Aalto University
School of Engineering

MEC-E1003
Machine Design Project

Sept. 8, 2023

Prof. Sven Bossuyt

Schedule: Overview and milestones

Week	Deadline	Description
Week 35-36	Sept 8	Project team formation and pre-questionnaire
Week 37	Sept 15	***Design brief for group project***
Week 37-39	Sept 27-29	Stirling engine starter project (individual work)
Week 40	Oct 6	Initial concept for group project
Week 43	Oct 27	Concept pitch + peer review & 1st evaluation questionnaire
Week 46	Nov 17	Status report & 2nd evaluation questionnaire
Week 47		Status report peer review
Week 48	Nov 29	Information poster
Week 48	Dec 1	Gala: Prototype demonstration & Demonstration gala reflections
Week 50	Dec 15	Final report & Final evaluation questionnaire

Engineering design

This is a machine design project course

- As a ***mechanical engineering designer***, what is your job?
- What do you do?
- What are your deliverables?

Engineering design

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- As a ***mechanical engineering designer***, what is your job?
- What do you do?
- What are your deliverables?
- ***Machines!***

Engineering design

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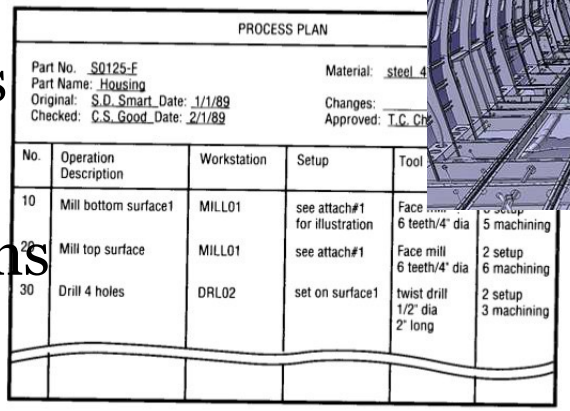
- As a ***mechanical engineering designer***, what is your job?
- What do you do?
- What are your deliverables?
- ~~***Machines!***~~

Engineering design

This is a machine design project course

- As a ***mechanical engineering designer***, what is your job?

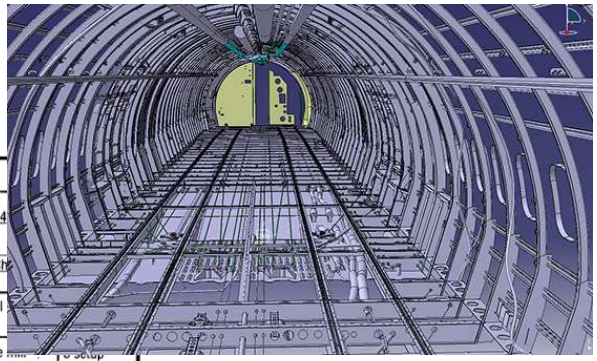
- **Your deliverables are the *design documentation* for machines**
  - Bill of Materials
  - CAD models
  - Supplier specifications
  - Assembly process specifications
  - Inspection specifications
  - System compliance specifications

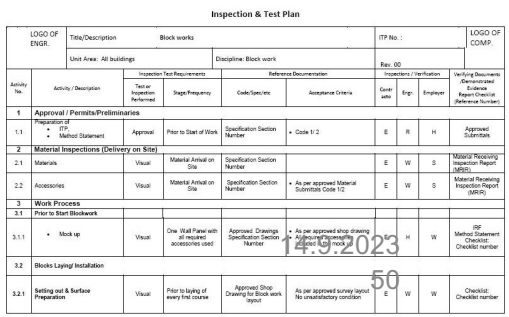

PROCESS PLAN

Part No. S0125-F
Part Name: Housing
Original: S.D. Smart Date: 1/1/89
Checked: C.S. Good Date: 2/1/89

Material: steel 4
Changes:
Approved: T.C. Ch

No.	Operation Description	Workstation	Setup	Tool	
10	Mill bottom surface1	MILL01	see attach#1 for illustration	Face ... 6 teeth/4" dia	5 machining
20	Mill top surface	MILL01	see attach#1	Face mill 6 teeth/4" dia	2 setup 6 machining
30	Drill 4 holes	DRL02	set on surface1	twist drill 1/2" dia 2" long	2 setup 3 machining




Inspection & Test Plan

LOGO OF ENGR.	Title/Description: Block works				ITP No. :			LOGO OF COMP.
	Unit Area: All buildings			Discipline: Block work	Rev. 00			

Activity No.	Activity / Description	Inspection Test Requirements: Type of Inspection Performed	Inspection Test Requirements: Stage/Frequency	Reference Documentation: Code/Spec/etc	Reference Documentation: Acceptance Criteria	Inspections / Verification: Contr. with	Inspections / Verification: Engr.	Inspections / Verification: Employer	Verifying Documents (Demonstrated Evidence Report Checklist (Reference Number))
1	**Approval / Permits/Preliminaries**								
1.1	Preparation of • ITP • Method Statement	Approval	Prior to Start of Work	Specification Section Number	• Code 1/ 2	E	R	H	Approved Submittals
2	**Material Inspections (Delivery on Site)**								
2.1	Materials	Visual	Material Arrival on Site	Specification Section Number		E	W	S	Material Receiving Inspection Report (MRIR)
2.2	Accessories	Visual	Material Arrival on Site	Specification Section Number	• As per approved Material Submittals Code 1/2	E	W	S	Material Receiving Inspection Report (MRIR)
3	**Work Process**								
3.1	**Prior to Start Blockwork**								
3.1.1	• Mock up	Visual	One. Wall Panel with all required accessories used	Approved Drawings Specification Section Number	• As per approved shop drawing • As per approved specification • Approved mock up	E	H	W	IRF Method Statement Checklist: Checklist number
3.2	**Blocks Laying/ Installation**								
3.2.1	**Setting out & Surface Preparation**	Visual	Prior to laying of every first course	Approved Shop Drawing for Block work layout	As per approved survey layout No unsatisfactory condition	E	W	W	Checklist: Checklist number

Design documentation

- In the Stirling engine starter project, you have been given the design documentation.
  - *Now, you are not the designer.*
  - *Now you are the supplier.*
  - *Now you are the manufacturer.*
  - *Now you are the quality control engineer.*

- In the main course project, you will be the designer.
  - *You will be required required to deliver design documentation.*
  - *You will build a prototype from which to learn how good your design and documentation are.*
  - *You can choose what you want to design and build.*

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Design Brief

Requirements & Constraints

There are general requirements & process requirements

Requirements = Set by staff

Constraints = Set because of realities

Must = You have to do this

Recommended = You don’t necessarily have to do this

General requirements

Must have sufficient complexity to showcase mechanical engineering design

- *Including at least 5 machine design elements (like power screw, spring, bearing, gear, clutch, brake, belt, chain, coupling, linkage, and/or cam) is sufficient.*

Must have some functionality

Must be ready for exhibition and live demonstration on Dec 1

Recommended to focus on mechanical engineering, as the course cannot support you with electronics, programming, and other such features

+ The course can offer limited budget for the teams

+ The course can accommodate collaboration with other courses, research groups, or external stakeholders who may have different constraints and requirements

Process requirements

Must be modeled in 3D CAD with a meaningful structure, dimensions, and tolerances, with regard to its operation

Must be structurally verified and analyzed with MBS

Must be manufactured according to CAD drawings

Must Include at least 1 part, whose shape is optimized with FEM, and material with Granta Edupack

- *alternatively to material selection, a business case for the design may be presented*

Must identify at least one part for which to verify key tolerances with appropriate measurement devices

Recommended to use Siemens NX for concurrent development.

