SP1: System Requirements and Teamwork

Unified Engineering Spring 2004

Thu 5-Feb-04

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Outline

- Whole semester in four slides!
- Why?
- UAC 2004 & SP1

Whole semester in four slides!

Systems

- People,
  Product,
  Process
- Deliver
  functionality

U.S. Airways

McDonald's

Global Positioning System

AWACS

CDIO

Groups of people:

- **conceive**
- **design**
- **implement and**
- **operate**

systems

CDIO

Getting groups of people to:

- **conceive**
- **design**
- **implement and**
- **operate**

systems is…not easy

Keys for Success

Design

- Process
- Analysis

Tools:

- FRDIARRC

Project Mgmt

- Time
- Resources
- Risk

Tools:

- WBS
- Gantt Chart

Teamwork

- Communication
- Coordination
- Roles & Responsibilities
- Motivation!

Tools:

- Comm Plan
- Roles & Resp
- Ground Rules
- Effective Mtgs

Why?

Reform of Engineering Education

Why is Reform Needed?

- **Emphasis** on teaching of engineering science.
- **De-emphasis** on teaching engineering practice.
- Students lacking abilities required in real world engineering situations.

Widening Gap between engineering education and engineering practice.

Why is Reform Needed?

Pressures to close the gap:

- Industry creation of desired engineering ***abilities*** that should be the ***outcome*** of engineering education.
- ***Accreditation*** board adoption of similar outcome and assessment criteria.

Attributes: Desired Outcomes

Boeing

- Good understanding of engineering science
- Good understanding of design and manufacturing
- Multi-disciplinary, systems perspective
- Understanding of the *context* in which engineering is practiced.
  - Economics
  - History
  - The environment
  - Customer and societal needs
- Good communication skills
- Profound understanding of the importance of teamwork

ABET

- Ability to apply knowledge
- Ability to design and conduct experiments
- Ability to design system, component, or process
- Ability to function on multi-disciplinary teams
- Understanding of ethical responsibility
- Understand impact of engineering in global and societal context
- Ability to use techniques, skills and tools necessary for engineering practice

New Syllabus - Outcomes

Essential Functions of an Engineer:

Graduating engineers should be able to:

Conceive-design-implement-operate (CDIO)

Complex value-added engineering systems (Technical)

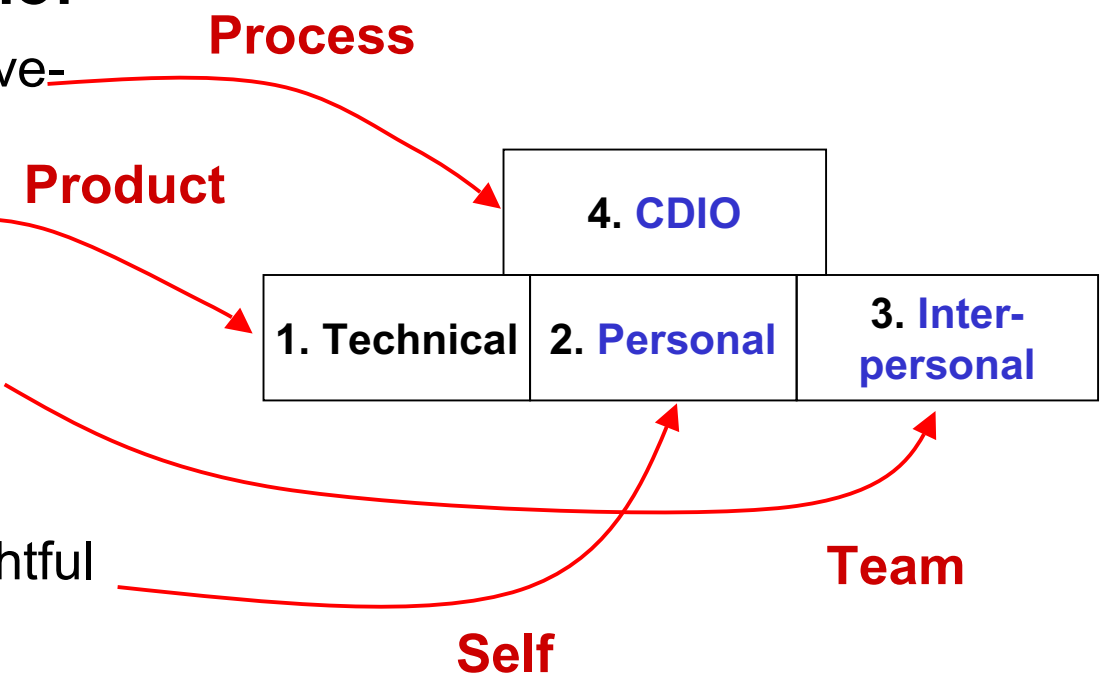
In a modern team-based environment (Interpersonal)

