Mechanical Analysis and Design
ME 2104

Lecture 12

From Embodiment to Detail design

Prof Ahmed Kovacevic

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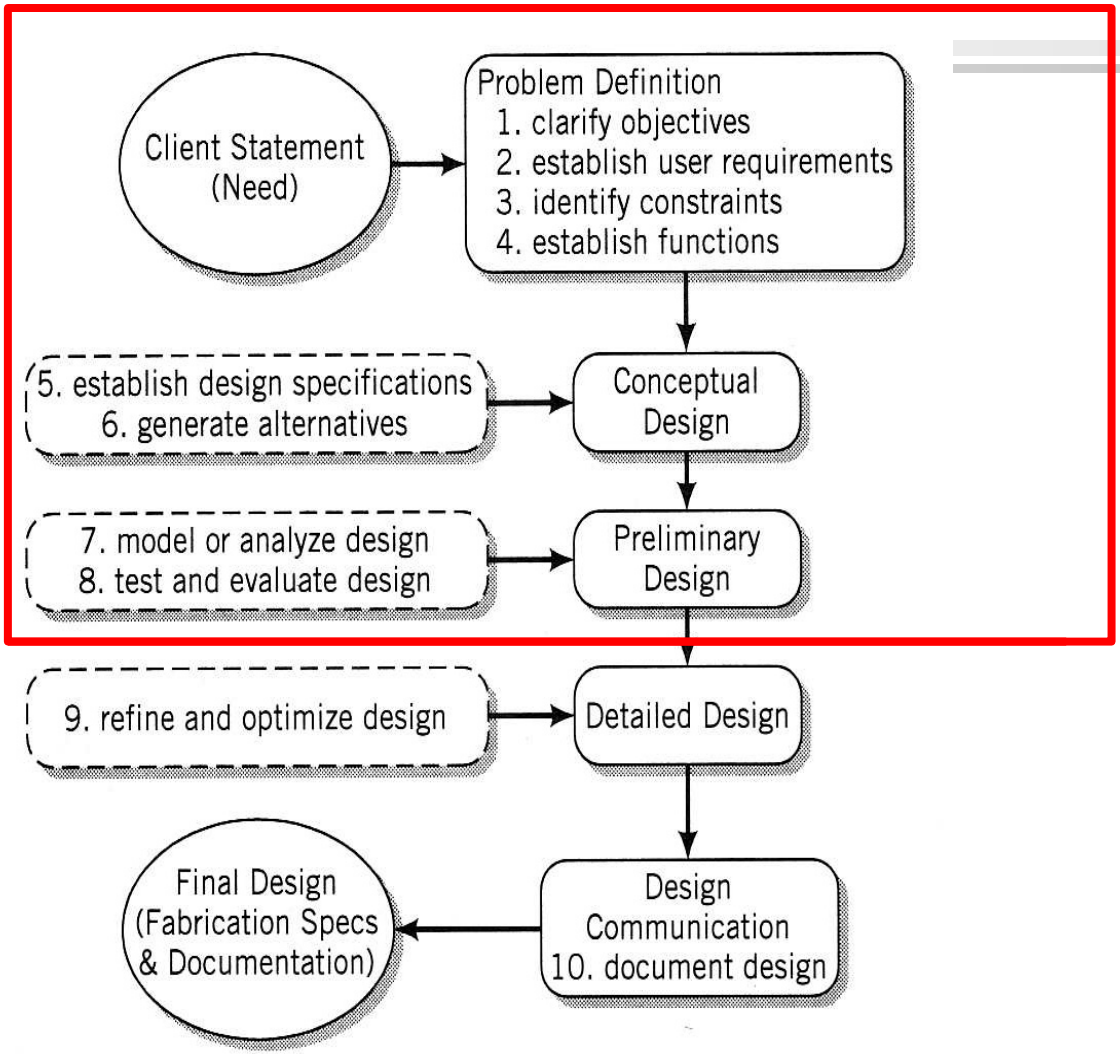
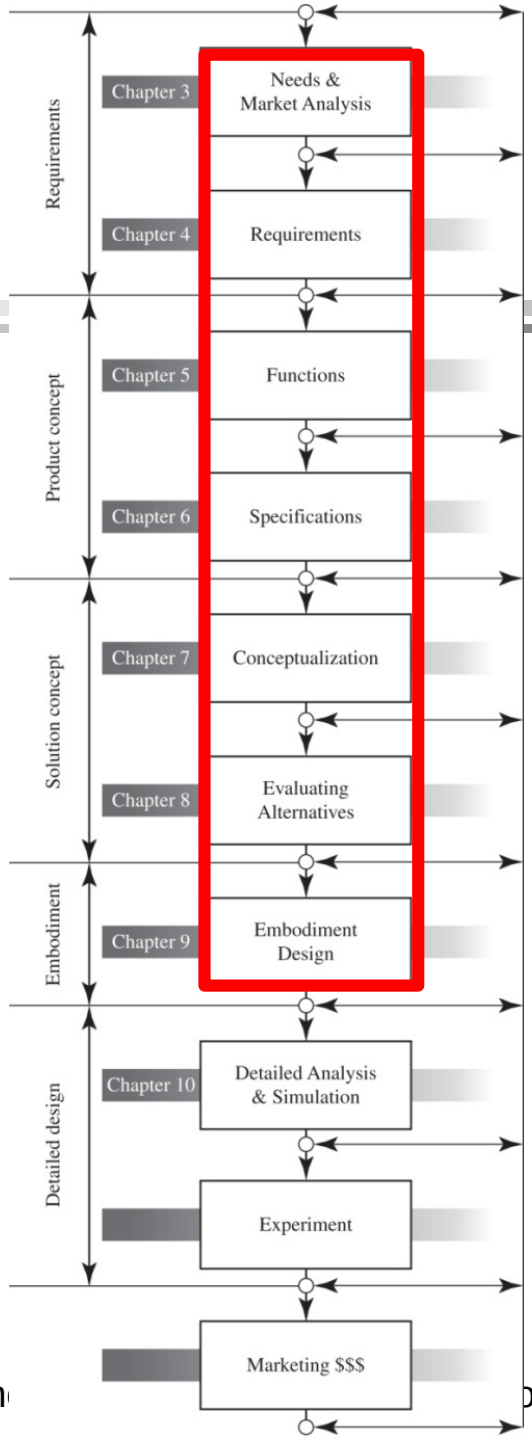
www.staff.city.ac.uk/~ra600/intro.htm