Project management

Frequent team meetings are essential

- Ensure common goals by sharing your expectations
- Focus on good communication

Be clear who does what

- Mutually agree on work allocation
- Decide if you want a project manager in your team

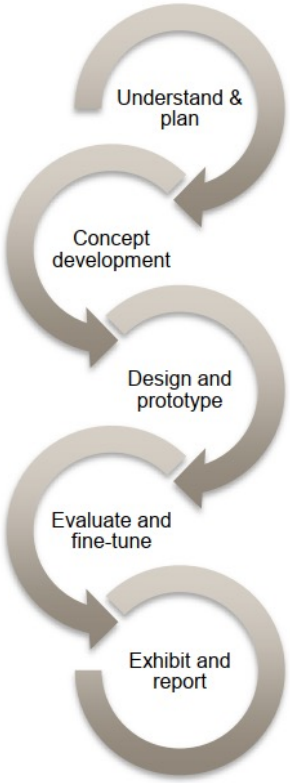
Follow a systematic process

- Maintain a project plan
- Identify potential risks so you can mitigate them
- Iteration is the key!

Document all the steps

- Have a draft report & update as the project progress

Project management



“Fail early to succeed sooner”

Please ask, rather than waiting for us to notice what you need.

Figure adapted from Product Design and Development process by Ulrich & Eppinger

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Collaboration ideas from other courses or research projects

Why this starter project?

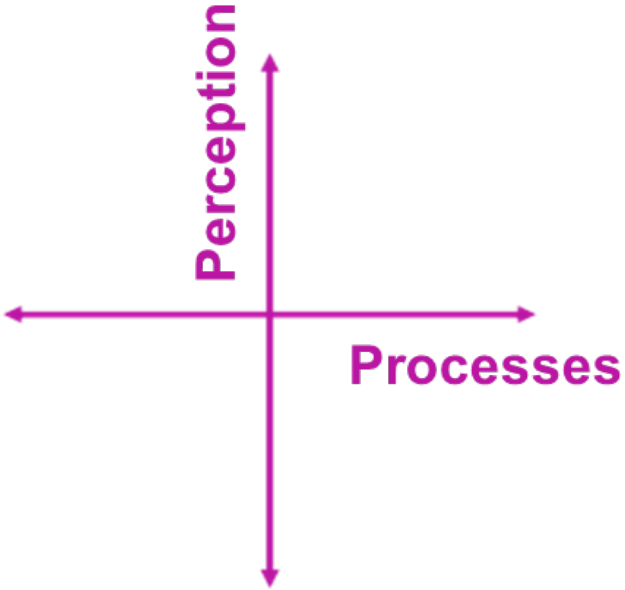
How do you learn?

Learning pedagogy

Learning theory:

the Kolb learning model

- **Perception**
  - What's going on in your head while learning?
- **Processes**
  - What are you doing while learning?