And are mature and thoughtful individuals (Personal)

Map of the new CDIO syllabus

Educate students who:

- Understand how to conceive-design-implement-operate
- Complex value-added engineering systems
- In a modern team-based engineering environment
- And are mature and thoughtful individuals



Detail of the CDIO syllabus

1 TECHNICAL KNOWLEDGE AND REASONING
- 1.1. KNOWLEDGE OF UNDERLYING SCIENCES
- 1.2. CORE ENGINEERING FUNDAMENTAL KNOWLEDGE
- 1.3. ADVANCED ENGINEERING FUNDAMENTAL KNOWLEDGE

2 PERSONAL AND PROFESSIONAL SKILLS AND ATTRIBUTES
- 2.1. ENGINEERING REASONING AND PROBLEM SOLVING
- 2.2. EXPERIMENTATION AND KNOWLEDGE DISCOVERY
- 2.3. SYSTEM THINKING
- 2.4. PERSONAL SKILLS AND ATTITUDES
- 2.5. PROFESSIONAL SKILLS AND ATTITUDES

3 INTERPERSONAL SKILLS: TEAMWORK AND COMMUNICATION
- 3.1. TEAMWORK
- 3.2. COMMUNICATION
- 3.3. COMMUNICATION IN FOREIGN LANGUAGES

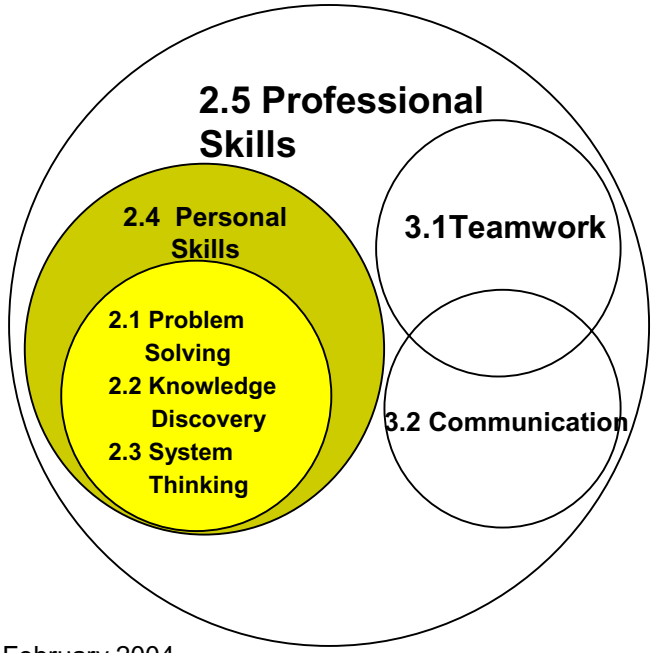
4 CONCEIVING, DESIGNING, IMPLEMENTING AND OPERATING SYSTEMS IN THE ENTERPRISE AND SOCIETAL CONTEXT
- 4.1. EXTERNAL AND SOCIETAL CONTEXT
- 4.2. ENTERPRISE AND BUSINESS CONTEXT
- 4.3. CONCEIVING AND ENGINEERING SYSTEMS
- 4.4. DESIGNING
- 4.5. IMPLEMENTING
- 4.6. OPERATING