Plan for today

- Lecture – Detail design (20 min)
- Deliverables for 3rd Project Review (5 min)
- Manufacturing – (20 min)
- Team meeting (45 min)
- Summary (5 min)

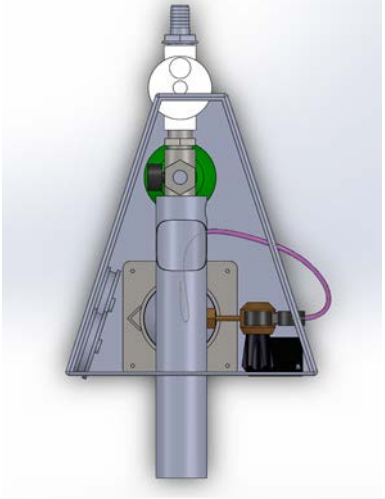
What did you do in Term 1?

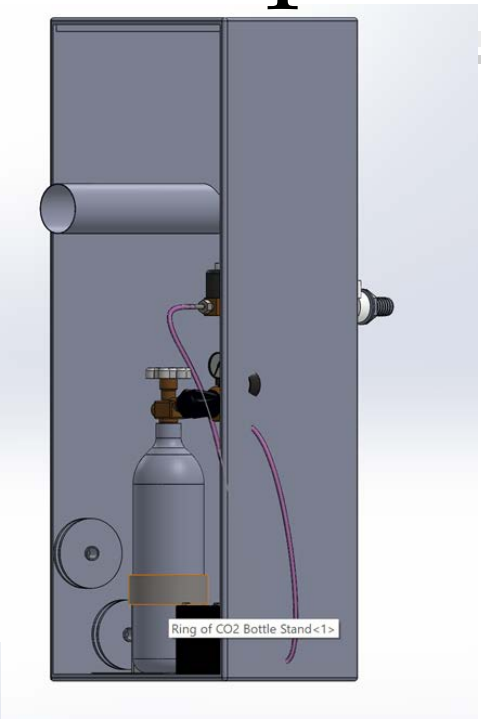




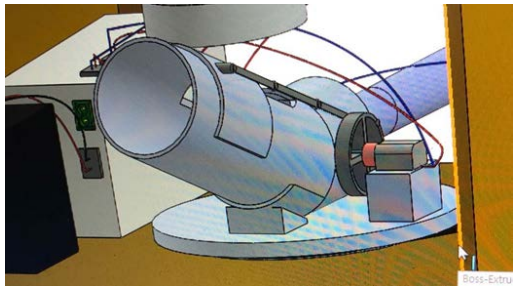
Concepts developed

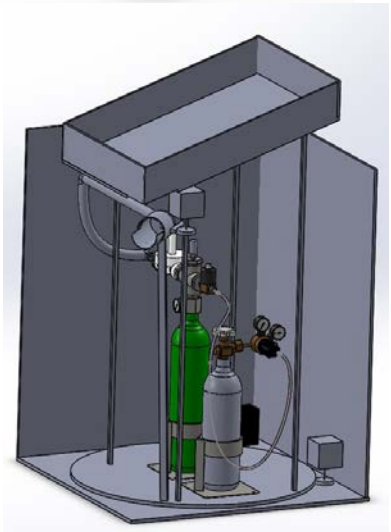
G1 – Active Plav