Learning pedagogy

the Kolb learning model

Hands On Activity

Perception

Processes

Sit and Listen

Learning pedagogy

the Kolb learning model

Experience & Feel it

Perception

Hands On Activity

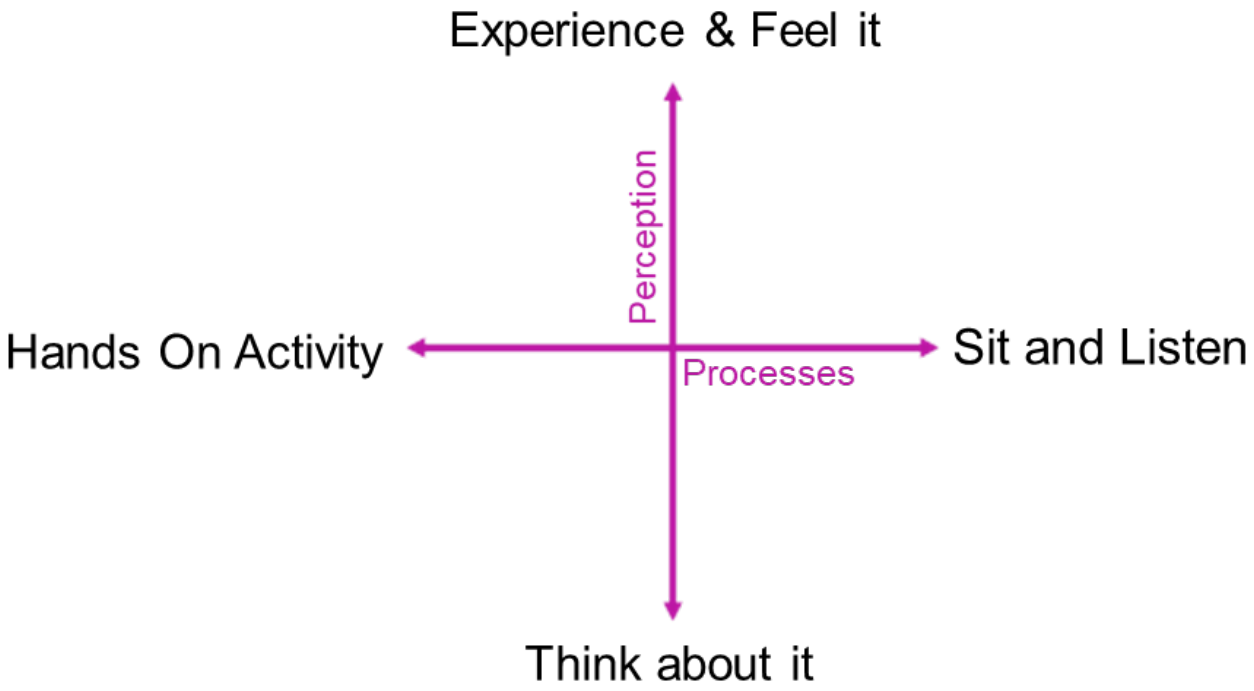
Sit and Listen

Processes

Think about it

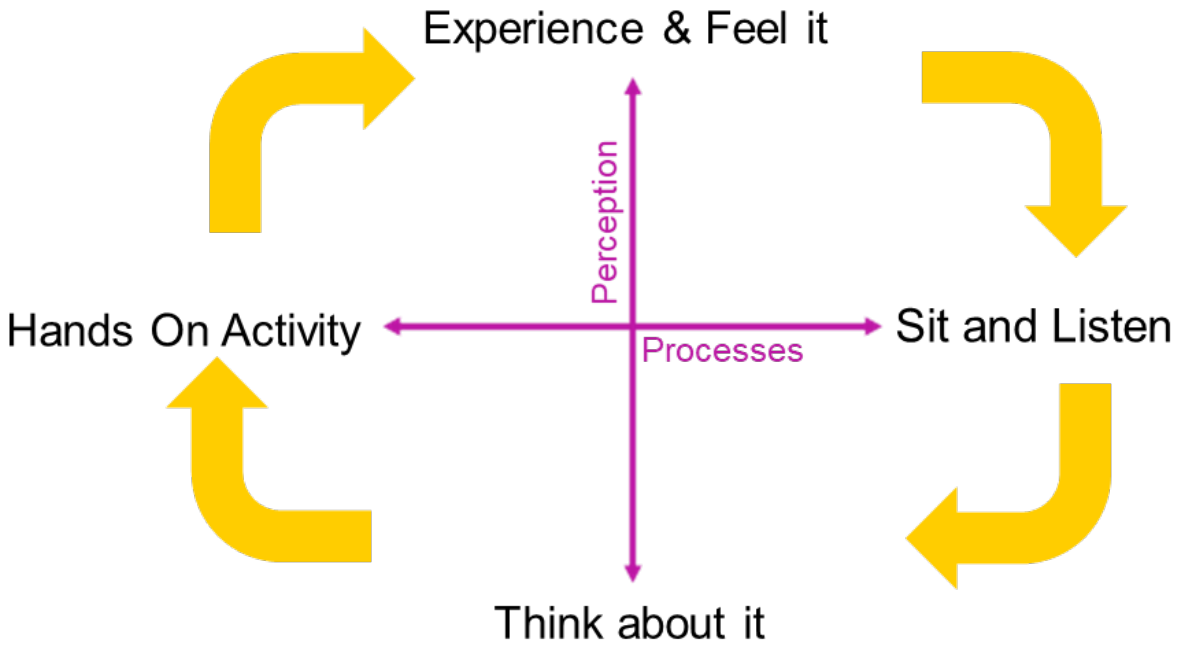
Learning pedagogy

the Kolb learning model



Learning pedagogy

the Kolb learning model

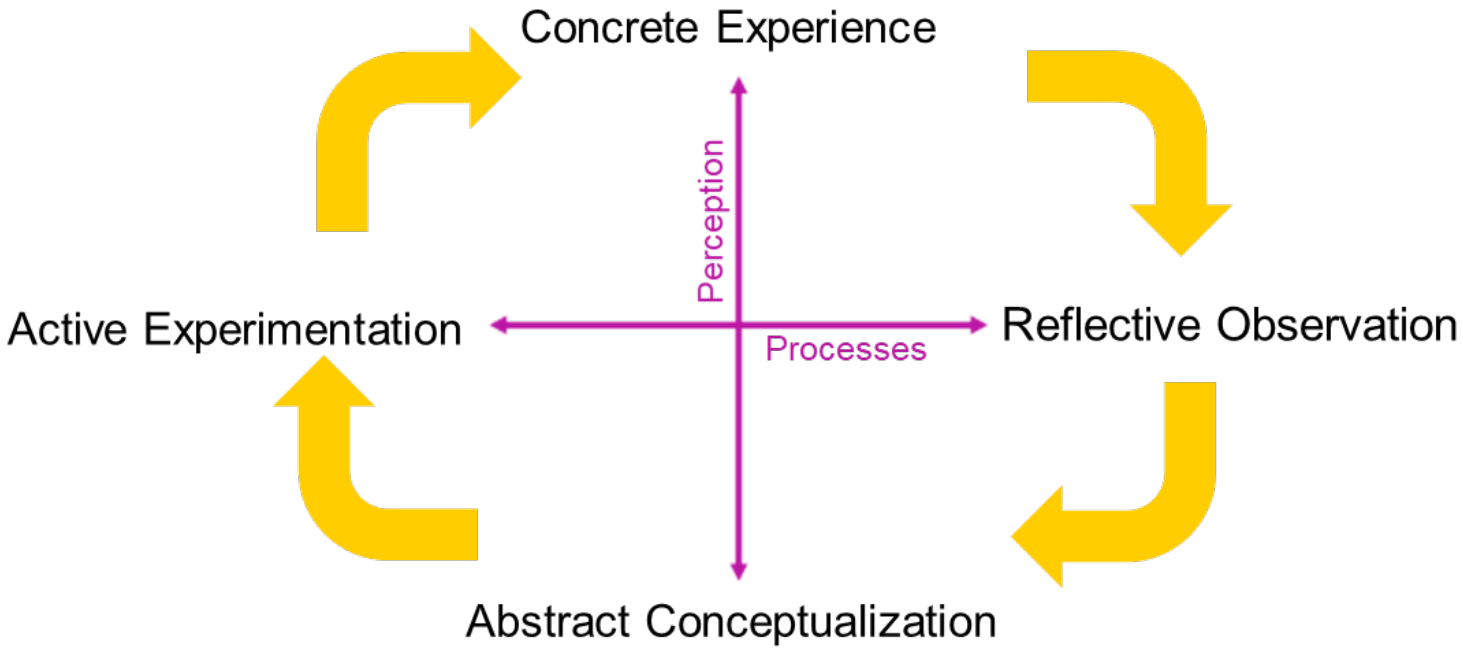


LEARNING!

Learning pedagogy

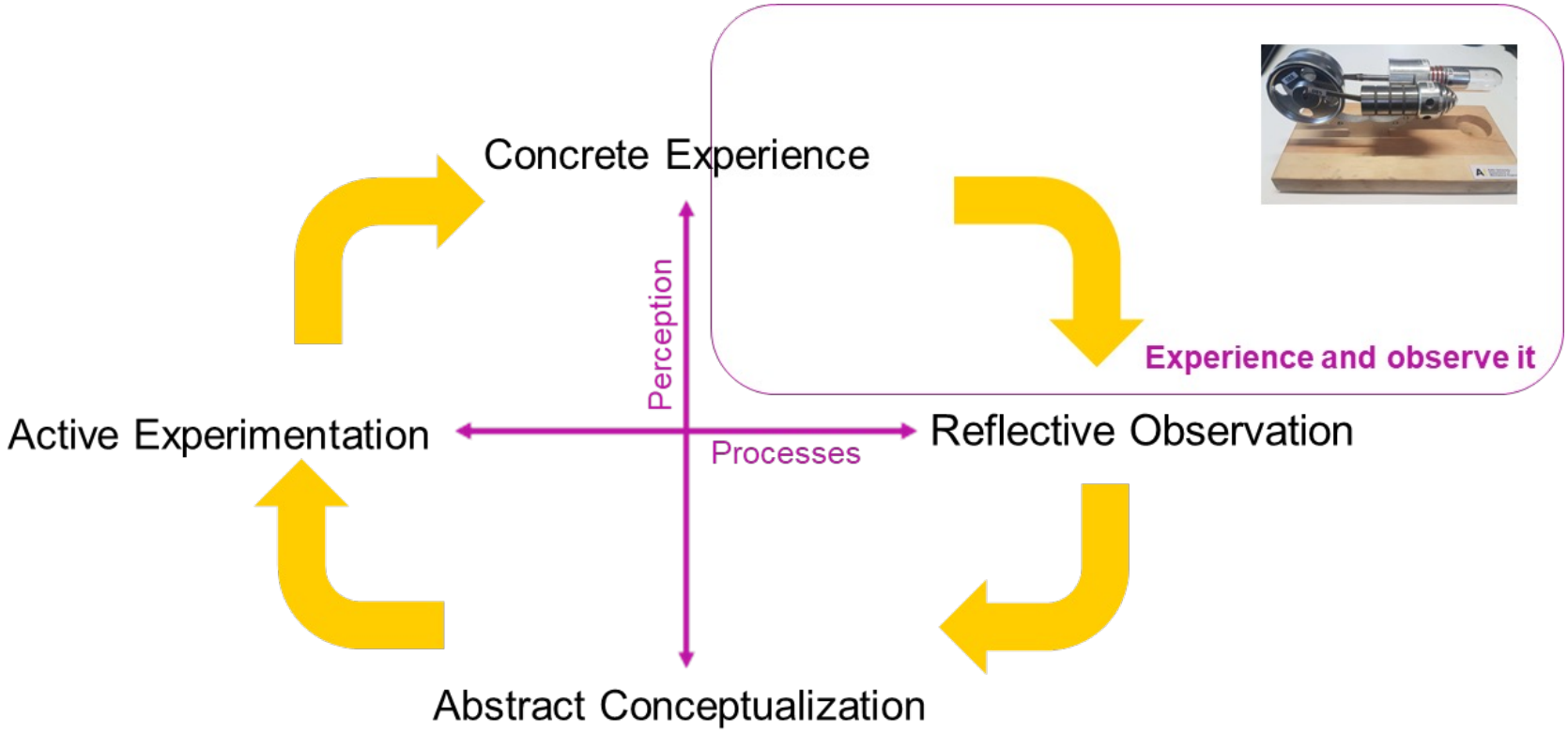
the Kolb learning model

The ***entire curriculum*** closes this loop.



