

An Introduction to Engineering Based on Manufacturing and Design - An Idea

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March 8, 2010**

Outline

- **Guiding Quotes and Goals**
 - **Help and Put Challenge In Perspective**
- **Development of Pilot Course**
 - **3 to 3.5 Phases**
- **Results of Pilot Course**
 - **Evaluation and Assessment Method**
 - **Positive Findings**
- **MatEd Opportunities and Summary**

Background

- **Kettering University**
 - Co-op Intensive
 - Manufacturing and Design Based Engineering Introduction
 - Automotive Heritage
- **IME 100**
 - Lecture/Lab Format
 - Design Labs Added
 - Very Traditional
- **Key to Our Department**
 - And Kettering

Some Guiding Quotes

**We are Continually
Faced by Great
Opportunities Brilliantly
Disguised as Unsolvable
Problems**

Lee Iacocca

**You Must Be On Top of
Change or Change Will
Be On Top of You**

Mark Victor Hansen

**The Difference Between
the Impossible and the
Possible Lies in a
Person's Determination**

Tommy Lasorda

If Not Now - When?

Hilltel

My Punishportunity

- **Took Initiative**
 - **Four (Interim) Department Heads**
 - **Three Provosts**
 - **Challenged Generally Accepted Myths**
 - **Tried to Include Everyone and Develop Real Consensus**
 - **Adapted to Change**
- **Results**
 - **ASEE 2009 Conference Paper**
 - **Planned CCLI Proposal**
 - **MatEd Collaboration Sought**

Proposal Development

- **Pilot Course Development**
 - **Systematic Survey**
 - **Continuous Improvement Report**
 - **Pilot Course Proposal**
 - **Key Questions Added**
- **Climbing Mount Everest**
 - **Sequence of Base Camps**
 - **Several Trips Between Each Camp**
 - **Go Forward Not Backward**

Proposal Development

- **Three “Camps”**
 - Multiple Trips
 - Many Involved
- **Peer Reviewed**
 - Progress Report
 - Final Report

Key Questions
Added

Prop. Pilot

CI Report

Survey

BS
Start

Making a Good Course Better

Survey Step 1- Brainstorm

- **Introduction to Engineering Based on Manufacturing and Design**
 - **Up to 20 Topics**
 - **Up to 10 Learning Items**
- **Results**
 - **10 Participants**
 - **132 Topics Condensed to 54**
 - **33 Learning Items Condensed to 21**

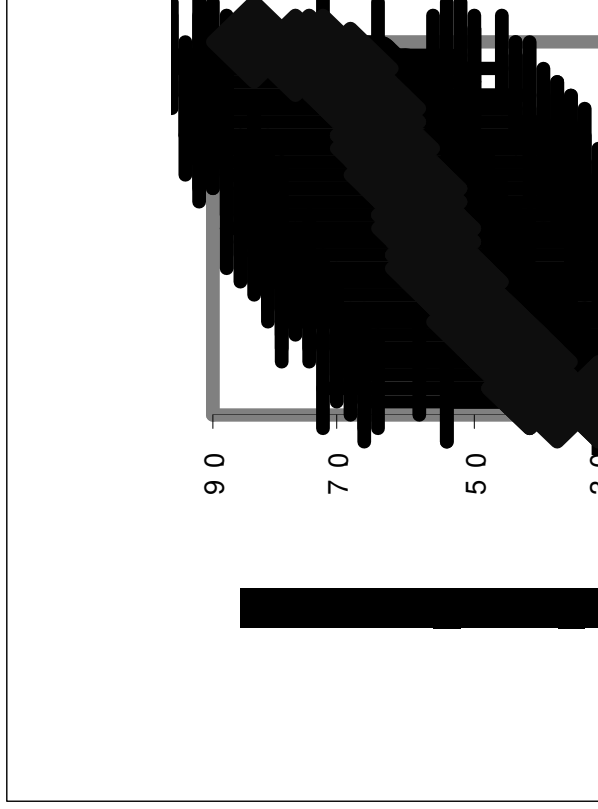
Survey Step 2 - Initial Rank

- **Expanded Participants**
 - 4 ECE, 7 IME, 4 ME
 - Bus, LS, SM, Co-op
- **Rank Each Item Topic 1-9**
- **Dissent Maximized**
- **Results**

