Keeping Students Alive In Freshman Mechanical Engineering Technology

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In recent years engineering academia is challenged to prepare the graduates to meet the globalization of engineering profession and the real world demands of global workforce. For the past several years, mechanical engineering programs embarked on reforming the curricula by introducing new courses at the freshman level to **enhance student motivation** and **improve retention**. This paper presents how in mechanical engineering technology program the existing **courses** at freshman level in the area of **engineering graphics** and **manufacturing methods** were used innovatively to provide the real world experience of **product design, manufacturing and operation**. It also shows how it addresses part of the **CDIO (Conceive, Design, Implement, Operate)** framework. Students taking these courses are involved in **reverse engineering project** where students work in teams in redesigning the product, developing technical drawings, exchanging drawings with a different group to manufacture their product, test and operate the product. This approach demonstrates the real world workplace environment of product design and manufacturing in which technical knowledge and other skills learned are practiced. The course project at freshman level is an early exposure to explain the relevance of **mechanical engineering technology graduates as practitioners of the profession, implementers of technology, job-ready and focused on applied engineering**.

Early Motivation of Freshman Students

Current Status

- Reformed undergraduate programs
- Introduced new courses to address design, manufacturing, Communication, and teamwork
- Courses with integrated disciplinary knowledge
- Project based courses with design simulation

Learning Outcomes

- Teamwork
- Communication
- Understand skills needed to design and build components and systems
- Leadership

What is new in our program at K-State at Salina?

- Experiential learning
- Real World workplace simulation (Product or system building experience)
- Inter-team and intra-team communication
- Exchanging technical drawings with another team
- Design, build, and test

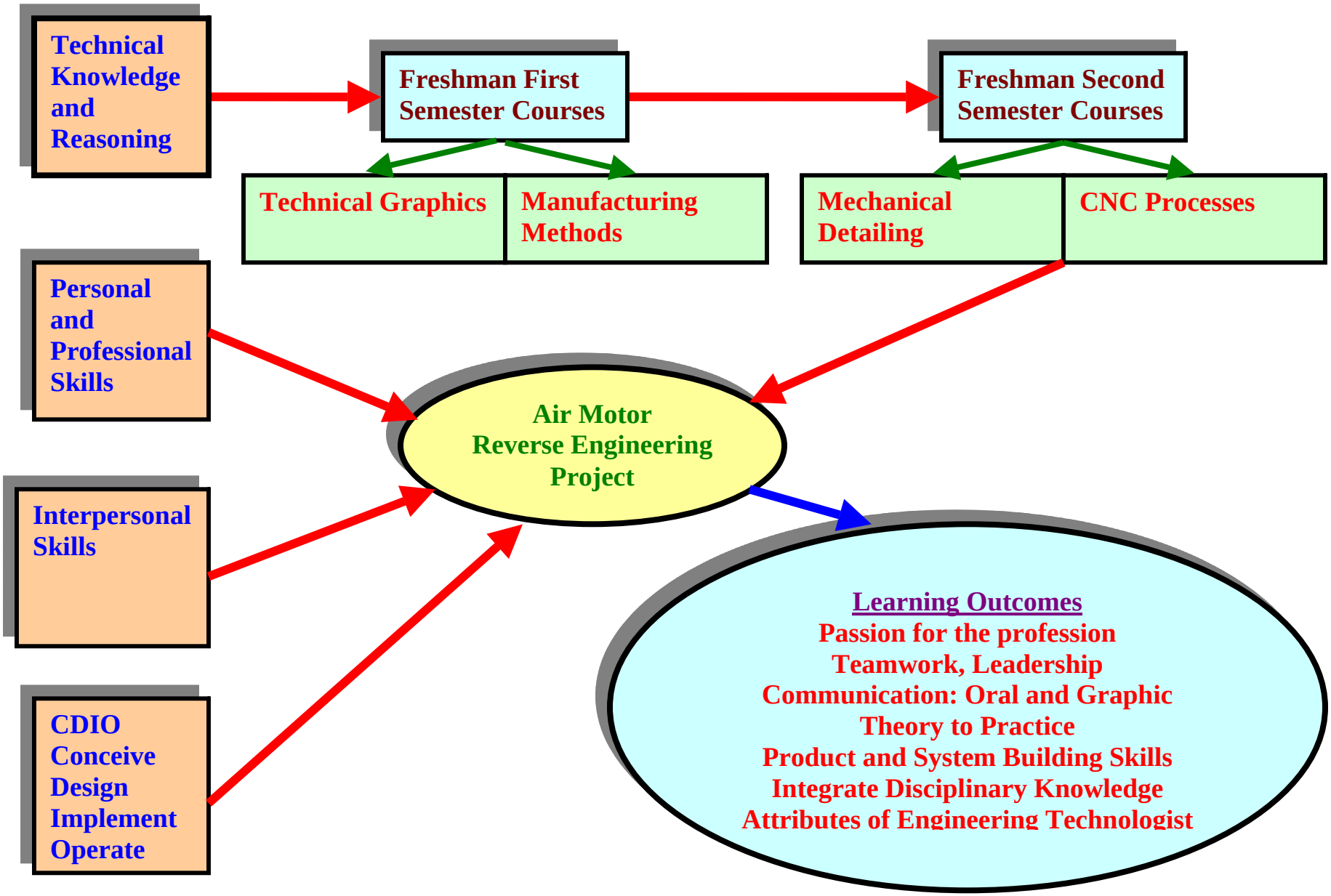
CDIO Syllabus, ABET EC2000 and TC2K Outcome Mapping

