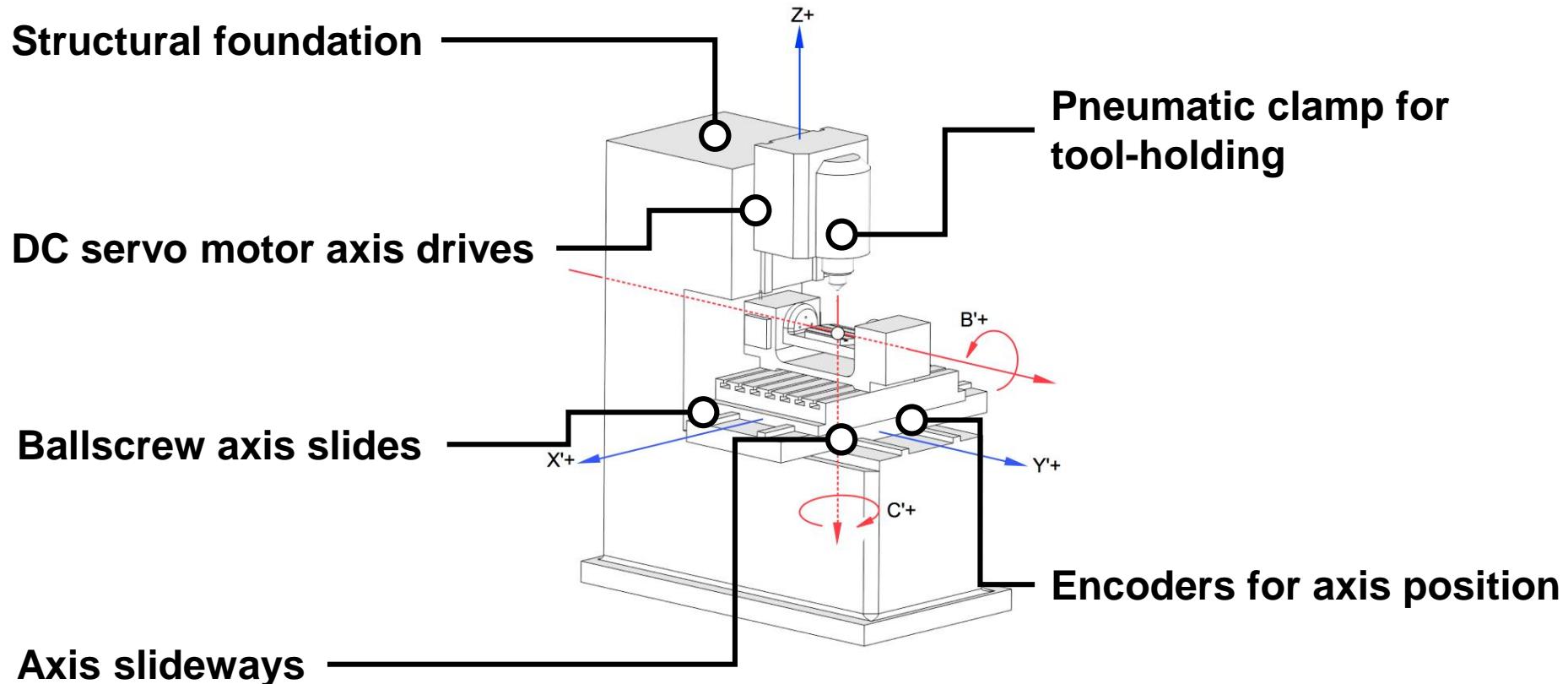
Modern Machines



Example: CNC Machine Tool

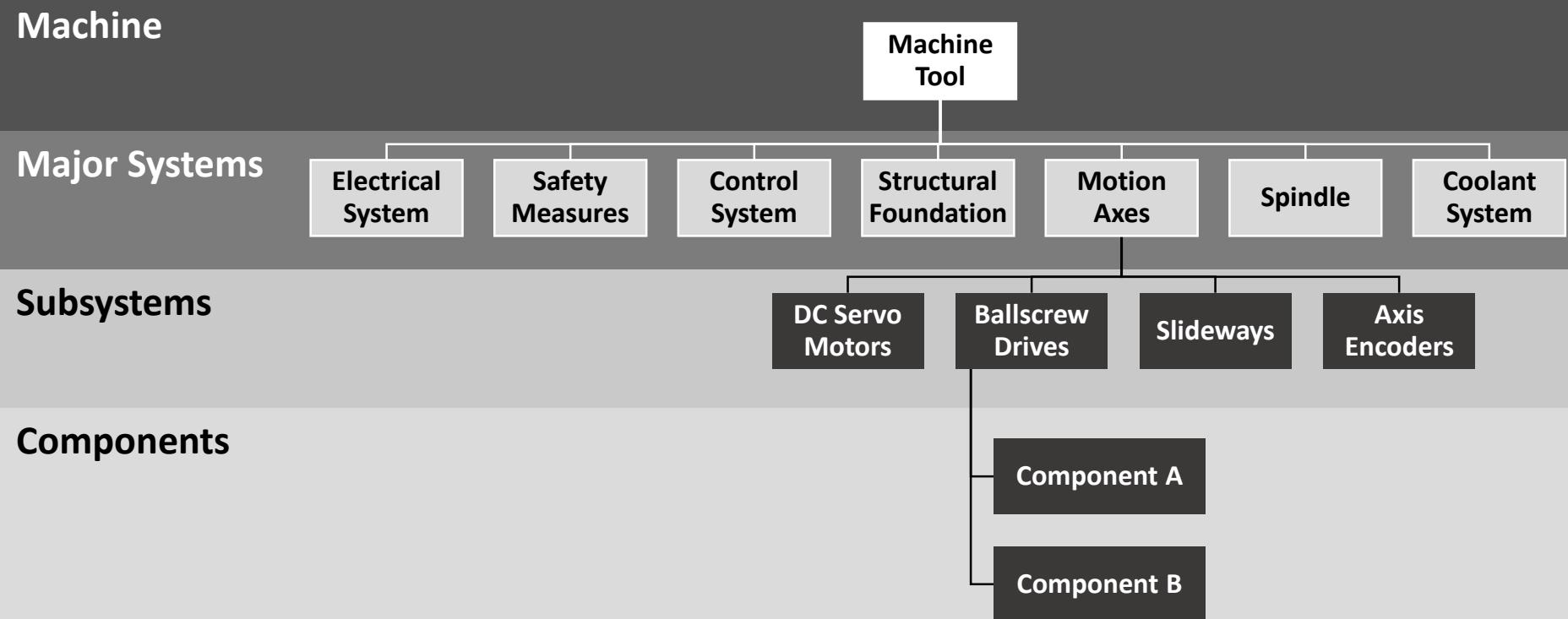