Category	Topics	Items
5- Must Include	2	1
4- Should Include	2	5
3- Could Include	22	14
2- Should Not Include	19	1
1- Waste of Time	9	1

Initial Ranking

- Dissent Maximized
- Raw Score $RS = \mu - 0.43\sigma$



Results of Round 2

- Dissent Maximized
- Adjusted Score (Parabolic Fit)

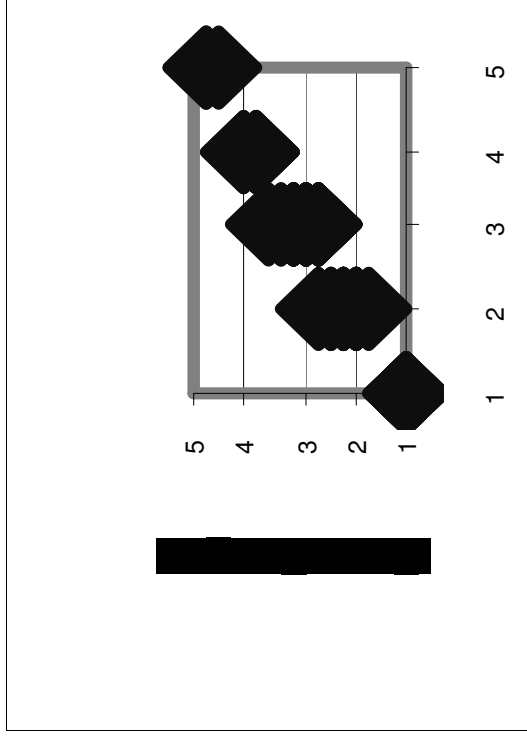
Must Include	3
Should Include	7
Could Include	30
Should Not Include	20
Waste of Time	10

Phase 3 Review of Rankings

- **Participants**
 - **Strongly Agree (2)**
 - **Agree (0)**
 - **Disagree (-1)**
 - **Strongly Disagree (-3)**
 - **Suggest New Ratings**
 - **Comment**
- Results**
- Categories 3-5**
- **All Topics Flagged**
 - **All But 1 Item Flagged**
- Category 2**
- **All But 2 Topics Flagged**
 - **All Items Flagged**
- Category 1**
- **Nothing Flagged**

Phase 4 Final Vote

- **Topics / Items Flagged If**
 - **Average ≤ -0.5**
 - **Standard Deviation ≥ 1.5**
- **Flagged Items**
 - **Reviewed**
 - **Revoted**
- **Final Average Considered**



Phase 2 - Conclusion

- **The Development of a Proposal for a Pilot Course was Warranted**
 - 14 Topics
 - 4-5 Not Currently In Course, Some Could Be Added as “Theme”
- **Pedagogy**
 - Best Practices Must Be Incorporated
 - Integration of 3 Dispartite Components
- **Constriants**
 - Logistics and Expense - Zero Impac

Proposal - Pilot Course

It's the Whole Package !!!

Topics

- Mechanical Properties
- Metrology
- Mechanical Processing
- Casting
- Powder Processing
- Machining
- **Electronic Mfg.**
- Joining
- Polymer Process
- **Systems Layout**
- **Design Process**
- **Cost Analysis**

+

Themes

- Are Samples Different?
- Problem Solving
- Communication

+

Pedagogy

- Integration
- Active Learning
- Higher Level Learning
- Process Education

Progress Report Actions

- **Building on Strengths**
 - **Continue Class Session Style**
 - **Continue Integration Between Practica and Class Sessions**
- **Addressing Areas for Improvement**
 - **Revise Class Session and Learning Exercises for Material Props / Mechanical Processing**
 - **Bring Cost Info Into Course Wherever Possible**