	ABET EC 2000 and TC2K OUTCOMES										
CDIO Syllabus	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
1.1	■										
		●									
1.2	■										
		●									
1.3	□										■
	●										
2.1					■						□
						●					
2.2		■									
			●								
2.3			□								
			○								
2.4									■		
								●			○
2.5						■					□
									●	●	○
3.1				■							
					●						
3.2							■				
							●				
3.3											
4.1								■		■	
										●	
4.2											
4.3			■								
				●							○
4.4			■								
				●							
4.5			■								
				●							
4.6			■								
				●							

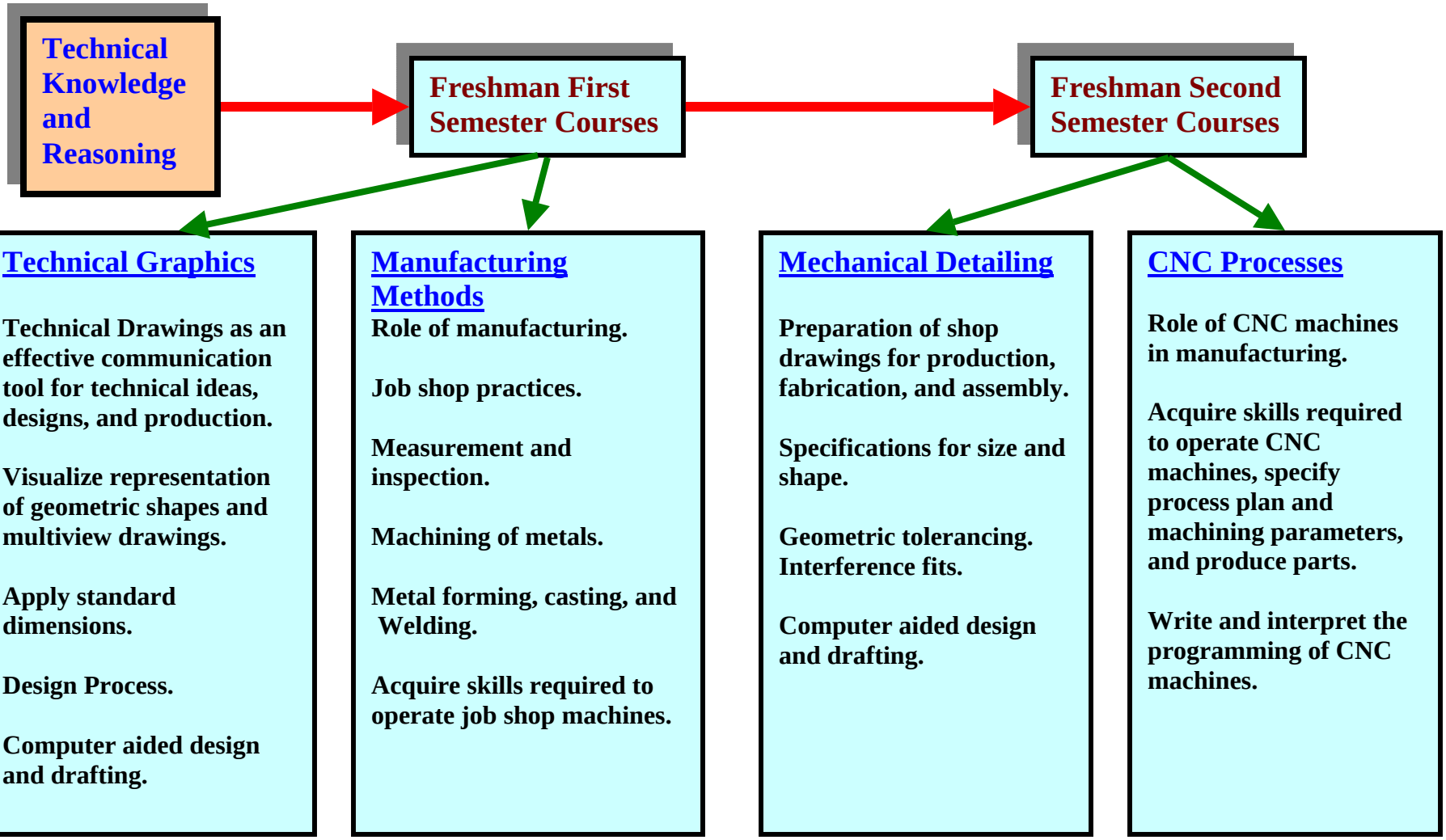
■	EC Strong Correlation
□	EC Good Correlation
●	TC2K Strong Correlation
○	TC2K Good Correlation