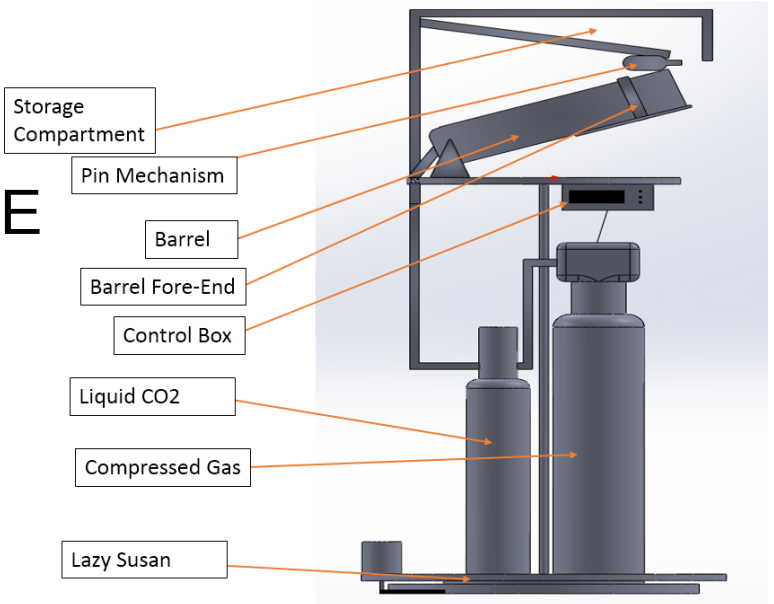
G2 – Advantage





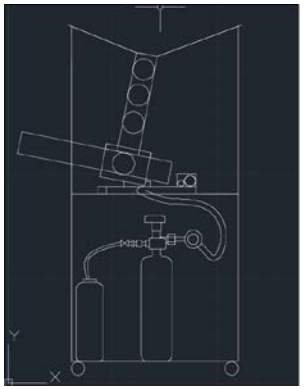
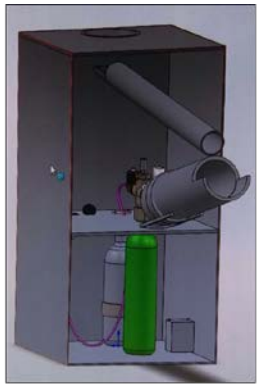
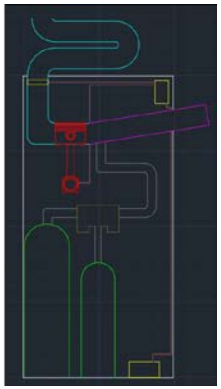
G3 - Flatline

G4 – ACE

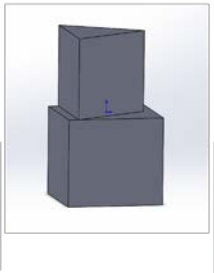


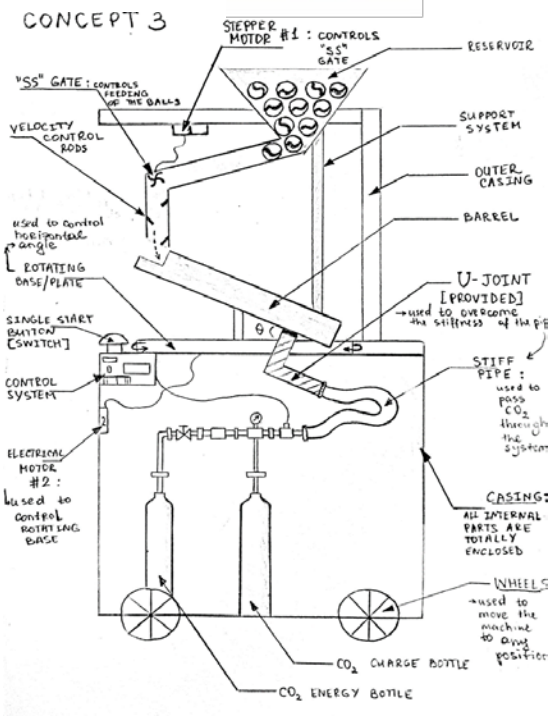
Concepts developed

G5 – ACE

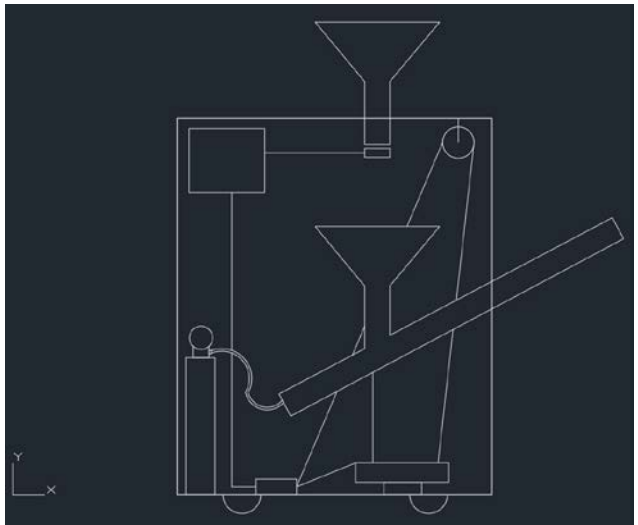
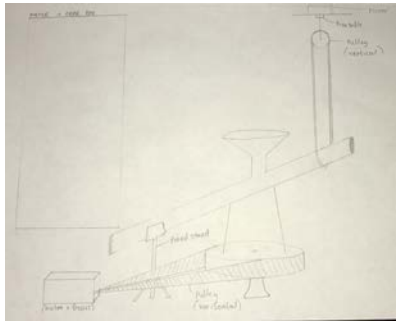