Spring Learning Objectives

Spring 2004 System Problem Objectives	CDIO Syllabus
Apply lecture disciplines to CDIO of an aerospace system	**1.0 Technical Knowledge and Reasoning** **2.1 Problem Solving** **2.2 Knowledge Discovery** **2.3 System Thinking** **2.4 Personal Skills**
Develop engineering design, reasoning, teamwork, and communication skills	**2.5 Professional Skills** **3.1 Teamwork** **3.2 Communication**
Develop engineering product development skills	
HAVE FUN!	**4.1 Societal Context** **4.2 Business Context** **4.3 Conceiving** **4.4 Designing** **4.5 Implementing** **4.6 Operating**
Objectives are to be achieved through class project	

CDIO Syllabus covered by System Problems

Fall	Spring
Weekly individual assignments	Semester long team assignment
Self-contained assignments	Interdependent assignments
Progressively more complex assignments	Progressively more complex assignments
Integration of 1-2 disciplines	Integration of 2-3+ disciplines



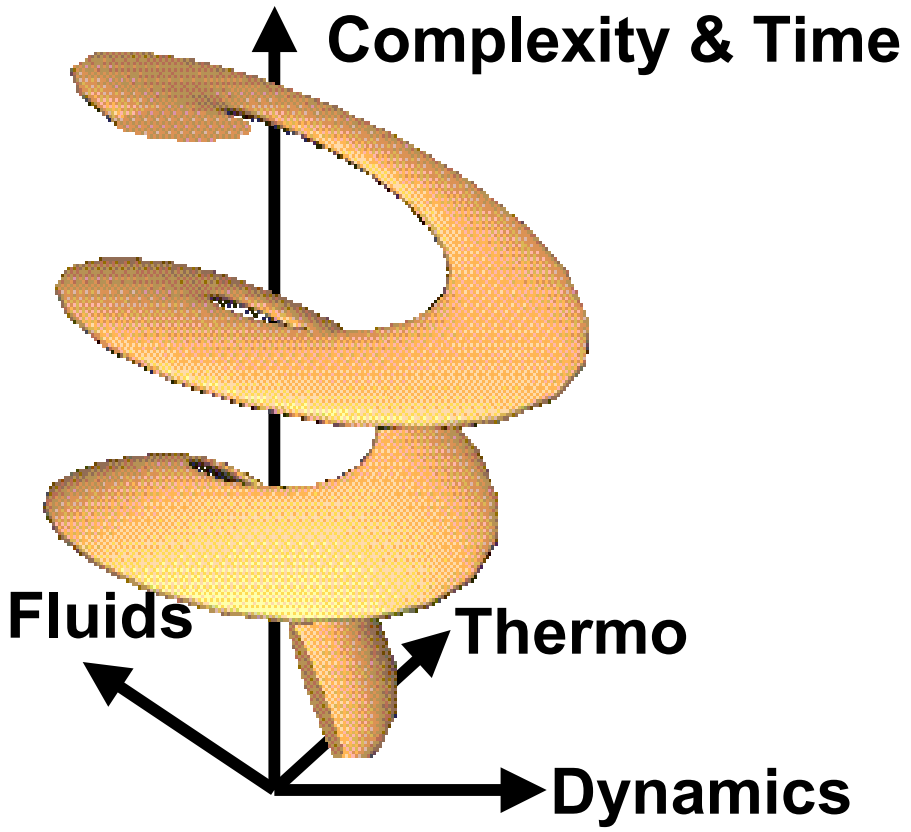
CDIO Syllabus Activities

16.8X

16.62X

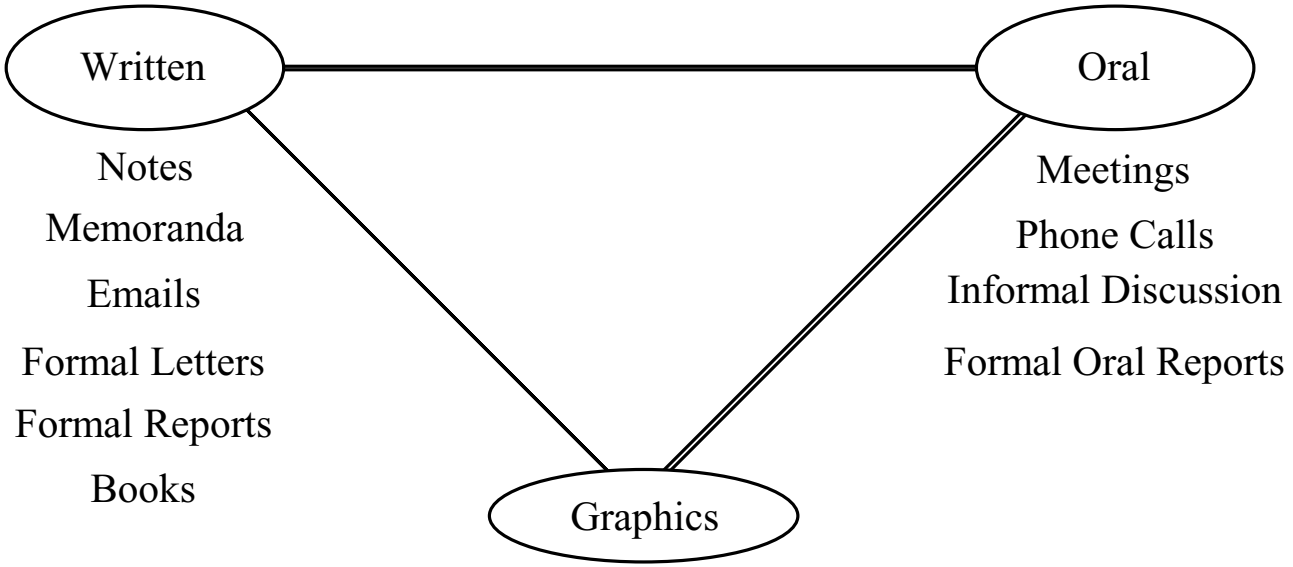
Unified { R/C Aircraft, Rocket, Glider }

16.00



Communication

Example Forms of Communication



U.S. Airways Systems

Functional Requirements	Design Idea	**Analysis**
Take reservations	Internet At the counter Telephone	Cost, Time, Cost, Efficiency Cost, Cust Sat
Give boarding passes	Kiosks At the counter	Usability, FAA Regs Efficiency cust sat
Put people on plane	Board by row Board by section Open seating	Cust Sat, Time, FAA Regulations
Fly people long distance	Boeing 777 Boeing 747	Efficiency, Load factor
	Rolls-Royce GE Aircraft engines	Efficiency, Reliability, Service cost

Design Selection

