2004 IAP Course

Engineering Design and Rapid Prototyping

A Rewarding CAD/CAE/CAM Experience for Undergraduates

Department of Aeronautics and Astronautics

Massachusetts Institute of Technology

Needs – from students

A 2001 survey of undergraduate students (Aero/Astro)

- **There is a perceived lack of understanding and training in modern design methods using state-of-the-art CAD/CAE/CAM technology and design optimization.**

- **Individual students have suggested the addition of a short and intense course of rapid prototyping, combined with design optimization.**

Needs – from industry

Industry wants/needs

People who are trained in integrated design methods and tools

People who have personally carried out the design chain from conception to implementation at least once.

People who have an initial understanding of:

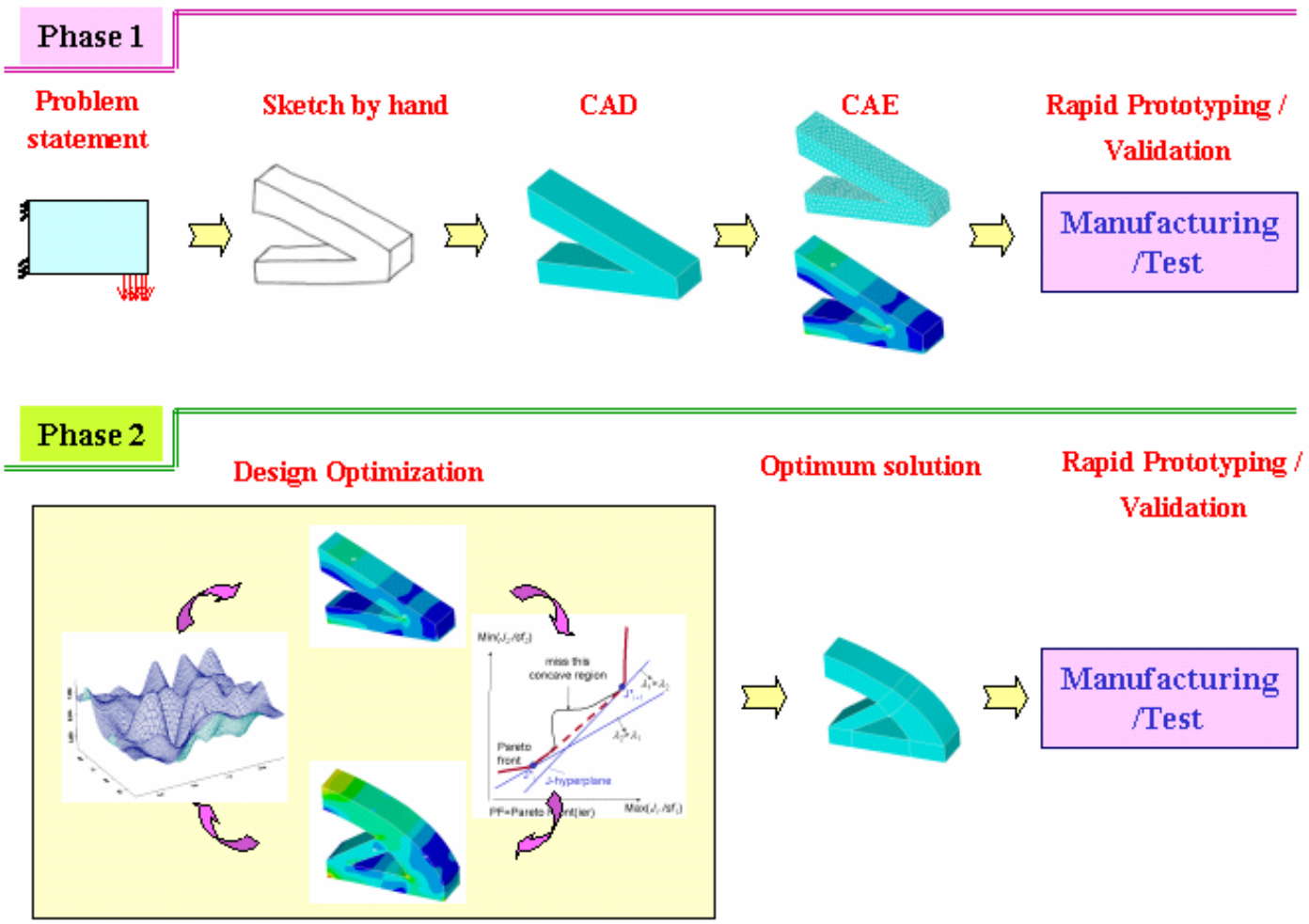
- **importance of requirements**
- **complementary roles of humans and computers in design**
- **difficulties at the CAD/CAE/CAM domain interfaces**
- **value of optimization**
- **importance of trading off competing objectives**
- **difference between predicted and actual behavior of the artifacts they design**

Learning objectives

Develop a holistic view and initial competency in engineering design by a applying a combination of human creativity and modern computational tools to the synthesis of a single structural component