G6 – Wilson Icarus

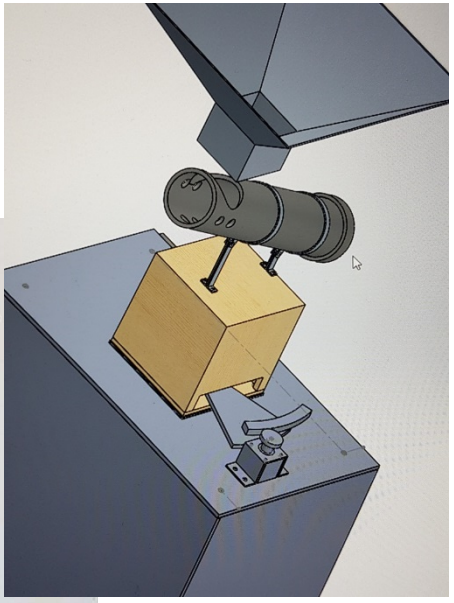
G7 – Serve

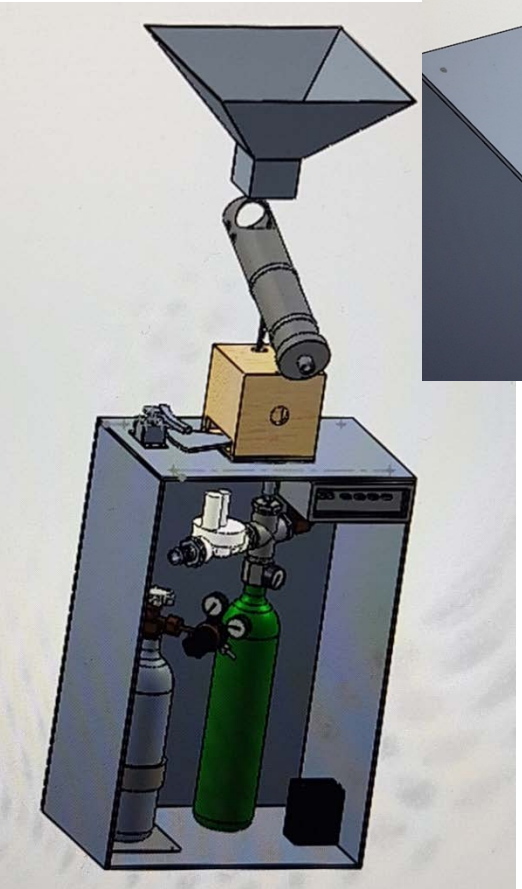



Ahmed Kovacevic, City, University of London

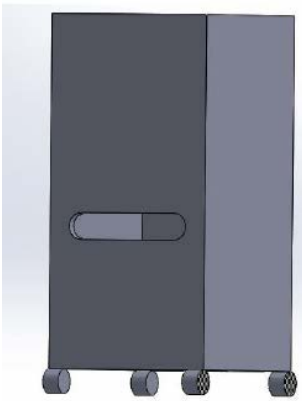
Concepts developed

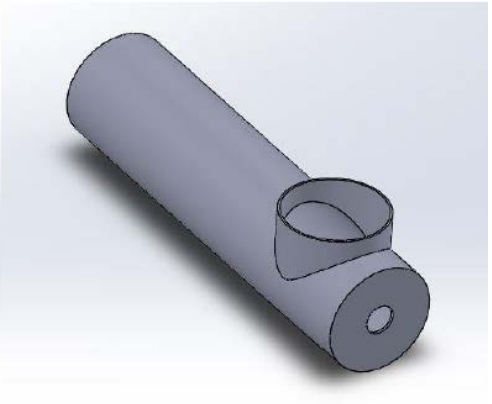
G8 - BACE

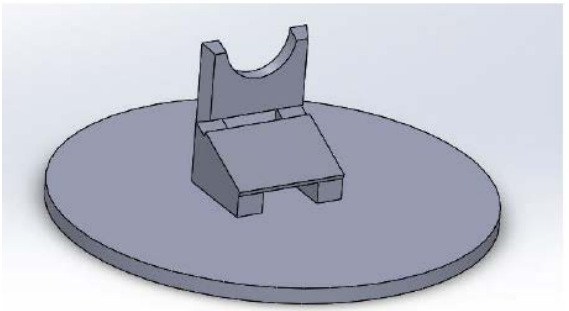




G9 – ACE Mate







What next?

- Implement feedback from coaches on 2nd PR
- 3rd Design review 12th February 2018
  - » To include detailed calculation of all relevant elements (fluid, bearings, transmission, motors, control protocols…)
  - » Full 3D CAD model in SolidWorks
  - » Manufacturing drawings (assembly and detailed)
  - » Shopping list, purchase plan and manufacturing plan
- Manufacturing starts on Monday 19th Feb 2018
- All materials to be ordered by 1st March 2018
- Testing in the Sports Centre on 26th Mar 2018
- “Dragons Den” presentation 9th April 2018

Schedule

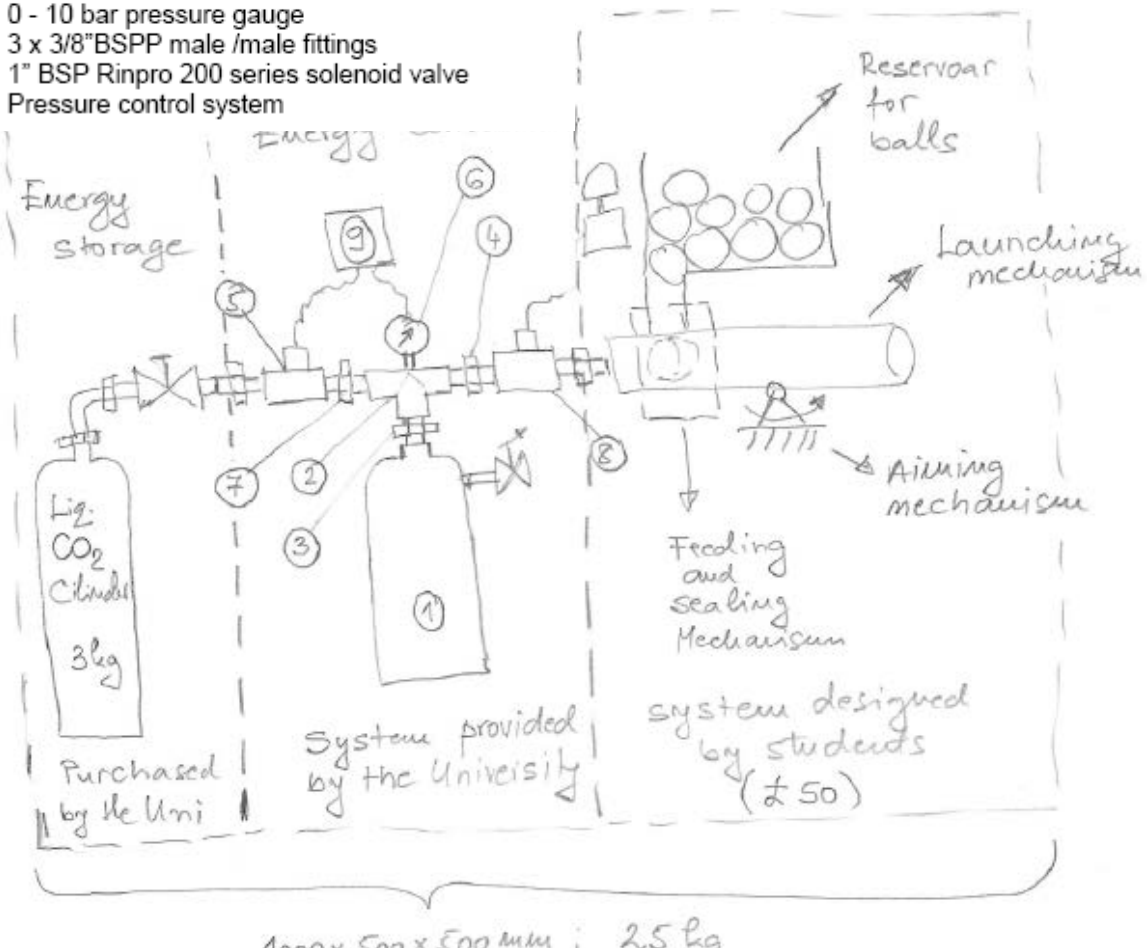
Term 2 | Return to ME2104 web page | DAE4: Banerjee