Example: CNC Machine Tool



How do you design one?

Hierarchical Approach

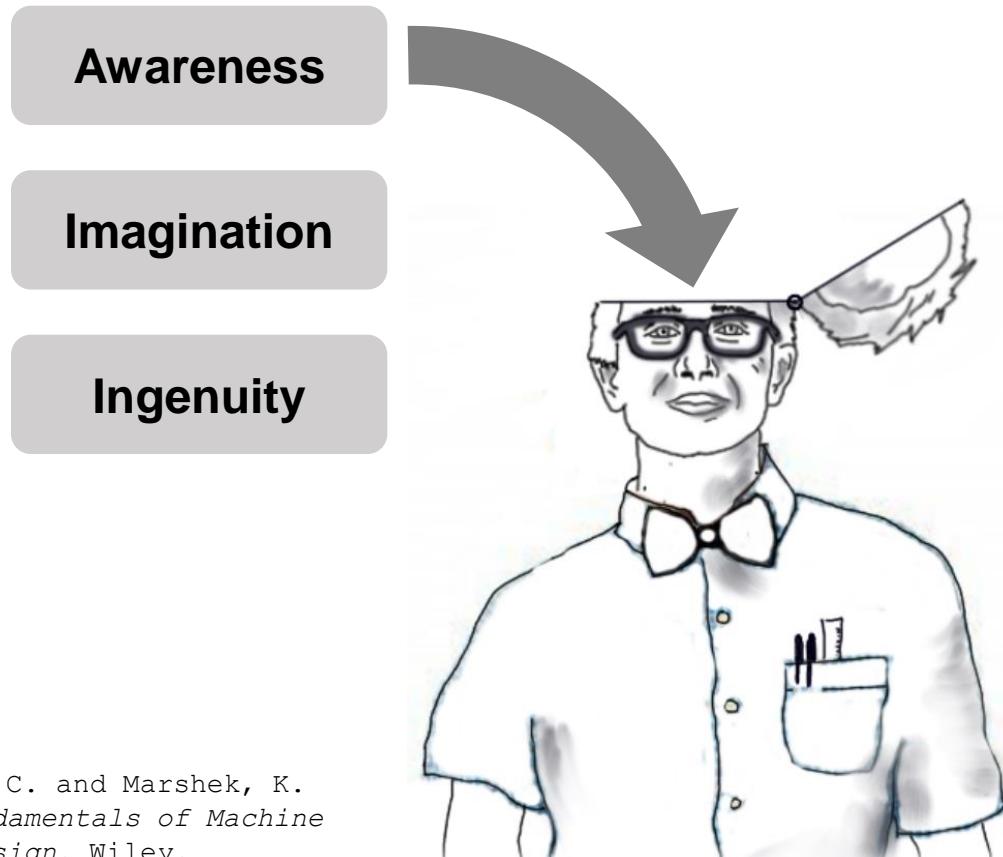


Some key ingredients...