Learning pedagogy

the Kolb learning model



Learning pedagogy

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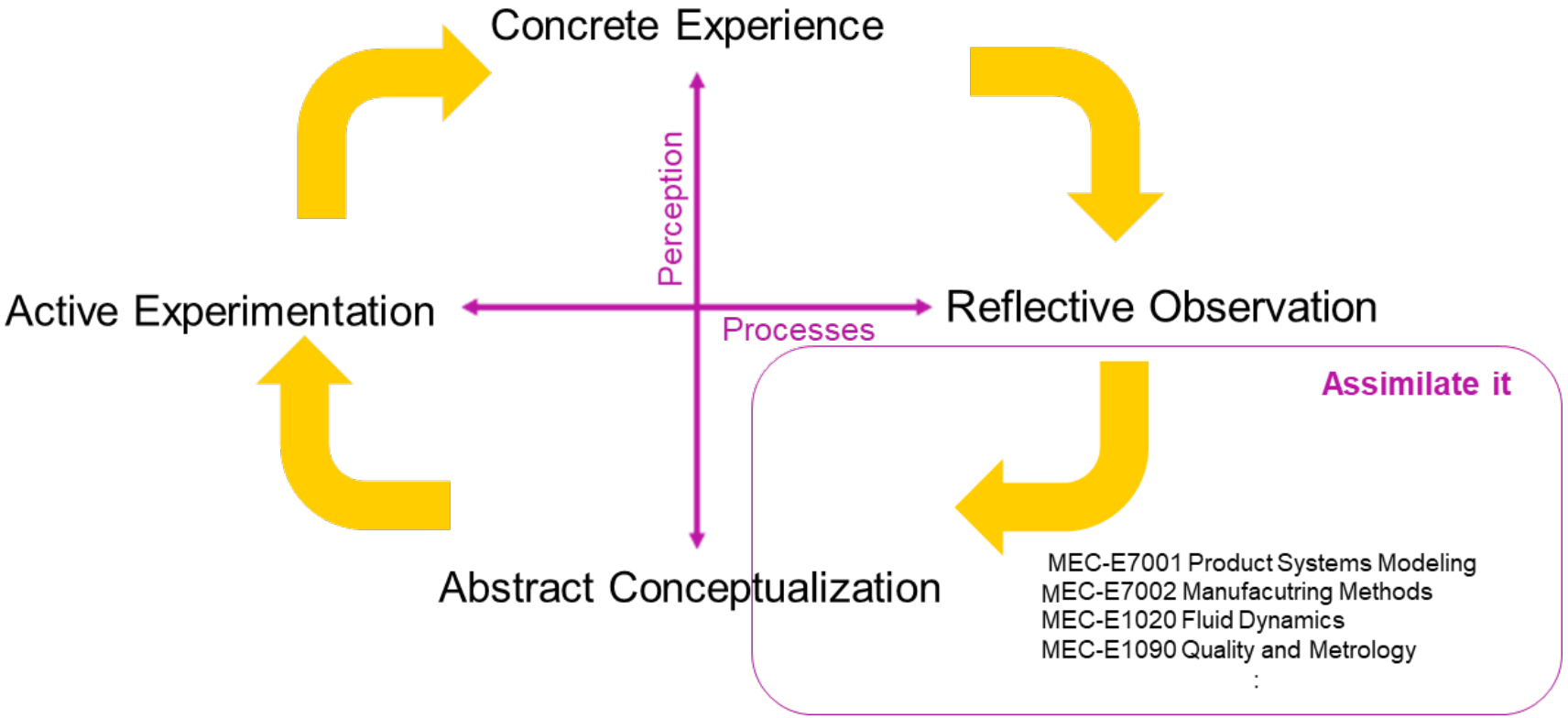