Week	Date	Design *ELG01 - Mondays 14,00-15,50*	Analysis **Geary** - *Thursdays 15,00-16,30*
11	29-Jan 02-Feb	Detailed design Project work - Embodyment design	DAE3: Dynamics Lecture
12	05-Feb 09-Feb	Detailed design - revision Project work - Detailed design	
13	12-Feb 16-Feb	3rd Project Review - Detailed Design	
14	19-Feb 23-Feb	Detailed design - revision Project work - Detailed design	
15	26-Feb 02-Mar	Manufacturing - briefing and rules Project - Purchasing/Manufacture	
RLW	05-Mar 09-Mar	Reflective learning week - Manufacturing Work on the Main Project	
16	12-Mar 16-Mar	Manufacturing - Issues Project work - Manufacturing	
17	19-Mar 23-Mar	Manufacturing - Refining prototypes Project work - Manufacturing	
18	26-Mar 30-Mar	Testing of Prototypes (FOM) (26/3/2018)	
19	02-Apr 06-Apr	Project work Report preparation	DAE4: Deformations&FEM - project work
20	09-Apr 13-Apr	Final Presentation	DAE4: Deformations&FEM - Assesment

Date	Week no	Time		AE1 & CLG01
Mon 19/02/2018	Week 4	16:00	18:00	Supervised Manufact.
Thu 22/02/2018	(5 hrs)	15:00	18:00	Manufacturing
Mon 26/02/2018	Week 5	16:00	18:00	Supervised Manufact.
Thu 01/03/2018	(5 hrs)	15:00	18:00	Manufacturing
Mon 05/03/2018	Reading	09:00	12:00	Supervised Manufact.
Tue 06/03/2018	week	09:00	17:00	Manufacturing
Wed 07/03/2018		09:00	12:00	Manufacturing
Thu 08/03/2018	(18 hours)	09:00	12:00	Manufacturing
Mon 12/03/2018	Week 6	16:00	18:00	Supervised Manufact.
Thu 15/03/2018	(5 hrs)	15:00	18:00	Manufacturing
Mon 19/03/2018	Week 7	16:00	18:00	Supervised Manufact.
Thu 22/03/2018	(5 hrs)	15:00	18:00	Manufacturing
Thu 26/03/2018	Week 8	13:00	17:00	FOM Testing Sports Centre
Mon 09/04/2018	Week 10	14:00	18:00	"Dragon's Den" 200 Aldersgate

To be supplied to you

1) CO_2 fire extinguishers to use as pressure vessel
2) BSP T piece 1"
3) 1" BSP male – 3/8"BSP female bush
4) 1" BSP male/male nipple
5) 10 bar 3/8"BSP female solenoid valve
6) 0 - 10 bar pressure gauge
7) 3 x 3/8"BSPP male /male fittings
8) 1" BSP Rinpro 200 series solenoid valve
9) Pressure control system



- Control box
- Some motors

Technical support

Mr Richard Leach – technical lead

Mr Keith Pammet – general support/ control systems

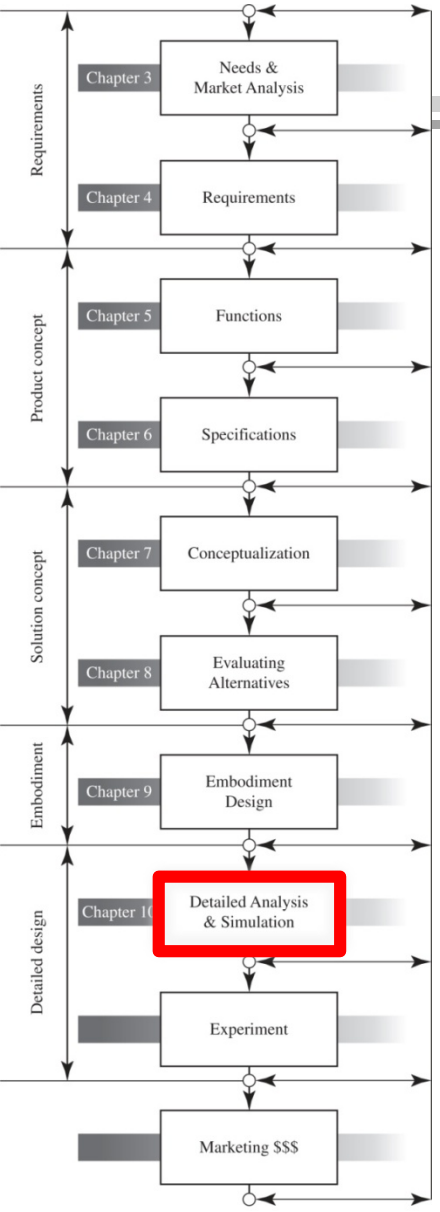
Mr Paolo Lo Giudice - gennral support

Mr Phil Beckwith - woodwork

Mr Rob Cherry – general support

Mr Zaheer Hashim – control systems

Detail design



- Engineering Design Process 2nd Edition, Chapter 10
  - » Understand the detailed design stage
  - » Identify and select engineering materials that suit a product
  - » Construct a bill of materials
  - » Use techniques introduced in this chapter to evaluate and analyze design cost