	F-14	F/A-18	Su-27	JSF
Available Now	N	Y	Y	N
Reasonable Cost	N	?	Y	N
Sea-based Deep Interdiction	Y	N	Y	Y
TOTAL			✓	

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U.S. Airways

McDonald's

Global Positioning System

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CDIO

Getting groups of people to:

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systems can be done well!

Keys for Success

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Project Mgmt

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Unified Aerial Competition 2004

2004 Requirements and Resources

- Develop a system to participate in an aerial competition
- System must be ready by late April 2004
- Endurance flight with operations and egg payload (1-4)
- Don’t crack or break egg during handling, loading, flight, landing
- 5 people, 9 weeks, 4hrs/person/week, kit, supplies, flight training

Backup

2001 - 2003 Performance

	2001			
Team	Fly	L1 Empty Flight	L2 Load Pennies	L3 Loaded Flight
14				
13				
12				
11				
10				
6				
4				
3				
2				
9				
8				
7				
5				
1				

	2002			
Team	Fly	L1 Empty Flight	L2 Load Egg	L3 Loaded Flight
12				
11				
9				
7				
6				
3				
2				
8				
1				
10				
5				
4				

	2003			
Team	Fly	L1 Empty Flight	L2 Load Eggs	L3 Loaded Flight
13				
12				
1				
2				
14				
10				
6				
9				
4				
5				
11				
3				
7				
8				

2001-2003 UAC Performance

	2001		2002		2003	
Number of Teams	14		12		14	
Number of Flying Planes	13	93%	12	100%	14	100%
Completed Competition	6	43%	7	58%	12	86%
Partially Completed Competition	3	21%	2	17%	0	0%
Did Not Complete Competition	5	36%	3	25%	2	14%
Number of Competition Flights	**26**		**52**		**39**	