INTRODUCTION TO MACHINE DESIGN

MET 4501

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WHAT IS MACHINE DESIGN?

MACHINE

A machine is a system of components designed to perform work.

These components, often referred to as machine elements or parts, work together to achieve a specific function.

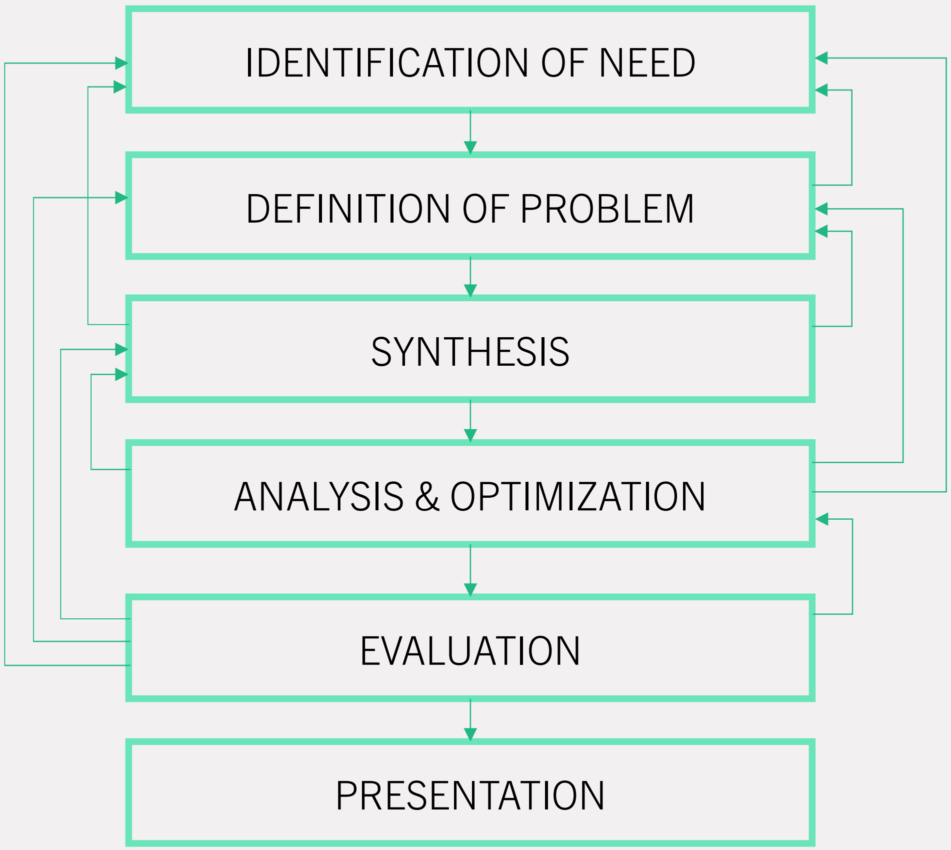
DESIGN

To design is to formulate a plan for the satisfaction of a specified need.

It is a decision-making process.

It is NOT the same as inventing a new device.

PHASES & INTERACTIONS OF THE DESIGN PROCESS



There is a demand for office furniture that enhances productivity and supports employee well-being, while also aligning with modern office aesthetics and budget constraints.

Design a chair that is ergonomic, stylish, and durable enough to last 10+ years, with materials and construction methods that keep it affordable for most businesses.

Develop multiple design concepts for the office chair, considering different materials, structural configurations, and aesthetic styles.