Source: Edward F. Crawley, MIT

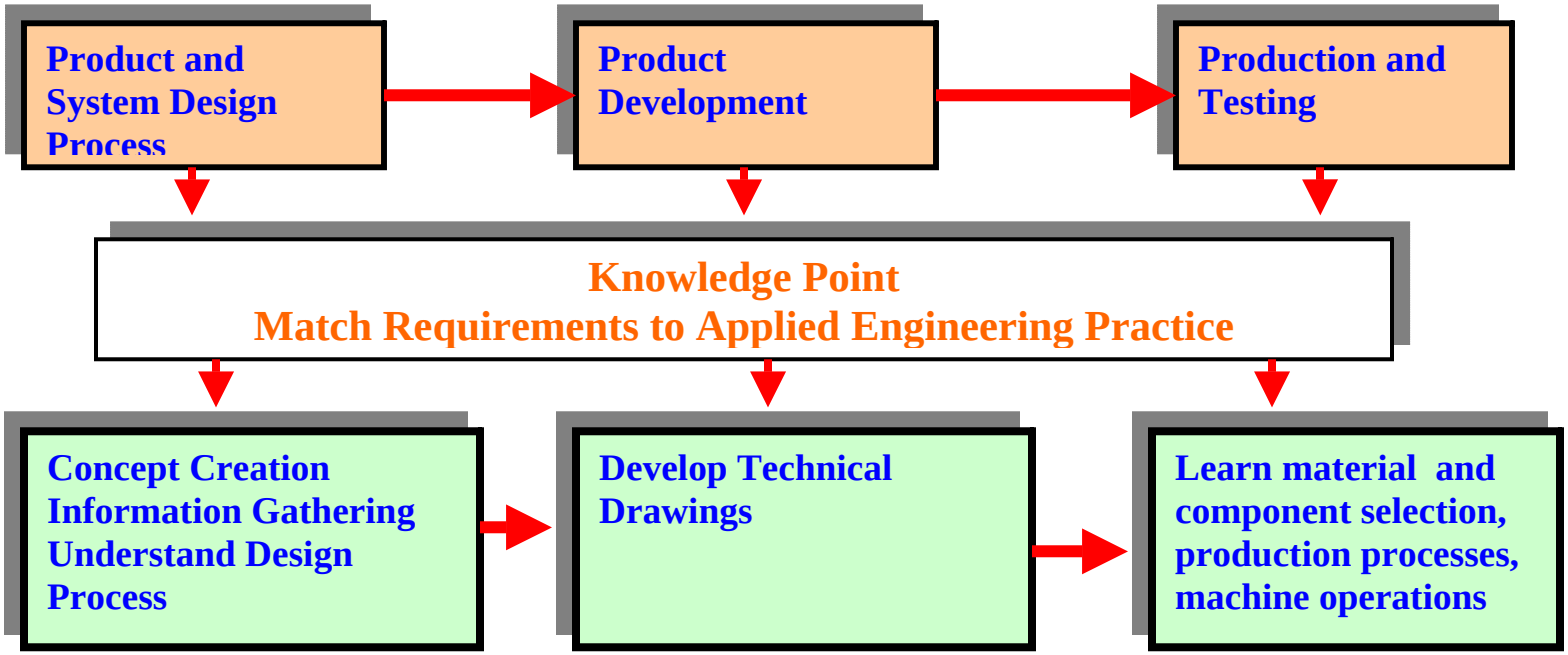
Addressing CDIO Framework



Knowledge Acquired in Courses



Integrate Disciplinary Knowledge



Learn specific knowledge about design and manufacturing before production begins.
Attainment of each successive knowledge point builds concurrently and on preceding one.
Understand awareness of limited knowledge leads to more risk.