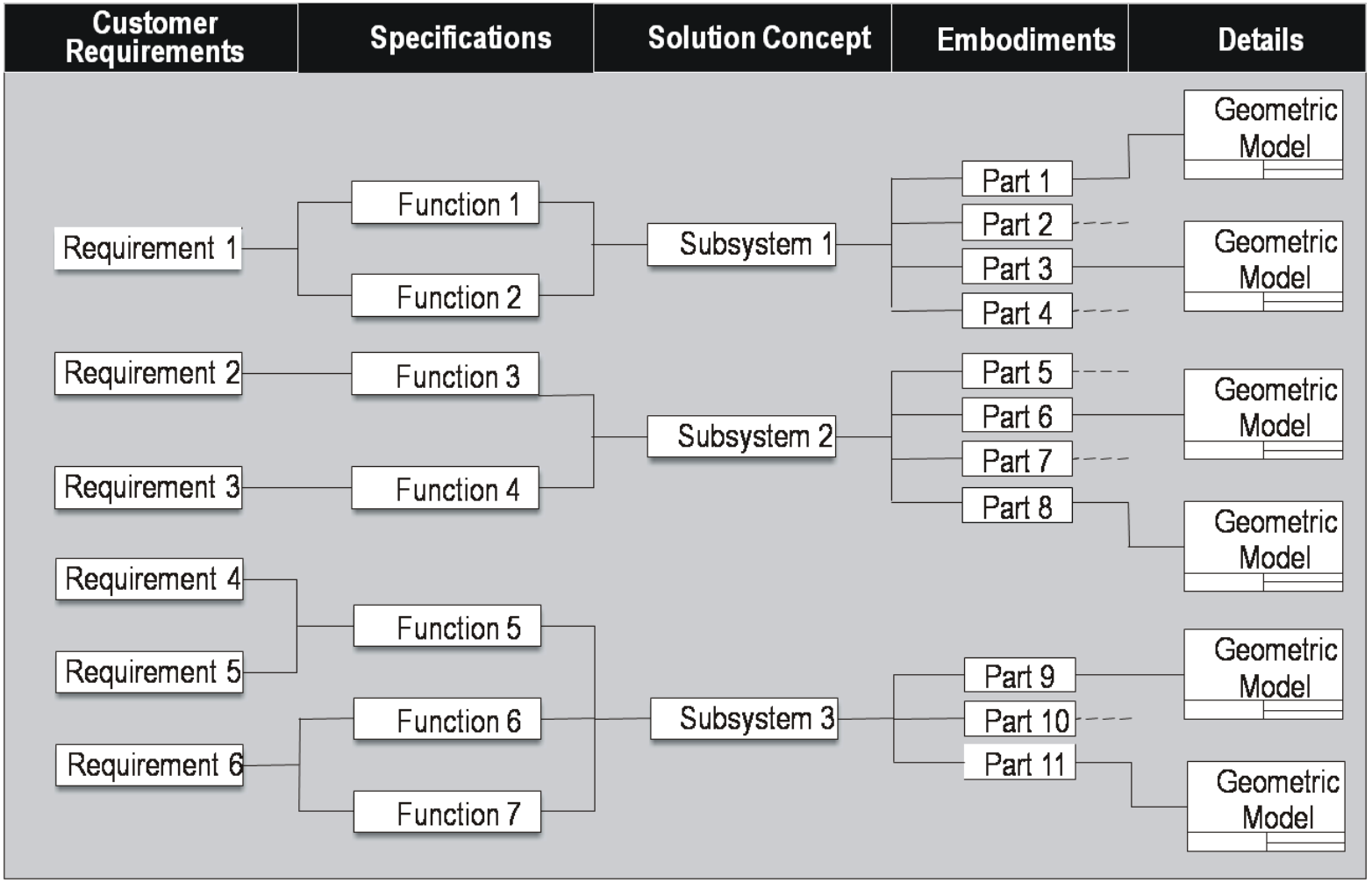
What is the detail design stage?

- Final step before prototyping
- Analysis and simulation
- Material selection
- Dimensions and tolerances
- 3D CAD model
- Assembly Drawings
- Manufacturing Drawings with all dimensions

Steps in detail design (analysis)

1. Check design safety -calculate all important components
2. Select materials – make a list of materials that satisfy stress requirements and using decision matrix select the best
3. 3D CAD model & manufacturing drawings (Solid Works)
4. Check manufacturability with available manufacturing methods.
   - » use rapid prototyping and CNC.
   - » Use laser cutting machine (very suitable for aluminium cutting)
5. Cost analysis for a prototype and production unit
6. Aesthetics