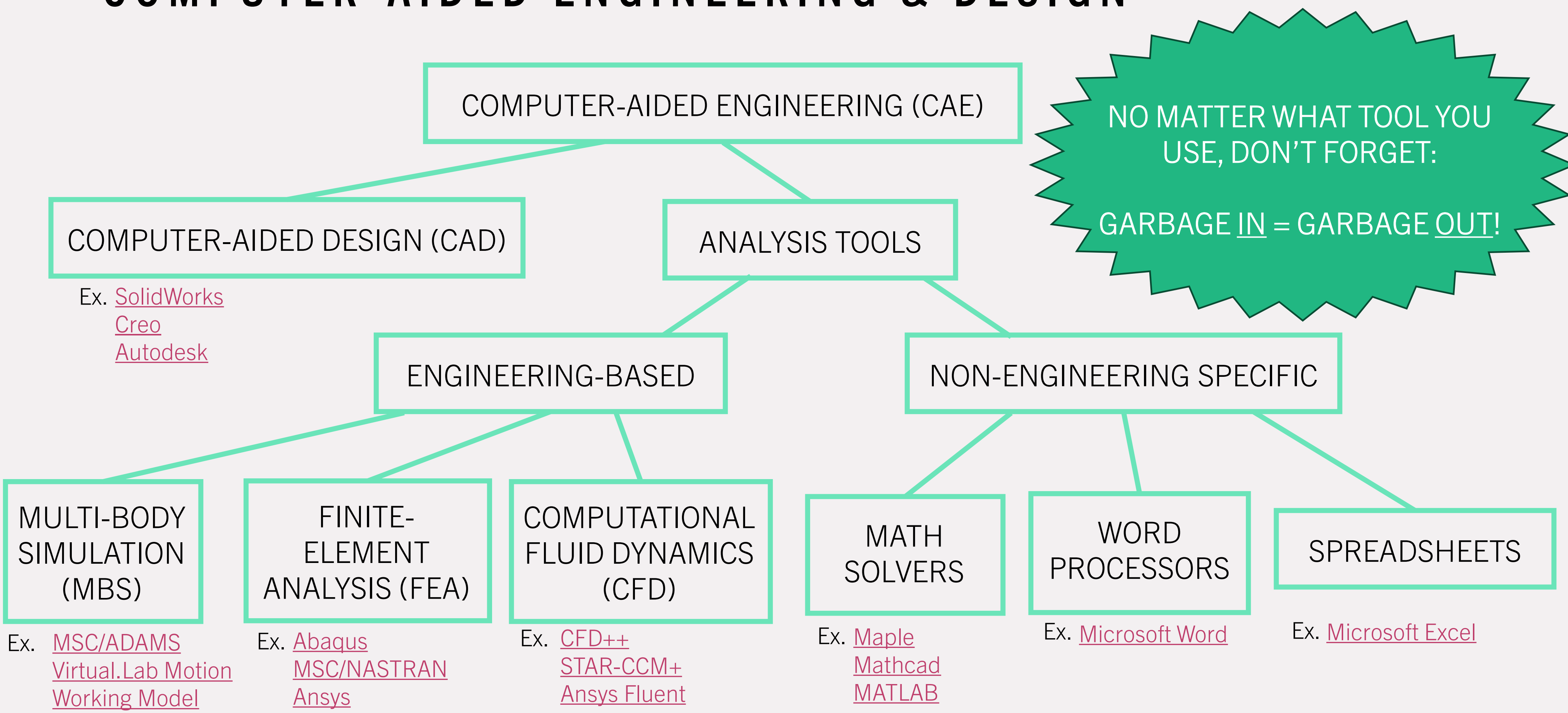
Evaluate the proposed chair designs through stress analysis, ergonomic testing, and cost assessments. Optimize the designs by selecting the most suitable materials, refining the structure for increased durability, and balancing cost with comfort and style.

Prototype the optimized chair design and conduct user testing to assess comfort, durability, and aesthetic appeal. Collect feedback to determine if the design meets the identified need and satisfies the problem definition.

SELL IT! (This is how you get promotions.)

Source: Budynas, R.G. & Nisbett, J. K., *Shigley's Mechanical Engineering Design,* 11th edition

COMPUTER-AIDED ENGINEERING & DESIGN



A NOTE ON ACQUIRING GOOD INFORMATION

It is vital to acquire good technical information for any CAE. You can find this information in many places, including:

- LIBRARIES
- GOVERNMENT SOURCES (DoE, DoD, NASA, USPTO, NIST, etc.)
- PROFESSIONAL SOURCES (ASME, SAE, ASTM, AWS, etc.)
- VENDORS (for specification sheets, etc.)
- INTERNET (e.g. www.thomasnet.com)

Be very careful using AI… Always double-check any information generated from an AI.

PROFESSIONAL RESPONSIBILITIES

YOU MUST BE:

- COMPETENT
- RESPONSIBLE
- ETHICAL
- PROFESSIONAL

COMMUNICATION IS KEY!

KEEP A JOURNAL.

PRACTICE SPEAKING.

DEVELOP A SYSTEMATIC APPROACH TO SOLVING DESIGN PROBLEMS.

1. Understand the problem.
2. Identify the knowns.

Communicate with your management, sales team, clients, etc.

3. Identify the unknowns and formulate a solution strategy. (Create charts, free-body diagrams, computer-aided design drawings, equations, etc.
4. State all assumptions and decisions. (Keep a *record* of all changes.)
5. Analyze the problem.
6. Evaluate your solution.
7. Present your solution. (Know your audience.)