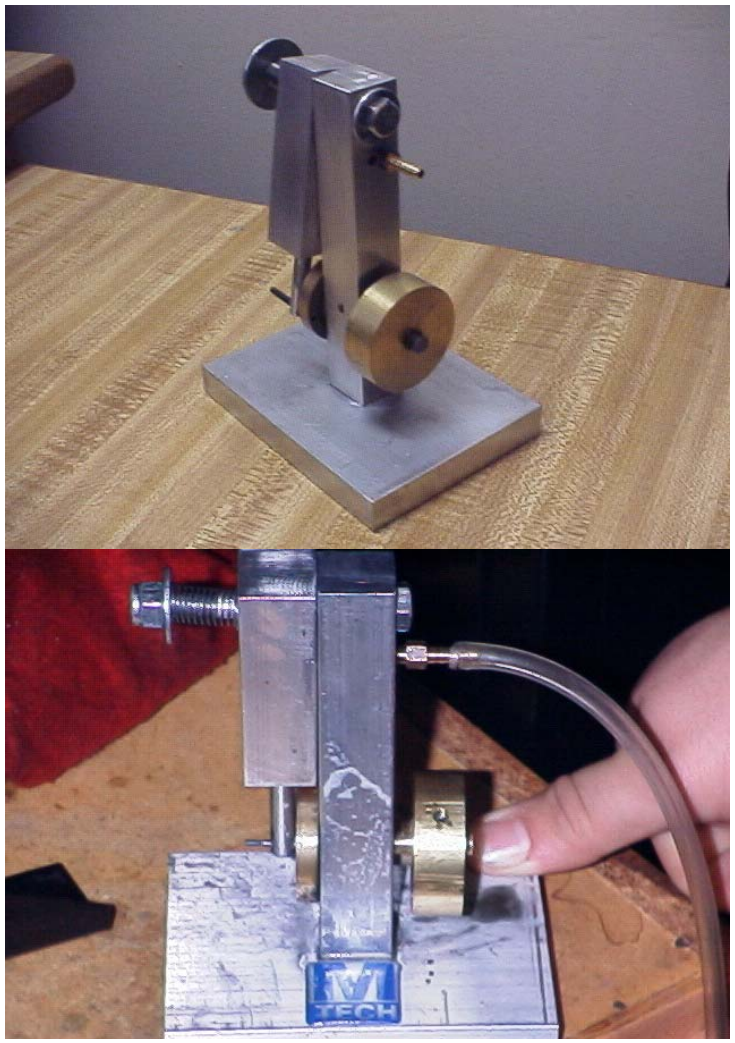
Air Motor Project

This project may involve measurements, review and changing of sizes, materials, and, decision making on process selection. The work also involves preparing detail drawings, assembly drawings, as well as graphing work - all to be done using computer techniques. Simulation using animation with a CAD software to observe the proper functioning of the ports.

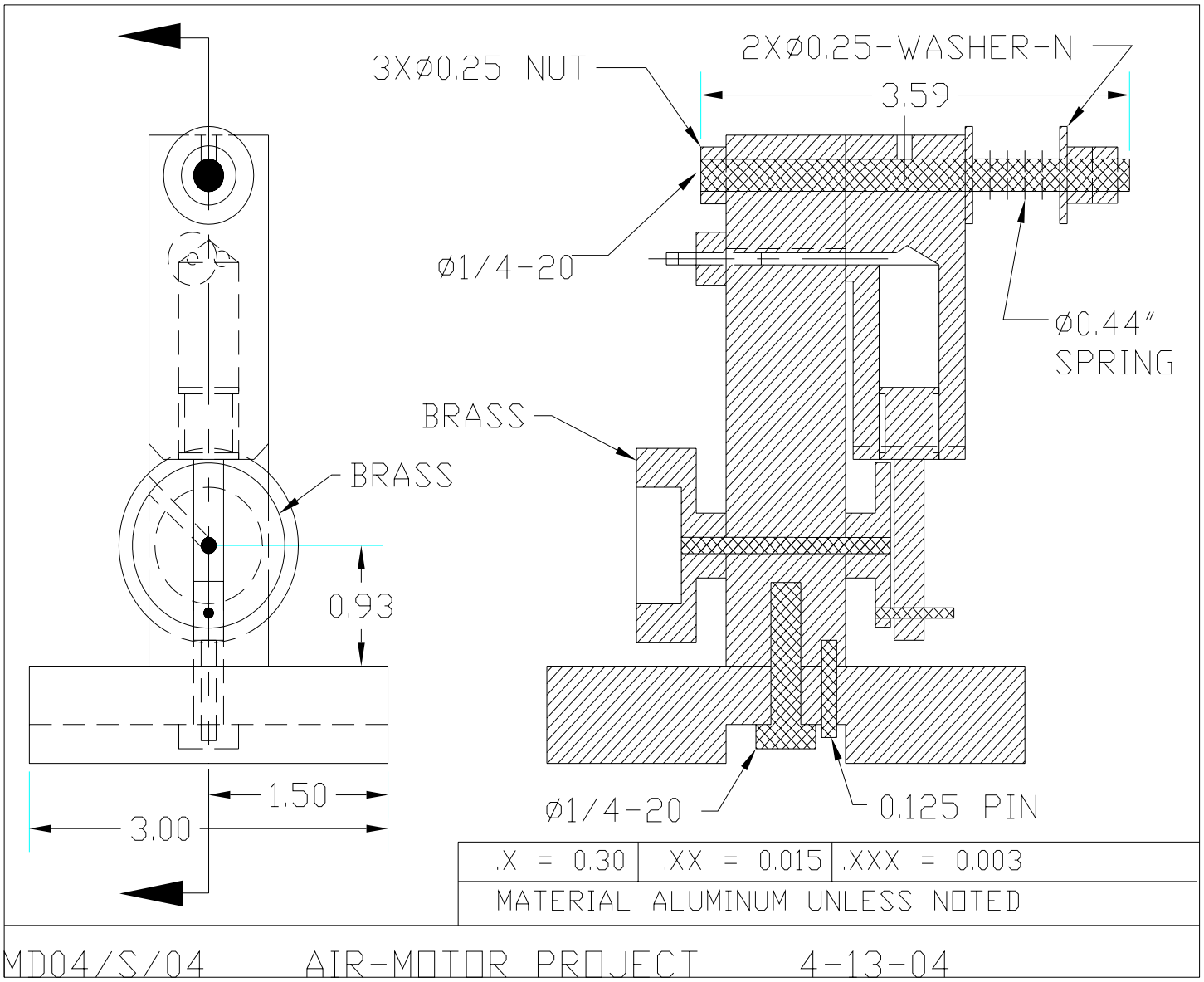
The following specifications must be kept in mind in the design and manufacturing of the AIR MOTOR:

