Unit 1
Introduction and Design Overview

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Need to study structural mechanics to design properly to prevent failure

There is no doubt that any of the disciplines of Aeronautics and Astronautics can contribute to an accident

- -engine failure
- -etc.

But, the vast majority of non-human induced accidents is due to structural (material) failure (ultimately).

Purpose of 16.20: Provide you with the tools to properly Design "Aerospace Structures" to assure "structural integrity" (i.e., it doesn't fail)

Note, 16.20 mainly oriented in past to aircraft structures because that is where the main experience lies. We will try to generalize and show examples for space structures.

Aeronautics and Astronautics deal with three major categories of structures:

1. Aircraft (atmospheric vehicles)
2. Launch vehicles
3. Space structures (partially a civil engineering task?)

(Note: Transatmospheric vehicles can be combinations of 1 and 2…the Shuttle is!)

IMPORTANT: Many of the design considerations for these three categories are different, *but* the same techniques and concepts are used to analyze the structures (basically)

In fact, except for special design considerations, the techniques used for all structures are basically the same:

Structure type	Possible considerations
Buildings	
Ships	
Cars	
Space stations	
Airplanes	
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The difference is often in the degree of refinement of the structural analysis (generally more refined in A & A!)

→ We will teach basic techniques and concepts and use specific examples. But, the technique may apply to another structural type as well.

Example: (aircraft to space station)

Fuselage --> space station living habitat (pressurized cylinders)

Overview of Structural Design Process

(Review from U.E.)

Purpose: Assure "structural integrity" while minimizing cost

In aerospace structures, cost often means weight.
Why?

Saving a pound of weight means more
- payload (extra passengers, more satellites)
- fuel (longer distance, longer duration via extended station keeping)

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Amount industries (civilian) are willing to pay to save a pound of weight:

Satellites	\$10,000 - \$20,000 (w/o servicing)
Transport Aircraft	\$100 - \$200
General Aircraft	\$25
Automobile	~ \$0.00

Sometimes willing to pay for performance
(military, FWC…polar orbit)

<u>Factors in determining cost</u>

- Material cost
- Waste amount
- Manufacturing
- Subassembly/assembly
- Durability and maintenance
- Useful life

An engineer must consider all these. In 16.20 we will focus on "structural integrity" and methods to assess such.

Definition of ***structural integrity***:

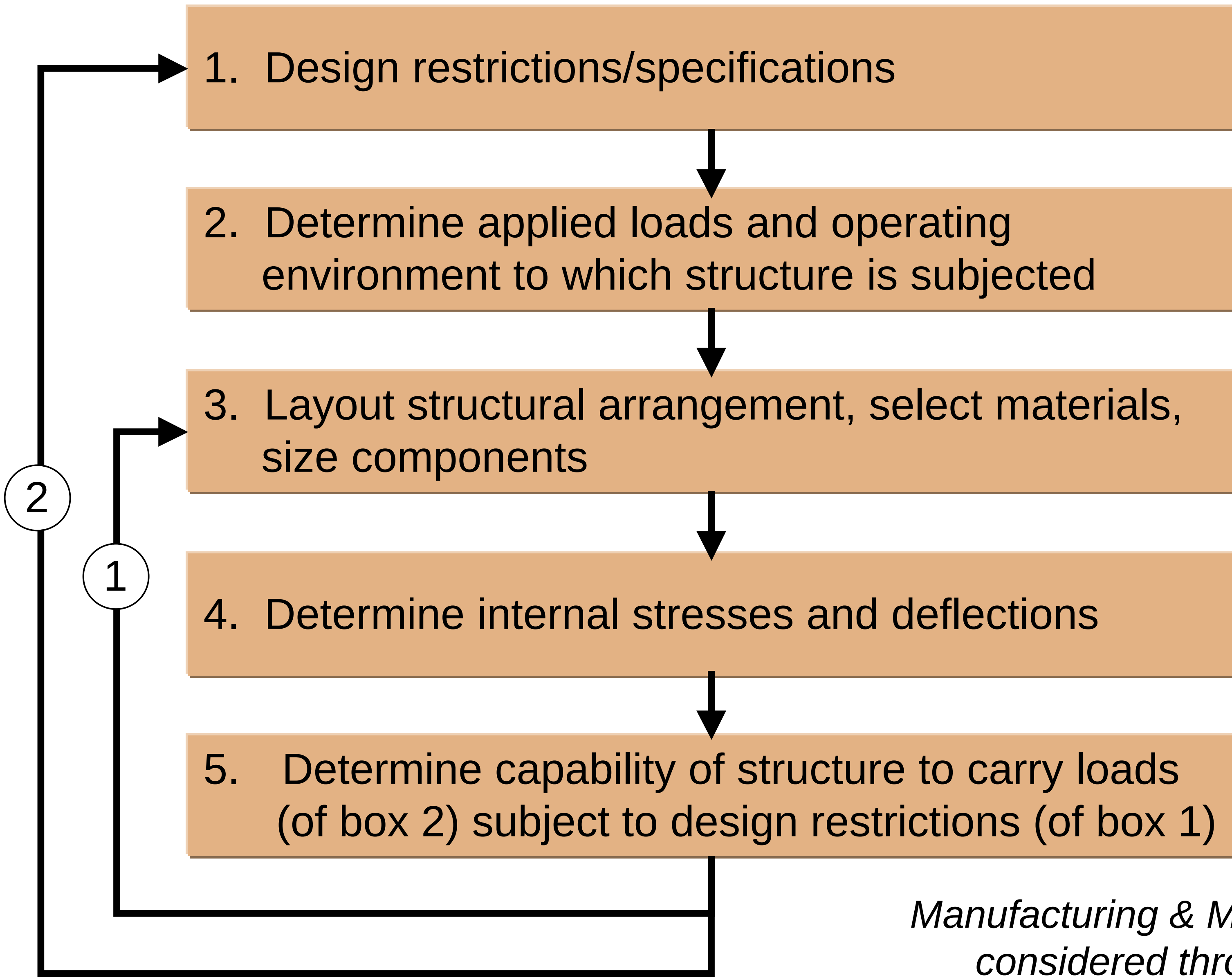
"Capability of a structure to carry out the operation for which it was designed."

Many aspects

- Required loads
- Required deformations
- Corrosion resistance (e.g., no penetration on pressure vessels)

Many aspects to “failure” (we will discuss later)

Design Process



Manufacturing & Maintenance considered throughout

Iterative loops

- Big loop (2) : May find there is no way to attain what was asked for

- Loop (1) : Go through this all the time. Get more and more specific on design each time
  - Use more refined techniques each time
  - Iterate to get most efficient structure

  - #1 usually given from “above”
  - #2 tells us what we need to consider

in 16.20

- Learn to do #4 and #5
- Use knowledge attained in 16.20 and by doing #4 a number of times to think about #3

Current use of IPT’s…customers involved