Learning pedagogy

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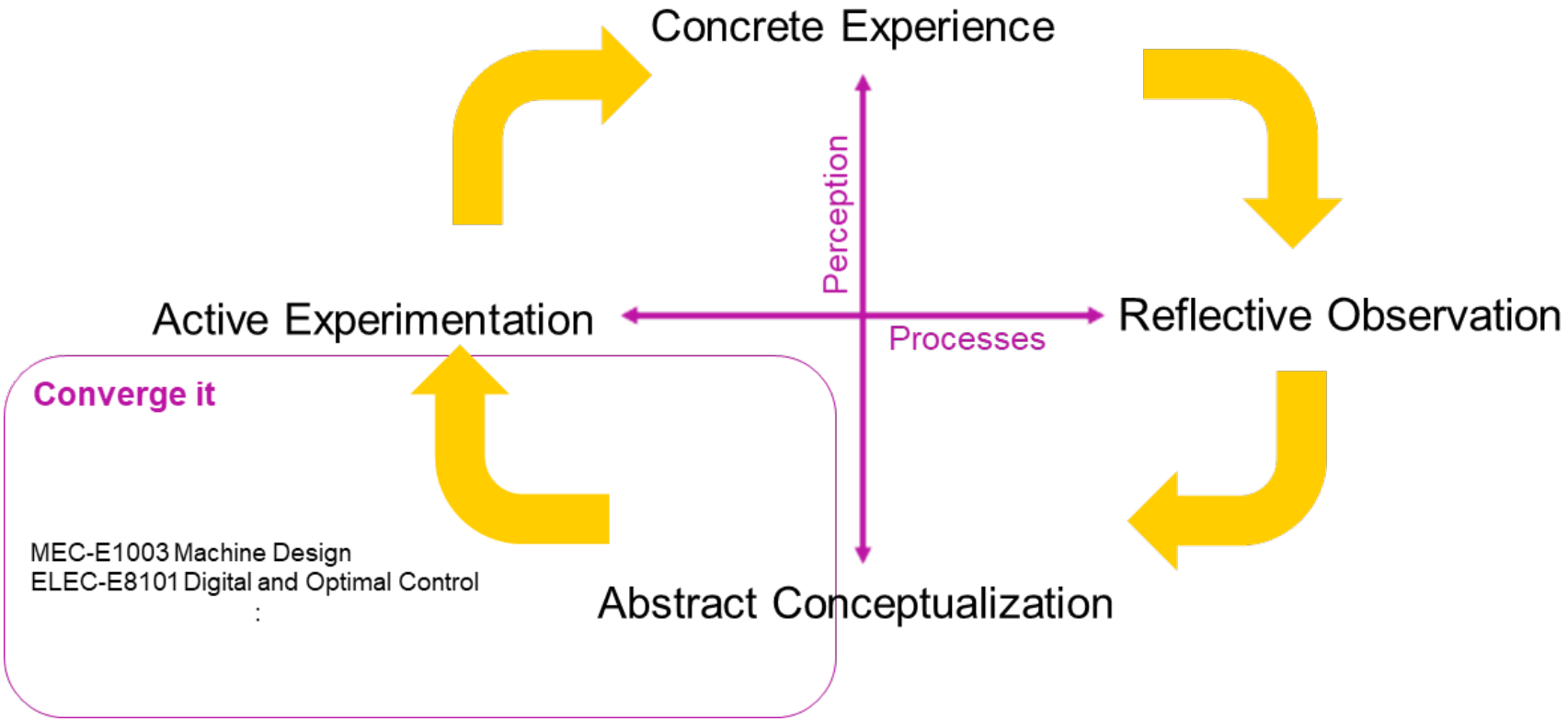
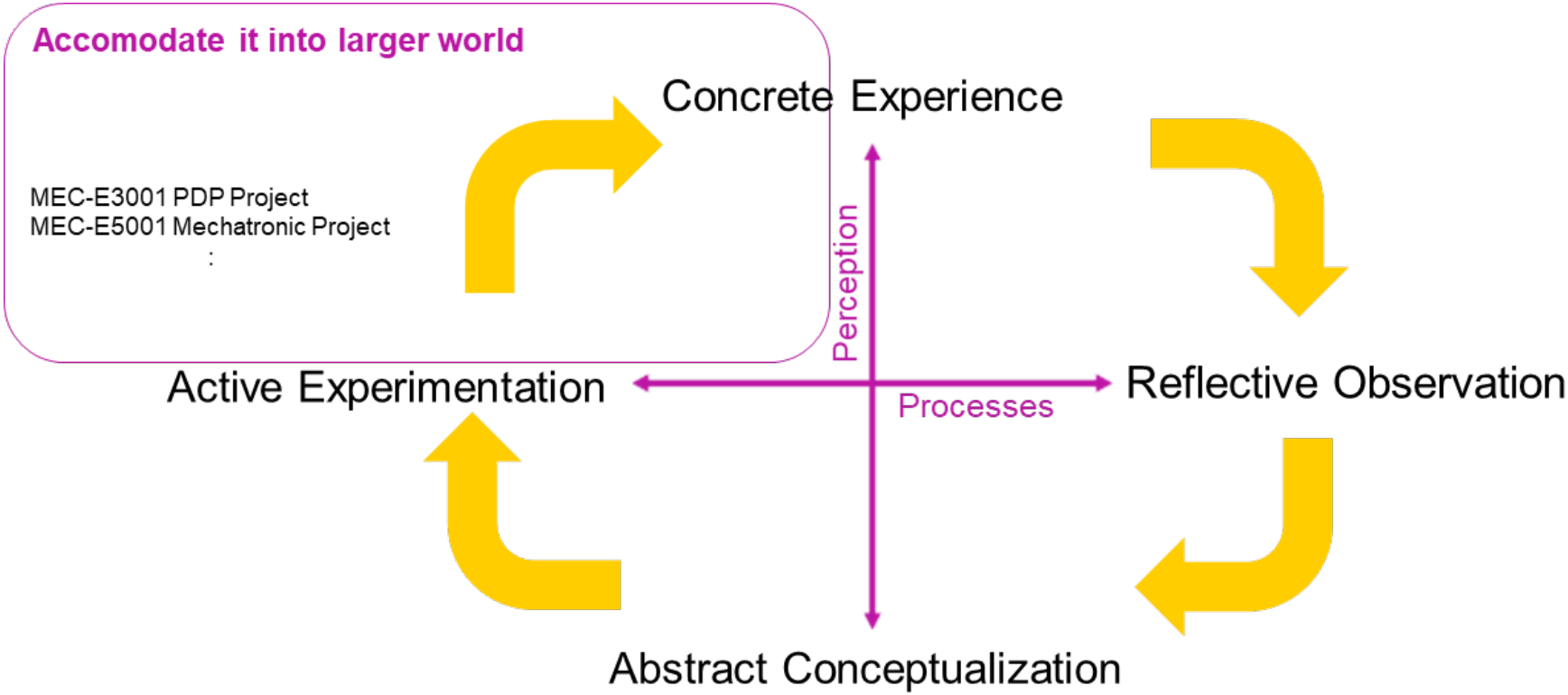