Evolution of a product within the Design Process



QFD 3

QFD 1: Objectives vs Functions

- To determine importance of each Function

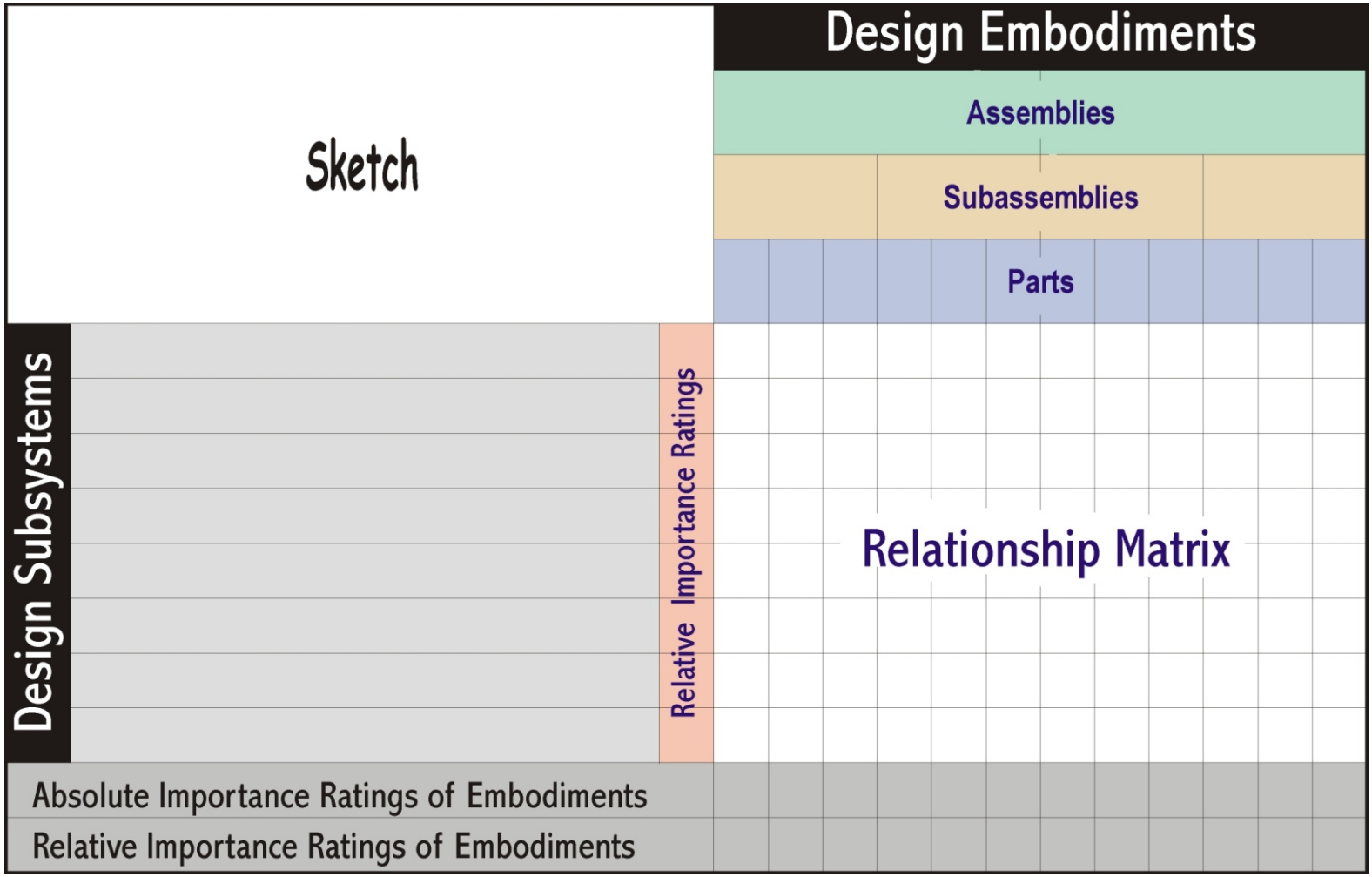
QFD 2: Functions vs Engineering Characteristics

- To determine importance of each Engineering characteristic
- What is important to calculate and design carefully

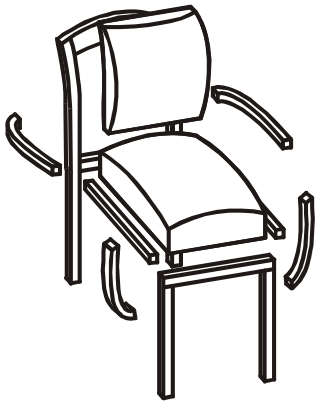
QFD 3: Subsystems vs Parts

- Functions grouped in subsystems (storing, feeding, sealing, aiming, pressure regulation, launching, …)
- Which parts are most important for the proper function - to be properly designed, selected and manufactured.

QFD 3 (Embodiments)



Chair Example - Stage 3 Chart



	Relative Importance	Back Cushion			Seat Cushion			Hind Leg Assembly			Left Seat Support	Right Seat Support	Front Leg Assembly			LeftAR Assy		RhtAR Assy	
		Cushion	Board	Cover	Cushion	Board	Cover	Back rest frame	Hind Seat Support	Hind Legs			Left Front Leg	Right Front Leg	Front Seat Support	Left Arm rest	Left A.R. Support	Right Arm rest	Right A.R. Support
Seat Cushion Assy	9				9	9	9		9		9	9			9				
4Legs	7									9			9	9					
Back rest assy.	6	9	9	9															
Back rest frame	3							9		3									
Hand rest	4															9		9	
Hand rest support	9																9		9
Good Surface	1			9			9			9			9	9		9		9	
Target Information		LEFT VACCANT																	
Absolute Importance		54	54	63	81	81	90	27	81	81	81	81	72	72	81	45	81	45	81
Relative Importance		5	5	6	8	8	9	3	8	8	8	8	7	7	8	5	8	5	8

QFD Stage 4 – Material and Manufacturing Process Selection

- An essential characteristic of the finished design is its **easiness and cost effectiveness for manufacture**. Therefore materials and associated manufacturing process selection is an essential consideration that has to be undertaken before any decisions on the detail design can be taken.

- **Material and Manufacturing process** selection involves:
  - The identification of design functions related to materials and manufacturing processes.
  - The material and manufacturing related functions are translated into quantitative, actionable and measurable material and manufacturing process characteristics
  - These form the basis to select the appropriate materials and manufacturing processes.

