

### Mechanical Analysis and Design ME 2104

#### Lecture 1

## Introduction

### Prof Ahmed Kovacevic

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# Plan for today

- What is Engineering Design
- About ME2104
- Teams and Personal preferences
- Team development
- Design Documents

# What is DESIGN in Engineering?

## Design is:

- » Systematic Process by which solution to the needs of humankind are obtained and communicated
- » Essence of **Engineering**
- » Structured problem solving activity

### Engineering Design Process is:

- » Multidisciplinary task which contains:
  - Technological factors
  - Social factors
- » Team iterative work

# Engineering & Mechanical Design

#### **Engineering design process**

an iterative <u>decision making activity</u>, to produce plans by which <u>resources</u> are <u>converted</u>, preferably optimally with due consideration for environment <u>into</u> <u>systems and devices</u> (products) to meet human needs.

(Woodson.T.T)

#### **Mechanical design process**

is the <u>use of scientific principles and technical information</u> along with innovations, ingenuity or imagination <u>in the definition of a machine, mechanical</u> <u>device or system</u> (product) to perform pre specified functions with maximum economy and efficiency.

(Engineering Design Council, UK)



## Products

#### Classical definition:

» Products are artifacts (i.e. artificial object) made by industry in order to fulfill society needs.

Conventional industrial economy is currently shifting to a service economy. In that light, the notion, role and appearance of products are all drastically changing with current economical changes.

#### Progressive definition:

» Products are flexible systems (packages) of artifacts and/or services aimed to fulfill society needs in sustainable ways.



# Plan for this academic year

- Three elements of the module:
  - 1. Mechanical Design
  - 2. Mechanical Analysis

**Prof Ahmed Kovacevic** 

Dr Matthew Read Prof Ahmed Kovacevic Dr M. Thomas-Rodriguez Prof Ranjan Banerjee

3. 3D CAD – Solid Works (part of ME2110) Dr Sham Rane



# Plan for this academic year

- Topics :
  - » Management of Engineering design process
  - » 3D CAD Catia (part of ME2110)
  - » Research, Conceptual, Preliminary & Detailed Design
  - » Design, build and test project Tennis Ball Server
- Lecturer: Prof Ahmed Kovacevic
   Tutors: Dr Matthew Read, Dr Chetan Jagadeesh
   Team coaches: Israt Kabir, Bhagya Chagarlamudi,
   Abdullah Qaban, Aamir Gulistan, Nusrat Tamanna
  Room: AG21 on Mondays 11,00 – 12,50

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Agenda <u>Web Page</u>



# What you need to have and what to do ?

- » Course web page: Moodle
- » A lot of patience and time to learn
- » Attendance to lectures, tutorials and design studio
- » Each week 1-2 hours work out of class for good results
- » Group Notebook Will be marked
- » Individual note book Will be marked



## Recommended literature

- Engineering Design Process, Yousef Haik, Tamer Shahin, Cengage Learning Engineering 2011, ISBN-13: 9780495668169
- Product Design and development, Ulrich, Eppinger, McGraw Hill, 2003, ISBN 007-247146-8
- The Mechanical Design Process, 3rd Edition, Ullman, McGraw Hill, 2003, ISBN 007-112281-8
- Mechanical Engineering Design, 7th edition, Shigley, Mischke, Budynas, McGraw Hill, 2004, ISBN 007-252036-1
- An Introduction to Mechanical Engineering, J Wickert, Brooks/Cole – Thomson learning, 2004, ISBN 0-534-39132-X
- Fundamentals of Manufacturing for Engineers, Waters, 1996, ISBN 1-85728-338-4
- http://www.staff.city.ac.uk/~ra600/intro.html





#### **Phases of Engineering Design**





## Ways to obtain a solution



## Find a solution directly



# Design Models

- Design Models are descriptions of the sequence of activities that takes place in the design process.
- Design Models are often drawn in the form of flow diagrams with feedback showing the iterative returns to the earlier stages.
- Design Models are classified as Descriptive or Prescriptive models.





**Figure 1.3** Oppoppersymap. (From ENGINEERING DESIGN: A SYSTEMATIC APPROACH by G. Pahl and W. Beitz, translated by Ken Wallace, Lucienne Blessing and Frank Bauert, Edited by Ken Wallace. Copyright © Springer-Verlag London Limited 1996. Reprinted by permission.)

#### The Pahl and Beitz design model represents the design process in four main phases

- Clarification of the task involves the collection of information about the problem in a solution neutral form
- Conceptual design phase involves the establishment of function structures, the search for suitable solution principles and their combinations into solution variants.
- At the embodiment phase the designer starting from the concept determines the layout and forms and develops a technical product or system.
- At the detail design phase the arrangement, form, dimensions, and surface properties are finally laid down, materials specified, the economical feasibility rechecked and all the drawings and other production documents are produced.