- Envelope dimensions shall not exceed 3x4x5 in inches.
- Either horizontal or vertical piston movement.
- Single piston - no impeller - no rotary valves.
- Maximum air pressure allowed is 60 psi.
- Inlet port to be threaded to accept tubing compatible with available lab sizes.
- Single acting.
- Drive shaft to be supported by a bushing.
- Bushing must be capable of delivering oil to drive shaft.

Do reverse engineering of Air Motor.
Come up with your own and improved design.
Exchange your product drawings with another group. (So the other group can manufacture the product)
Do literature search to identify patent information on air motors.



Air Motor Assembly Drawing



Sample Student Project Presentation

Project Overview

- Disassemble air motors
- Brainstorm ideas
- Rough sketches
- Finished drawings
- Manufacture parts
- Assembly
- Testing
- Written report

Information Gathering

- Studied existing air motors to gain ideas for our own.
- Two piston air motor design.
- Used Autocad and trigonometry skills to obtain dimensions.

Research

- Researched for patents on Internet.
- Observed and tested existing air motors.
- Measured existing air motor.

Problems Encountered

Errors on reading dimensions
Had to redo some parts
Missing dimensions on drawings
The oil passageway was drilled at such an angle that it wanted to bend the drill bit.
Missed the mark for the height of the axle hole for the flywheel.
The flywheel hit the bottom of the cylinder.
Misinterpreted drawing design (intake hole)
Air intake holes did not match up.
This prevented the air motor from running.
Broke off the drill bit for the air intake hole caused the piston to catch on the end of the bit.

Problems Encountered

Design

- Team work
- Lack of communication
- Positioning of Intake
- Stroke length

Manufacturing

- Team work
- Lack of communication
- Breakage of Drill Bits
- Trouble finding material

How Problems Were Fixed

Design

- Never fixed teamwork
- Used AutoCAD to position intake
- Again, used AutoCAD to find appropriate stroke length

Manufacturing

- Communication got better
- We kept on drilling until it went all the way through after 3 drill bits
- Scrapped parts that were beyond repair

Sample Student Project Presentation

Failures

Design not followed to specifications.
Misalignment of connecting bolt hole.
Misalignment of ports.

Resources

Technical Graphics textbook.
Assignment #17 handout from Dr. Hassan.
Knowledge from other professors.
Manufactures handbook.
Knowledge learned from previous courses.

Student Comments

Have reservations to exchange drawings with other teams.
Large commitment of time. Very Frustrating. Learned the back ground being precise. Learned about working with various materials.

Difficulties of using certain materials. Check for availability of materials and parts. Time management for use of shop machines.

Drawings were not dimensioned completely. Thinking in the design phase can prevent future frustration.

Why students were excited?

- **Best workplace practices are introduced at freshman level.**
- **Students see and experience beyond the boundaries of course contents.**
- **Early awareness of required competencies and skills to be successful in real world.**
- **All aspects of engineering and engineering technology are presumed to be applied.**
- **Understanding of ground-up approach to systems thinking and building.**
- **Recognize that limited knowledge may lead to more risk.**
- **Appreciation of experiential learning.**