Learning pedagogy

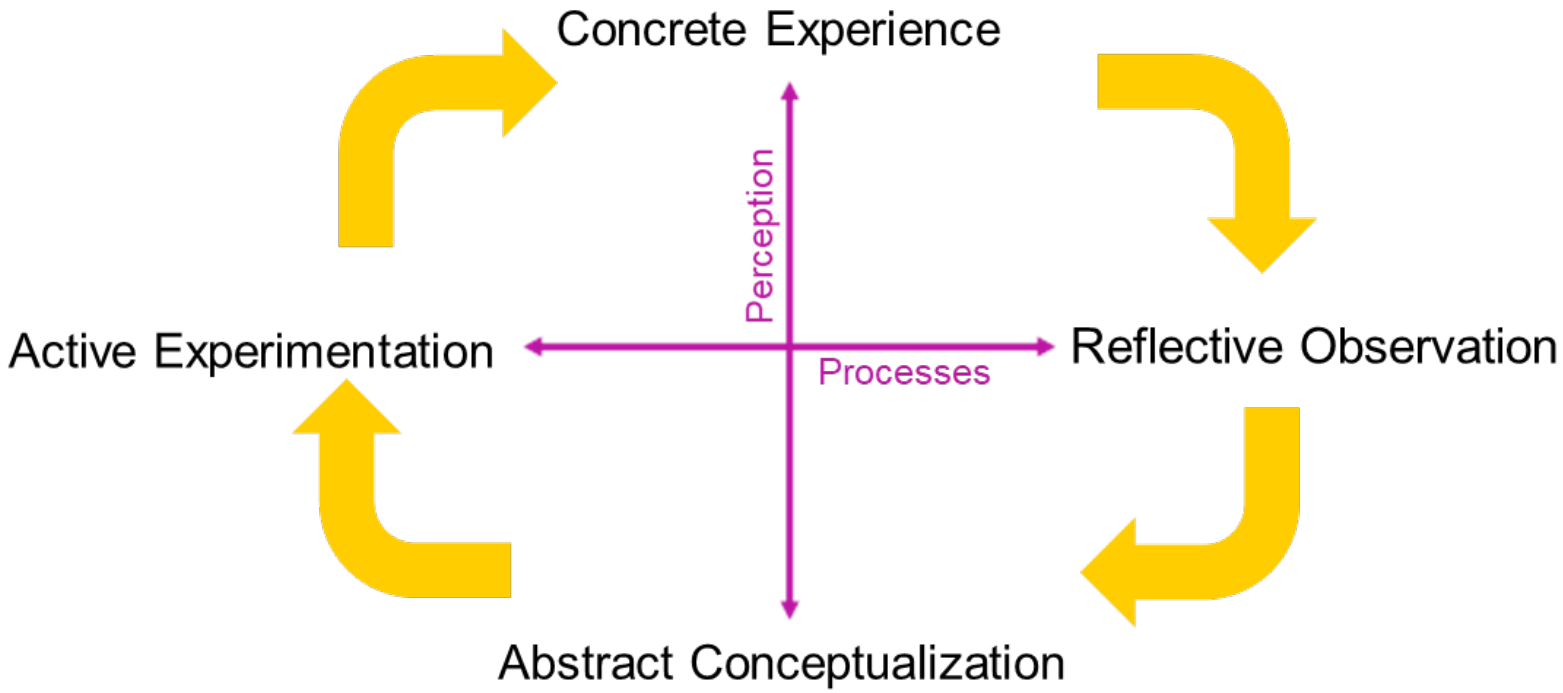
the Kolb learning model



Learning pedagogy

the Kolb learning model

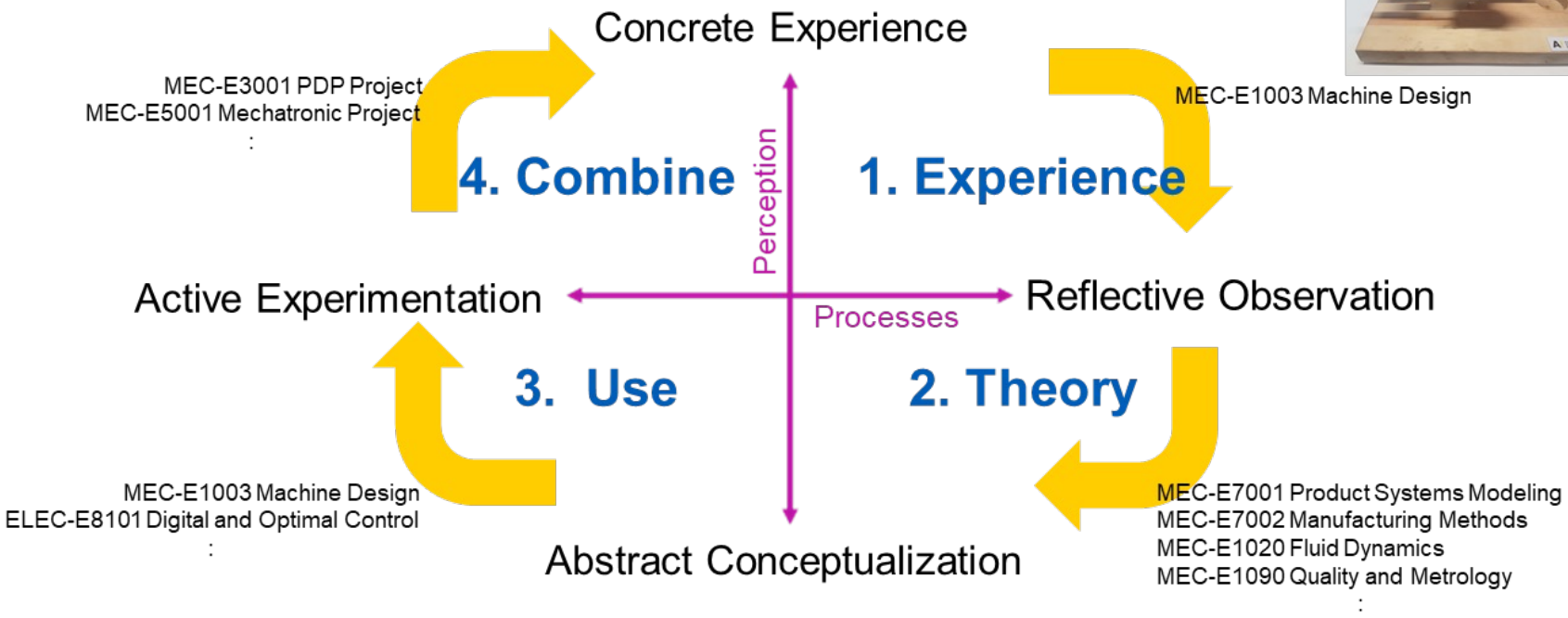
Which do you do first?



Learning pedagogy

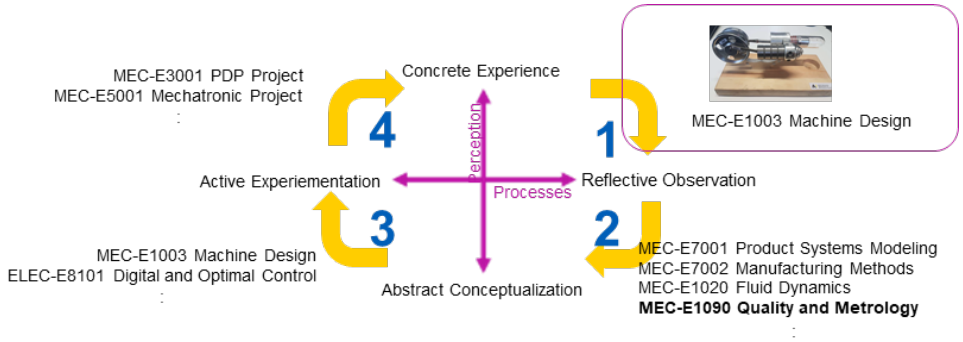
the Kolb learning model

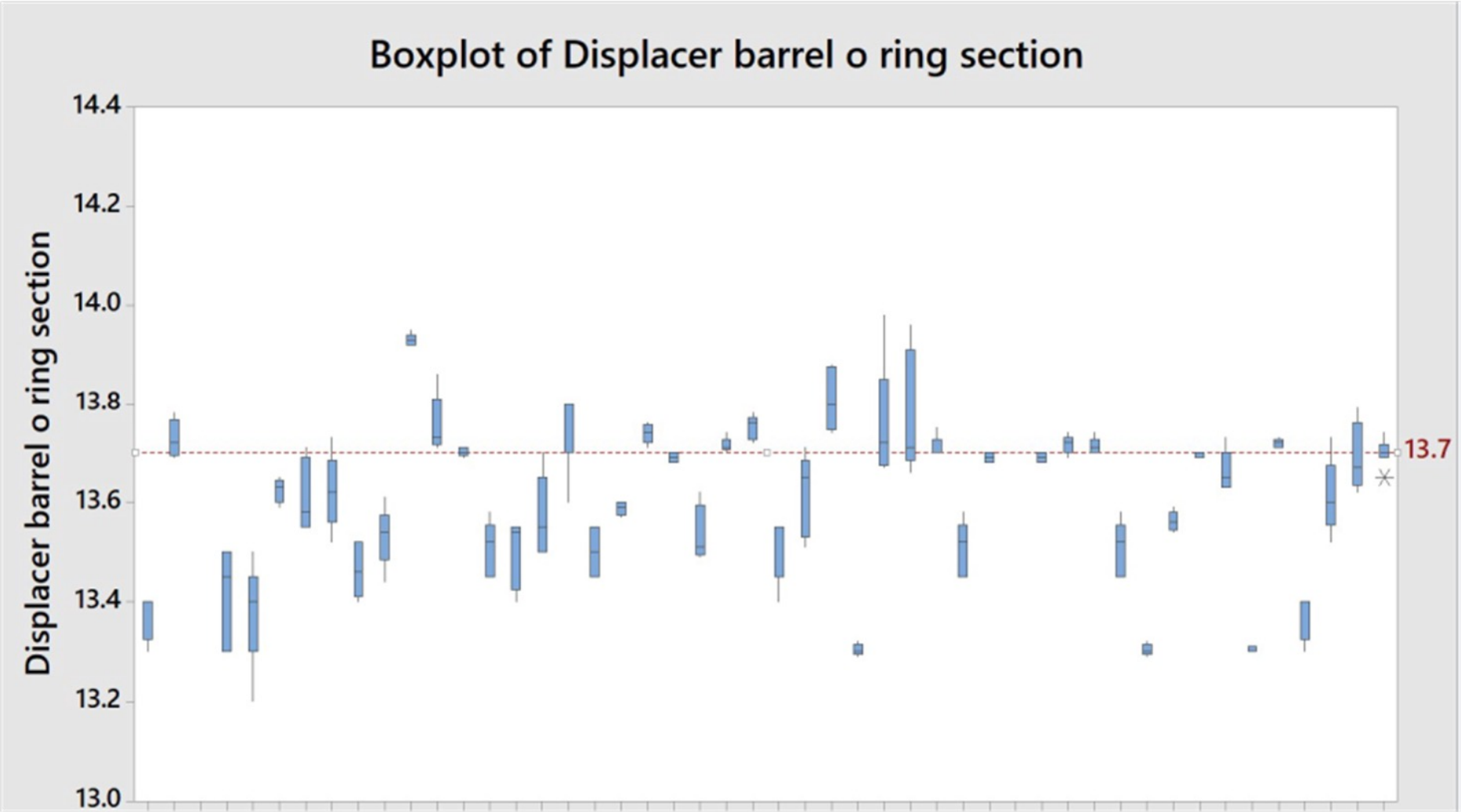
Learning is best when first *experienced*.