Ahmed Kovacevic, City University London

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# **Engineering Design Process**



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# The Engineering Design Process





# Design Process Timing



All projects have time constraints

An adequate planning leads to a satisfactory project finish

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# Curry Customer (Examiner) Satisfaction



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## Who makes costs?

#### Product costs in [%]



- Management% company policy
  - Marketing & Sales link to customers
  - Development team links:
    - -customer's dream
    - -technology
    - changes
    - -techno-economical feasibility
  - Production/Purchas rationalisation in production



## When costs occur?



# Philosophy of Designing in general

- Governing everything could be seen in one overriding principle of 'Necessity'
  - Principle of 'Necessity' dictates that the form always perfectly fits function in nature, with no insufficiency or redundancy; it compels every force to expand itself in the most direct way available for it; it prescribes that the simplest design to achieve a given end will be followed; and it must be respected by any human contriver of artificial things.
- 'Necessity' is the mistress and teacher of nature; necessity is the theme and inventor of nature, the curb, the rule and the theme.'
- The universal architecture of Necessity is geometry

From Martin Kemp's book "Leonardo"



Teamwork and Personality Preferences

## Working in Teams

- » Today, most new products, systems and processes are produced by teams
- » Teams bring together INDIVIDUALS with different strengths to generate a better product
- » Individually created items tend to be from a past era
- » Most of products are multidisciplinary



# Influence of activity styles





## Teamwork and Personality Preferences

- Personality Preferences important for success
  - » MBTI-Meyers-Briggs Type Indicator
  - » Provides a measure of your preferences along four dimensions
  - » Personality preferences influence problem-solving approaches
  - » Teams that are diverse in terms of personality preferences are often more effective
- Tasks:
  - » See MBTI self-score and explanation sheet
  - » Fill in MBTI for yourself

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### • Extraversion - E

- » Attuned to external environment
- » Prefer talking
- » Breadth of interest
- » Tend to speak first, reflect later
- » Sociable and expressive

- Introversion -
  - » Attuned to internal environment
  - » Prefer writing, listening
  - » Depth of interest
  - » Think before speaking
  - » Private and contained



Question 2:

How do you take in data, find out about things?

## • Sensing - S

- » Focus on details
- » Value practical applications
- » Factual and concrete
- » Present-oriented
- » Like step-by-step
- » Trust experience

## • iNtuition - N

- » Focus on big picture
- » Value imaginative insight
- » Abstract and theoretical
- » Future-oriented
- » Jump around, leap in anywhere
- » Trust inspirations



## Question 3: How do you make decisions?

## • Thinking - T

- » Analytical
- » Logical problemsolvers
- » Strive for objective truth
- » Reasonable and fair

## • Feeling - F

- » Sympathetic
- » Assess impact on people
- » Strive for harmony
- » Compassionate and accepting



Question 4:

How do you orient to the outside world?

### • Judging - J

- » Scheduled
- » Organized
- » Systematic
- » Like to plan
- » Avoid last-minute stress

- Perceiving P
  - » Spontaneous
  - » Open-ended
  - » Casual
  - » Adaptable
  - » Energized by last-minute pressures

ISTJ (16.5%)	ISFJ (4.6%)	INFJ (2.7%)	INTJ (9.5%)
Stop working so hard!	Stop worrying about everyone!	Stop staring off into space!	Stop being so stubborn!
Projects get done when we pay attention to facts and to what needs to happen now. Play comes later.	Each team member matters. Attention to each person's needs and wants helps us function well.	Thinking about the future and its implications for our team is vital to team productivity.	A team's vision that's well thought out is worth fighting for!
ISTP (6.2%)	ISFP (2.6%)	INFP (3.9%)	INTP (8.5%)
Stop nit-picking!	Stop wearing your heart on your sleeve!	Stop feeling hurt!	Stop being so theoretical!
Precision and accuracy of information allows our team to produce good work.	Caring for our teammates displays our humanity and can translate into increased team involvement.	Exploring our deeply held beliefs and values keeps this team on the right path.	Teams need to develop models and carefully analyze concepts before they can begin effective work.
ESTP (4.2%)	ESFP (2.3%)	ENFP (3.7%)	ENTP (7.4%)
Stop being so blunt!	Stop playing!	Stop changing your mind!	Stop generating new actions!
Sometimes this team needs a jolt to get it back to work.	Life should be lived; work should be enjoyed. Happy people are productive people.	This team needs to explore all the options as it gets down to work.	Entrepreneurial teams keep business coming in.
ESTJ (12.7%)	ESFJ (3.5%)	ENFJ (2.1%)	ENTJ (9.4%)
Stop driving things so hard!	Stop socializing!	Stop talking!	Stop trying to manage us!
Some tough work needs to be done right now.	Friends and relationships keep people committed and loyal to the team.	Knowing each team member well is one of the things that holds this team together.	Someone needs to take charge.
Personality proferences for students Krebshirsh, S., 1992, MBTI Team Building Program: Leader's			

Personality preferences for students

*Resource Guide*, Consulting Pschologists Press, Inc.



Assignment

• Can you identify your personality preference