Outline of the course

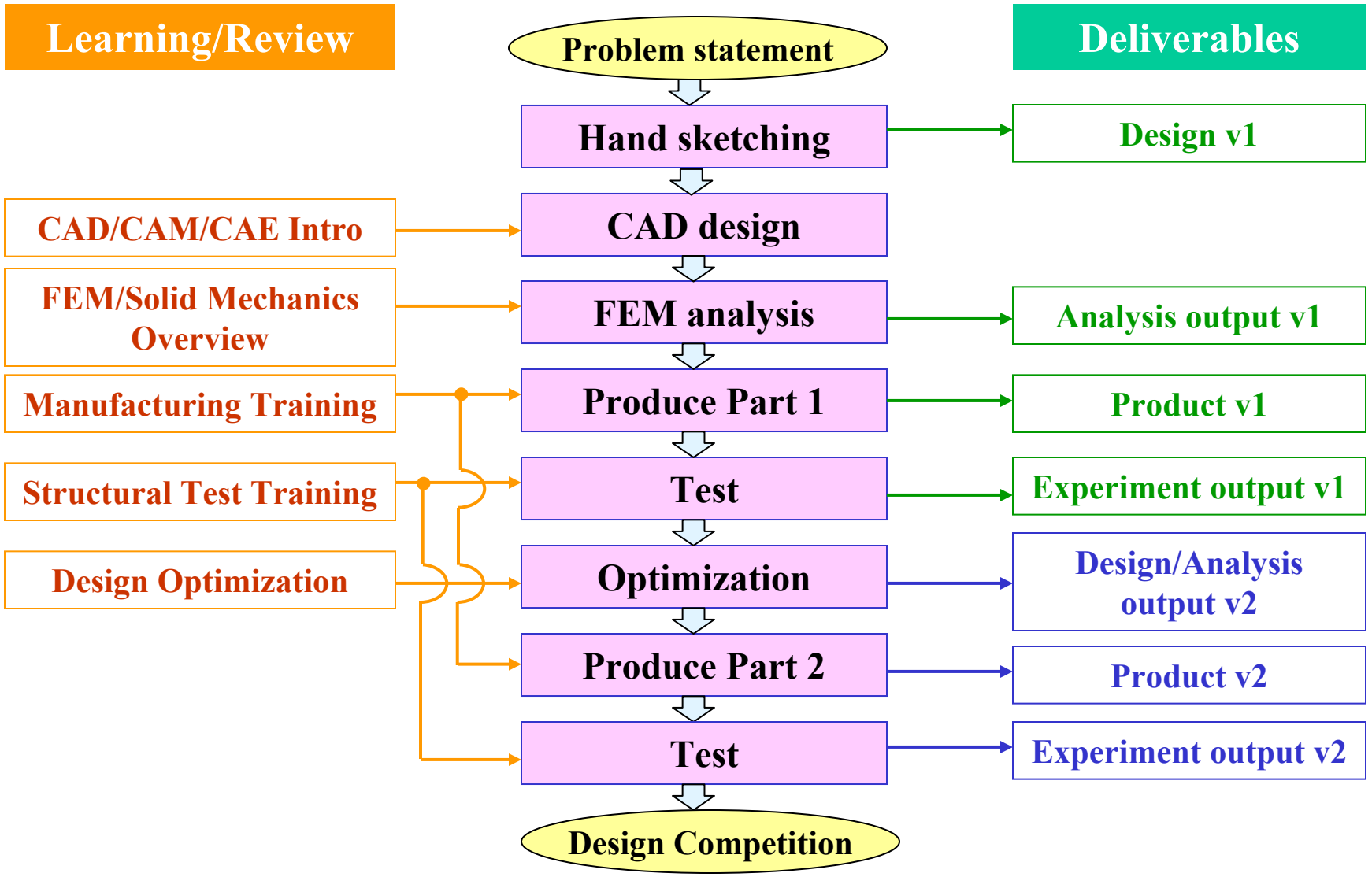
The goal of the class is to provide the students with an opportunity to conceive, design and implement products quickly as a single component, using the latest rapid prototyping methods and the CAD/CAE/CAM technology.



Overview of the course

Week	Lectures	Hands-on Activities
1	Introduction to the course Requirements CAD/CAM/CAE Introduction	Hand-Sketching CAD Modeling
2	Review of Math & Solid Mechanics Analysis - FEM/CAE Manufacturing Introduction	FEM Analysis Workshop Initialization
3	Structural Testing Design Optimization Integration of Analysis & Design Optimization	Master CAM introduction Produce Parts v1 Test Parts v1
4	Industrial Examples & Issues	Optimize Parts Produce Parts v2 Competition

Schematic of the course activities



Educational Aspects

This class will help students gain several educational insights:

(1) Understand the systematic design process from conception to design/implementation/verification with an example of a single structural component.

(2) Understand predictive accuracy of CAE versus actual test results.

(3) Understand relative improvement that computer optimization can yield relative to an initial, manual solution.

(4) Illustrate the capabilities and limitations of the human mind and the digital computer.

Facilities

* Design Studio (33-218)

- 14 networked CAD/CAE workstations that are used for complex systems design and optimization.

* Software and Manufacturing Equipment

- MATLAB
- Solidworks
- Cosmos

* Machine Shop

-Water Jet cutter
-2-axis milling machine
-3-axis milling machine
- lathe

Staff

Instructors: de Weck, Kim, Wallace, Young

TA: Nadir

Lectures

- Design and optimization – de Weck, Kim
- Hand sketching – Wallace

Hands-on Activities

- CAE/FEM/Optimization – de Weck, Kim
- Software/Design studio – Kim, Donovan
- Design Competition – de Weck, Kim, Young
- Manufacturing – Kim, Weiner
- Structural Testing – Kim, Kane