There is always a first time for everything

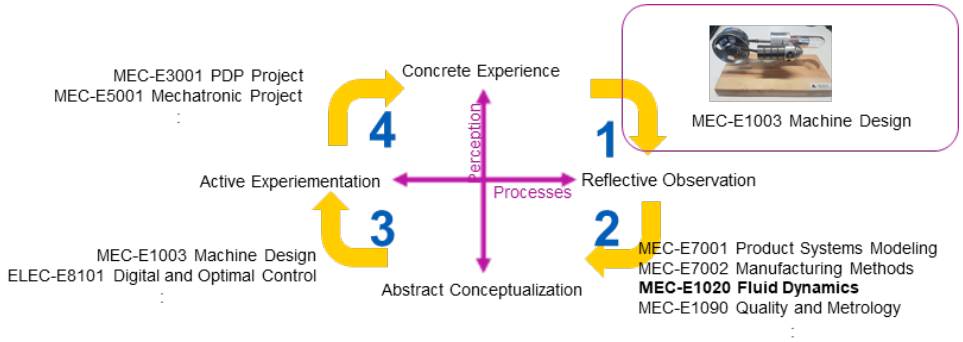
Why are you making us take all of these measurements?



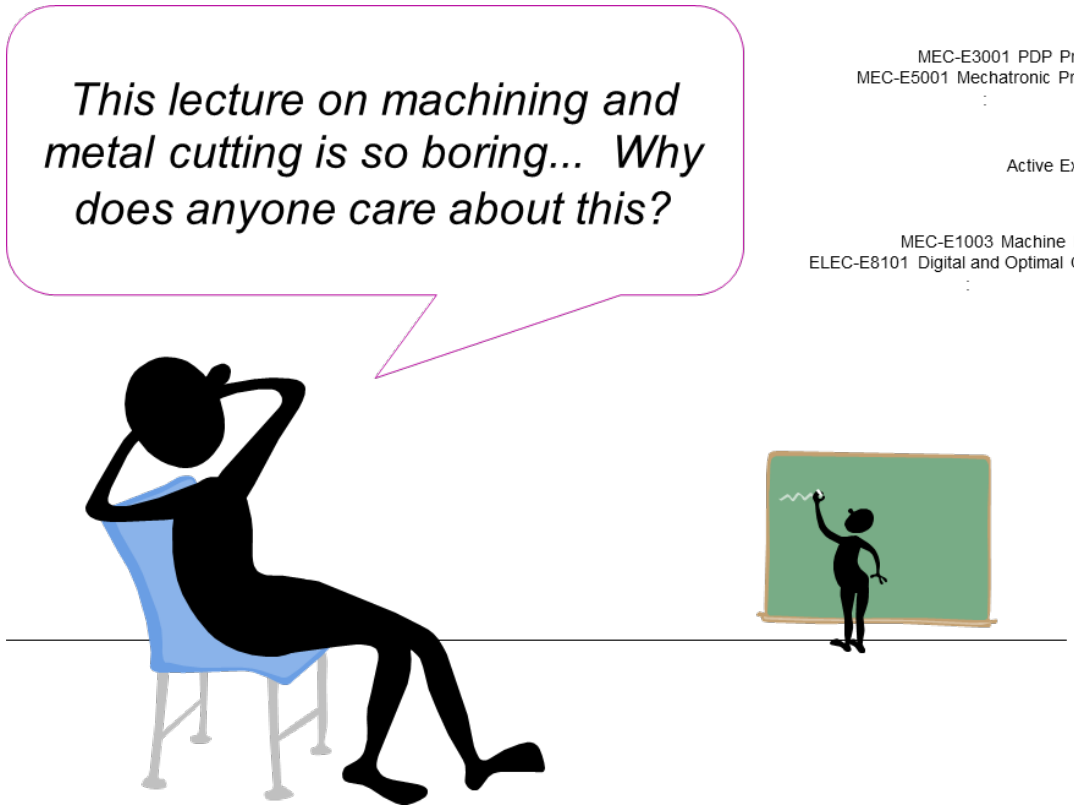

Boxplot of Displacer barrel o ring section
Displacer barrel o ring section
14.4
14.2
14.0
13.8
13.6
13.4
13.2
13.0
13.7

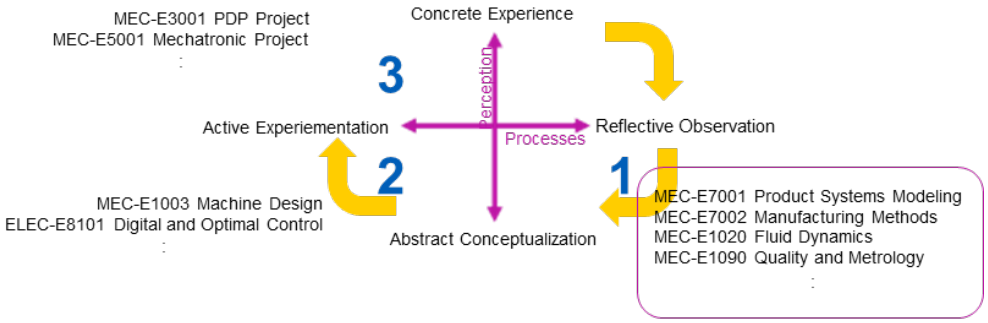
There is always a first time for everything