According to Juvinal and Marshek...



Some key ingredients...



Technical Approach

Analysis

Kinematic Analysis Analysis of Loads

Response to Analysis

Material selection Sizing to avoid failure

Specific Technologies

Joining techniques Bearings
Shafts Couplings Motors & Actuators Brakes & clutches
Sensors & Control Rotating elements

Design for 'X'

Design for manufacture Design for assembly Design for reliability Design for cost

Morphological Design

For this assignment, we will be taking a Morphological approach:

- Take 'Major System' or machine 'Functions'
- Generate concepts of a set of 'means' for each function
- Produce a Morphological Chart
- Combine function concepts to create viable full-machine concepts (not random!!)
- Document how/why concepts are being created/combined

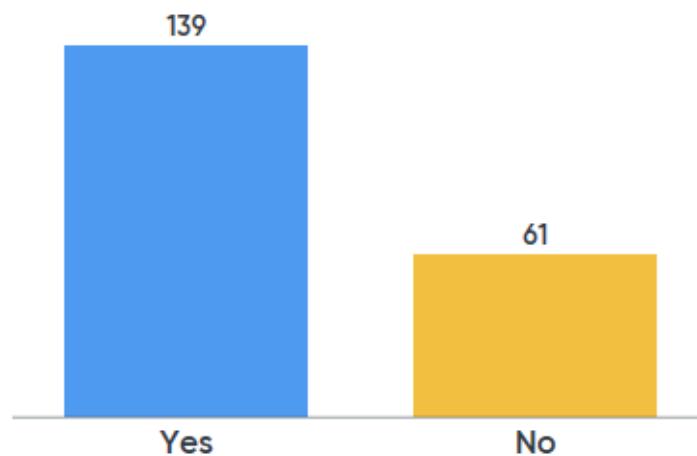
Title: Example Morphological Chart			
Machine Function	Concepts		
Function 1	Sketch 1a	Sketch 1b	Sketch 1c
Function 2	Sketch 2a	Sketch 2b	Sketch 2c
Function 3	Sketch 3a	Sketch 3b	Sketch 3c
Function 4	Sketch 4a	Sketch 4b	Sketch 4c

A Quick Test...

Go to www.menti.com and use the code **81 47 95**

If we were designing a table, should table legs be one of the morphological functions?

 Mentimeter



 200

A Quick Test...



Memes...



Morphological Functions

- Morphological functions should capture the essential requirements for your machine
- Be very careful to ensure that you are specifying functions and not solutions
- Instead of table legs, perhaps...

“A means through which to support a load placed upon the table, acting in the direction of gravity”

“A method to maintain sufficient clearance beneath the table to allow adequate legroom (where appropriate)”

“A method to prevent unwanted tilting, swaying or other forms of instability from the perspective of the user or an object placed upon the tabletop”

FURTHER READING

- [1] Shigley, J. E. and Mischke, C. R. (2003) *Mechanical Engineering Design*. McGraw-Hill (McGraw-Hill Series in Mechanical Engineering).
- [2] Dimarogonas, A. D. (2001) *Machine Design: A CAD Approach*. Wiley (A Wiley-Interscience publication).
- [3] Juvinal, R. C. and Marshek, K. M. (2017) *Fundamentals of Machine Component Design*. Wiley.

What is your assignment?

Background



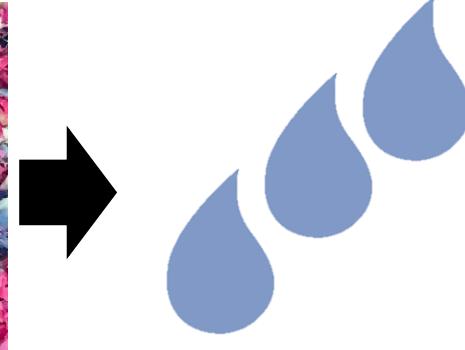
Proposed Solution



Plastic waste collected



Plastic waste cleaned & shredded



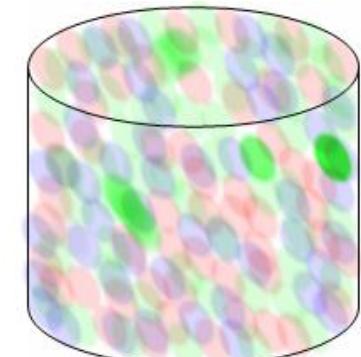
Bonding agent added



Crates stored underground



Briquettes packed into crates for storage



Shredded plastic pressed into cylindrical briquettes

Go now and...

- 1. Get into pairs and sign-up to a group on Moodle**
- 2. Read the Initial Project Brief on Moodle**
- 3. Prepare for the Q&A session (11:30)**
- 4. Get ready to create a PDS and Morphological Chart**