PROFESSIONAL RESPONSIBILITIES

KEEP CURRENT IN YOUR FIELD

- JOIN A PROFESSIONAL SOCIETY
- TAKE GRADUATE CLASSES
- READ TECHNICAL PAPERS

ASME

SETTING THE STANDARD

SAE INTERNATIONAL®

ME 6220: Advanced Solid Mechanics

ME 6220: Advanced Solid Mechanics

3 Credit Hours

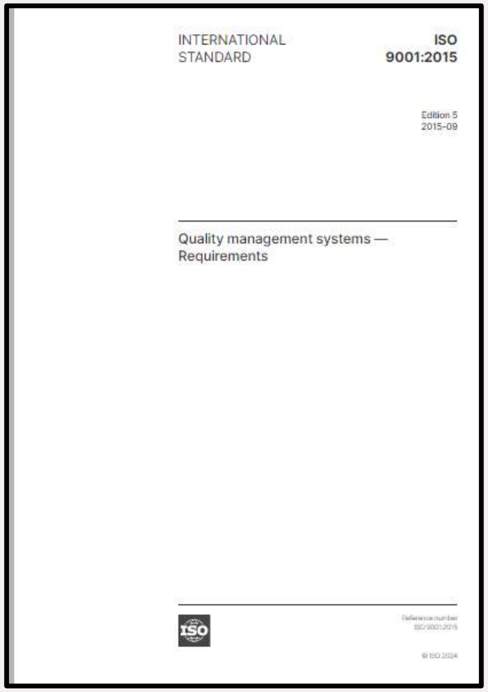
This course focuses on Cartesian tensors, state of stress, kinematics of deformation, and the general principles of solid mechanics. Topics include constitutive equations of elasticity, viscoelasticity, and plasticity (continuum mechanics), with an emphasis on the design criteria based on variable and fluctuating loads (fatigue) and the failure of components based on crack propagation (fracture mechanics). Applications of linear elastic fracture, propagation fatigue life prediction, toughness, and strain energy release rate will be studied.

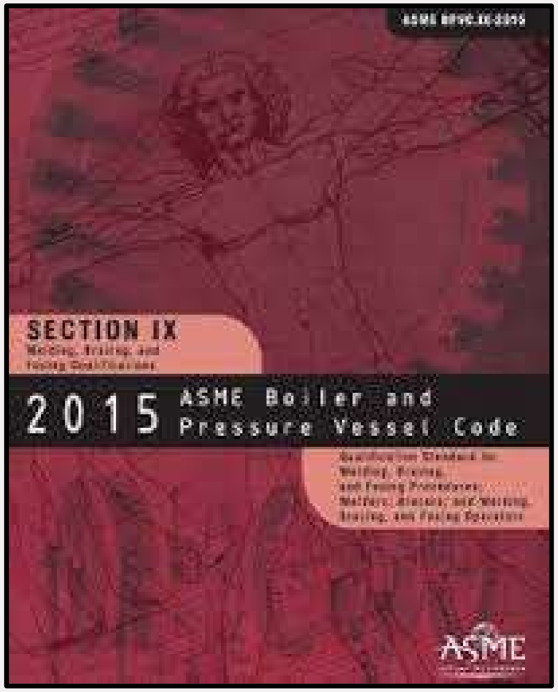
YOU MAY BE DONE WITH EXAMS SOON, BUT NOT WITH LEARNING!

STANDARDS & CODES

- A standard is a set of specifications for parts, materials or processes intended to achieve uniformity, efficiency, and a specified quality.

- A code is a set of specifications for the analysis, design, manufacture, and construction of something.





SAFETY CODES DO NOT IMPLY ABSOLUTE SAFETY!

FACTORS OF SAFETY

- The factor of safety is always unitless and compares a loss-of-function parameter to the maximum allowed, or predicted, value of that parameter.

$$n = \frac{\text{loss-of-function parameter}}{\text{maximum allowed, or predicted, parameter value}}$$

where the parameter can be load, stress, deflection, etc.

- Note: A part can (and likely will) have multiple safety factors. Each safety factor (n) characterizes a potential failure mode. The most likely failure mode is the one with the smallest safety factor.
- Note: The choice of safety factor may be dictated by a design code or standard. More often, engineering judgment is required to choose a safety factor.

FACTORS OF SAFETY

Some parameters that typically affect the selection of safety factor are listed below with a comparison showing how those parameters typically affect the value of safety factor.*

Factor of safety (aka safety factor)	Material reliability	Loads/environmental conditions	Does weight matter?
$1.0 < n \leq 1.2$	HIGH	NOT SEVERE	YES
↓	↓	↓	↓
$n \geq 5.0$	LOW	SEVERE	NO

*These are generic guidelines and exceptions to these guidelines exist.