- **Production Plans** greatly depend on the Manufacturing facilities available and the quantity to be produced.

Cost Analysis

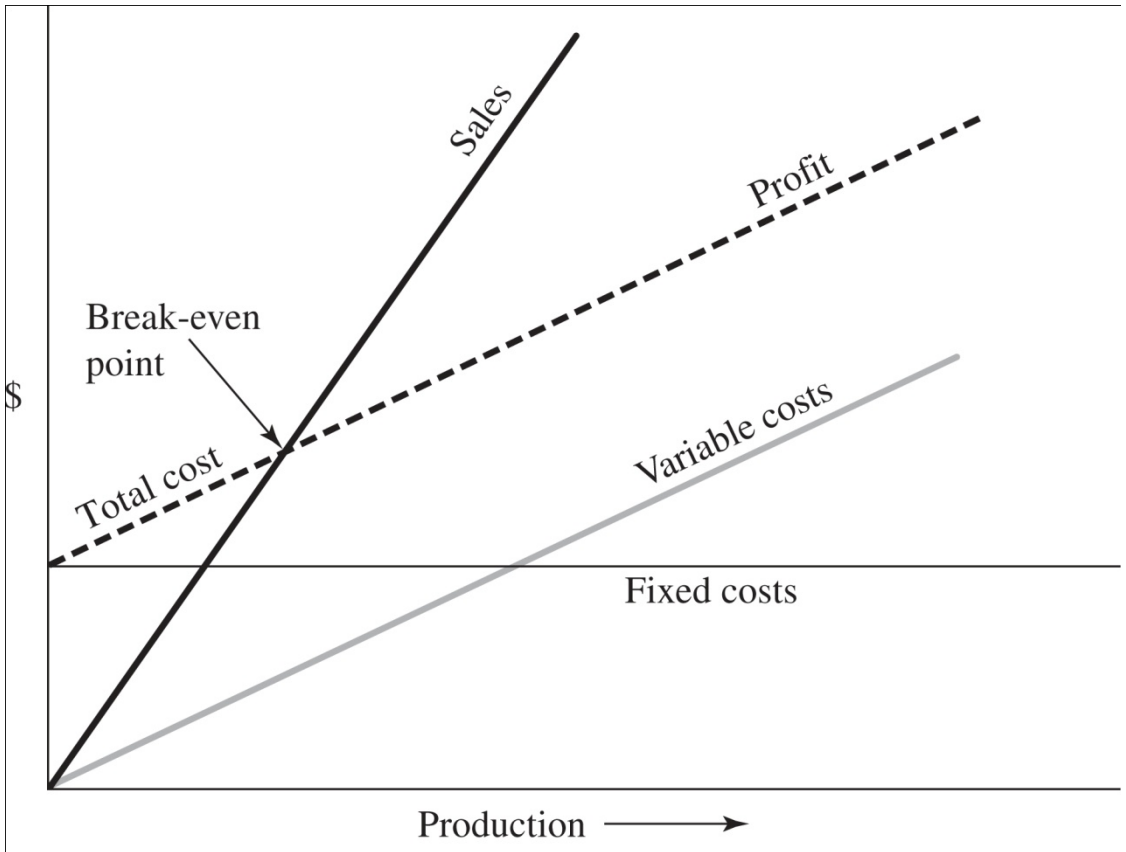


Figure 10.14 Break-even chart.

TABLE 10.3 The Make–Buy Decision

Reason to Make	Reason to Buy
Cheaper to make	Cheaper to buy
Company has experience making it	Production facilities are unavailable
Idle production capacity available	Avoid fluctuating or seasonal demand
Compatible and fits in production line	Inexperience with making process
Part is proprietary	Existence and availability of suppliers
Wish to avoid dependency on supplier	Maintain existing supplier
Part fragility requiring high packing	Higher reliability and quality
Transportation costs are high	

Q & A

Places to purchase materials

- Electrical http://onecall.farnell.com/
- Electronics http://www.rapidonline.com/
- Electrical/Mech. http://uk.rs-online.com/web/
- Tubing http://www.directplastics.co.uk/
- Metal http://www.smithmetal.com/
- General http://www.screwfix.com/jsp/container.jsp

Tasks for this week

- Finalise function carrier analysis
- 3rd QFD
- 3D SW models
- Meeting on Thursday…

Content for 3nd Project Review

- Updated, Functional model, QFD2, Requirements list etc. from Phase 2
- QFD 3
- Calculations for all transmission systems, motors, pressure for launching
- 3D CAD Model
- Assembly & Manufacturing Drawings
- Specification on materials to by and produce
- Prototype costs

Report (max.10 Pages + Drawings in Appendix) Due: Sunday, 11th February 2018, 11:59 PM

- Introduction 5%
- Updated Objectives, Functional model, QFD, Requirements list (10%) (In appendices)
- QFD3 20%
- Calculations of function carriers* 25%
- 3D CAD model 10%
- Assembly drawings 5%
- Detailed drawings 15%
- Specifications and costs 5%
- Summary 5%

% Indicates weighting of Marks

* Function carriers are devices to perform sub-functions like motors, gears, belts, valves …

Presentation (10 Slides, 15 mins + 10min Q's)

Due: Sunday, 11th February 2016, 11:59 PM

Presentations:

Mon. 12th Feb 14,00 – 18,00, ELG01

- Introduction (Team and summary of concept) 5%
- Updated Functional model, QFD, Requirements list (10%)
- QFD3 20%
- Calculations of Function carriers 25%
- 3D CAD model 10%
- Assembly drawings 5%
- Detailed drawings 15%
- Specifications and costs 5%
- Summary 5%

% Also indicates weighting of Marks