Why are you asking me about thermodynamics? I haven't had that course yet…

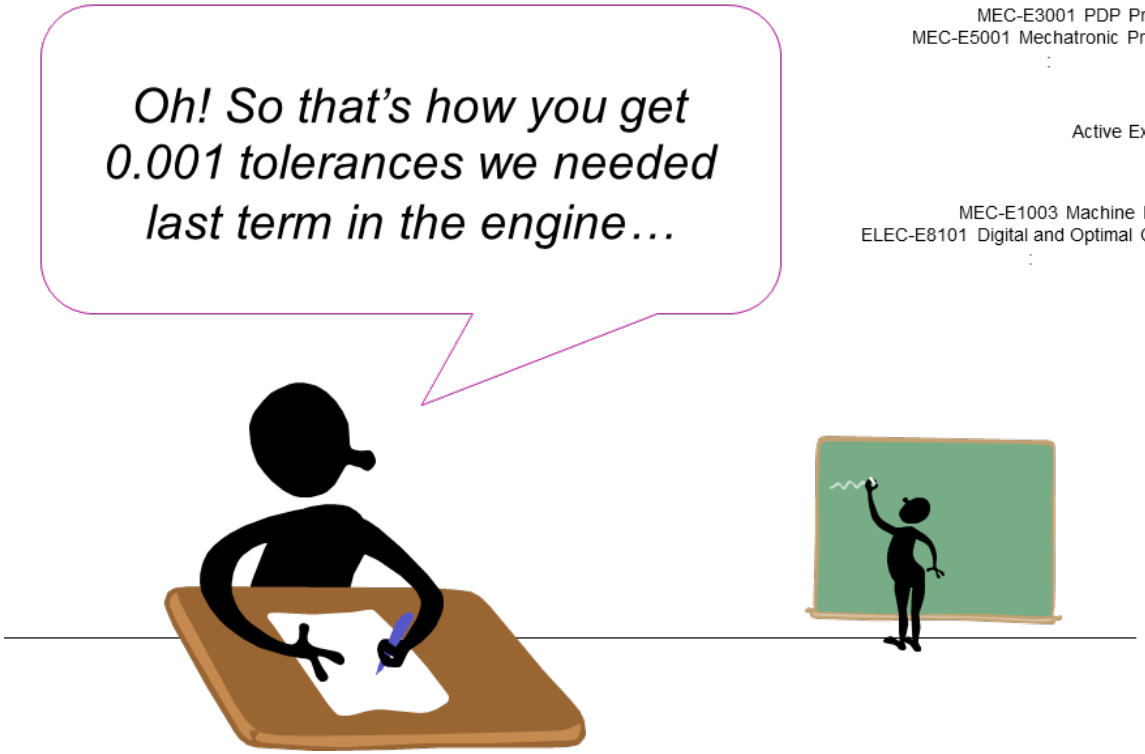


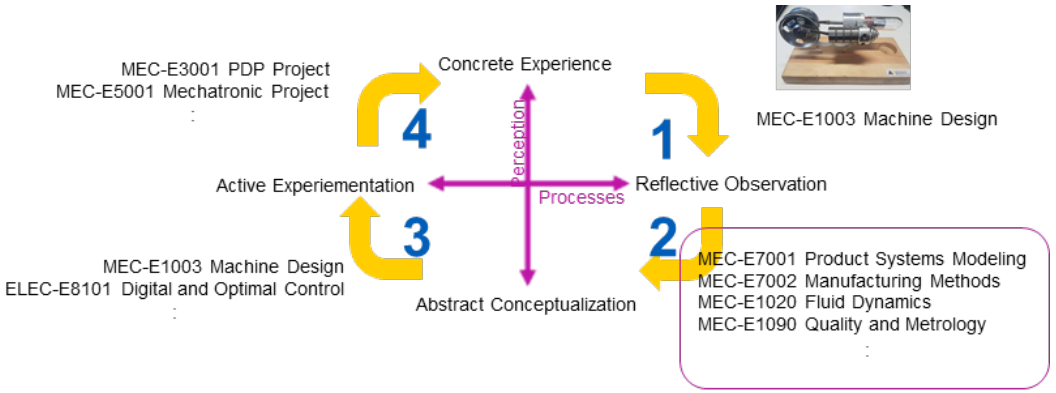
Suppose you get theory first



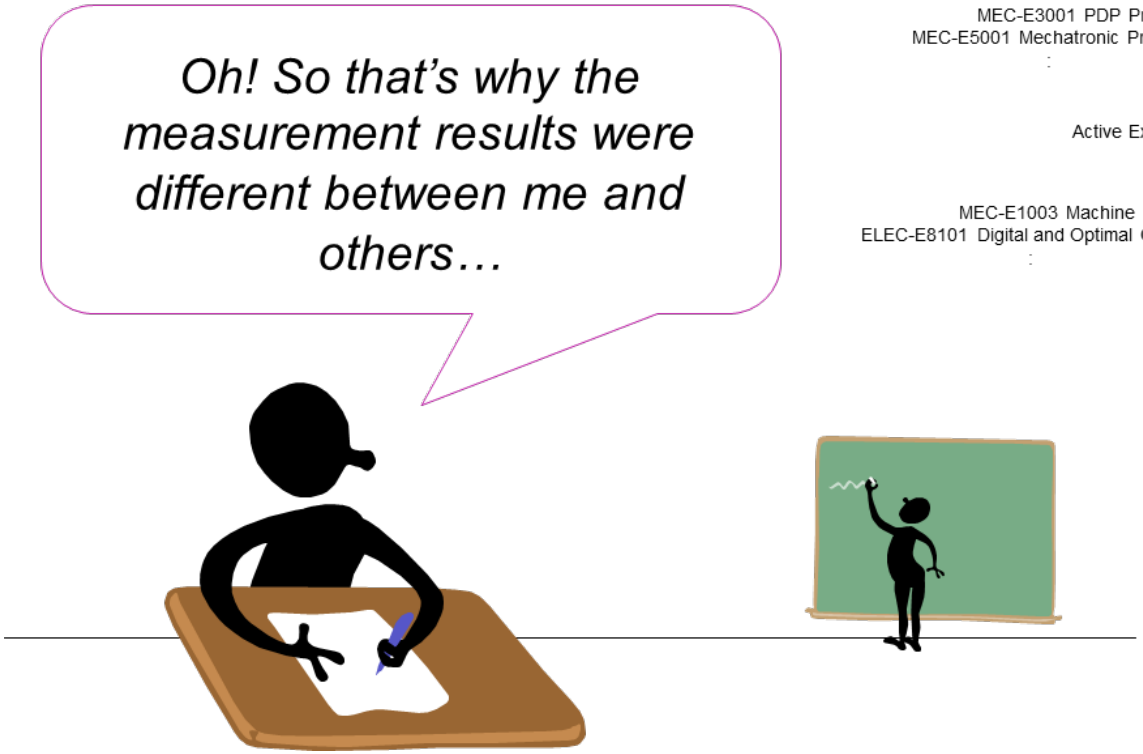


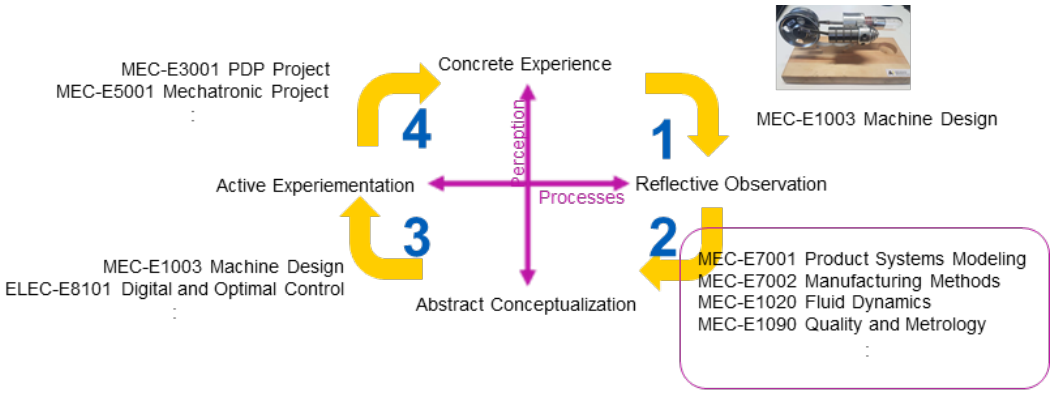
Hands-on experience





Hands-on experience





Why this starter project?

This starter project is to provide a *hands-on experience* for the basis of future courses.
After completing the starter-project the successful student will be more comfortable designing ***machined parts and assemblies***