Progress Report Actions

- **Addressing Integration**
 - **Dialog with Design Studio Instructors**
 - **Dialog with COMM 101 and ORTN 101**
- **Addressing Lab Manual**
 - **Develop Lab Manual for Pilot Based On Existing Lab Manual**
 - **All Safety and Equipment Procedures**
 - **Better Link to Class Sessions and Homework**
 - **Reflect Activities of Practica in Pilot**
 - **Slightly Diff Schedule Weeks 1 and 2**

Results Summary

- **Pilot Course Successful**
- **Goals Met**
 - **All But One Course Topic Learned at an Acceptable Level**
 - **Answers to All Key Questions Except One - Yes**
- **Explanations**
 - **Analysis**
 - **Results**
 - **Future Actions for Department to Consider**

Definitions

- **Proficiency (92-94 now A)**
 - **Comprehension of all relevant concepts.**
 - **Ability to correctly apply these concepts to a variety of situations**
 - **Errors few and minor**
- **Competency (78-80 now C)**
 - **Knowledge of all concepts but a lack of complete comprehension**
 - **Requires some guidance to properly apply concepts in new situations.**
 - **Makes some errors.**

IME Evaluation System

■ Learning Items

Competent	Proficient														
	0%	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%
100%	3.15	3.21	3.27	3.33	3.39	3.45	3.51	3.58	3.64	3.70	3.76	3.82	3.88	3.94	4.00
95%	3.13	3.19	3.25	3.31	3.38	3.44	3.50	3.56	3.63	3.69	3.75	3.81	3.88	3.94	4.00
90%	3.10	3.16	3.23	3.29	3.36	3.42	3.49	3.55	3.61	3.68	3.74	3.81	3.87	3.94	4.00
85%	3.08	3.14	3.21	3.27	3.34	3.41	3.47	3.54	3.60	3.67	3.74	3.80	3.87	3.93	4.00
80%	3.05	3.12	3.19	3.25	3.32	3.39	3.46	3.53	3.59	3.66	3.73	3.80	3.86	3.93	4.00
75%	3.03	3.09	3.16	3.23	3.30	3.37	3.44	3.51	3.58	3.65	3.72	3.79	3.86	3.93	4.00
70%	3.00	3.07	3.14	3.21	3.29	3.36	3.43	3.50	3.57	3.64	3.71	3.79	3.86	3.93	4.00
65%	2.75	2.77	2.79	2.81	2.83	2.85	2.88	2.90	2.92	2.94	2.96	2.98	3.00	3.50	
60%	2.50	2.54	2.58	2.63	2.67	2.71	2.75	2.79	2.83	2.88	2.92	2.96	3.00		
55%	2.25	2.31	2.38	2.44	2.50	2.56	2.63	2.69	2.75	2.81	2.88	2.94			
50%	2.00	2.08	2.17	2.25	2.33	2.42	2.50	2.58	2.67	2.75	2.83	2.92			
45%	1.75	1.77	1.78	1.80	1.82	1.83	1.85	1.87	1.88	1.90					
40%	1.50	1.53	1.57	1.60	1.63	1.67	1.70	1.73	1.77						
35%	1.25	1.30	1.35	1.40	1.45	1.50	1.55	1.60							
30%	1.00	1.07	1.13	1.20	1.27	1.34	1.40								
25%	0.83	0.84	0.85	0.86	0.87	0.88									
20%	0.67	0.69	0.70	0.72	0.74										
15%	0.50	0.53	0.56	0.58											
10%	0.33	0.37	0.41												
5%	0.17	0.21													
0%	0														

The rationale is included as a

Combining Feedback

Rating Based on Graded Records	Rating Based on Student Feedback	Overall Rating
Unacceptable	Any	Unacceptable
Marginal	Unacceptable	Unacceptable
	Marginal - Outstanding	Marginal
Acceptable	Unacceptable	Marginal
	Marginal-Good	Acceptable
	Outstanding	Acceptable/Good
Good	Unacceptable - Marginal	Acceptable/Good
	Acceptable-Outstanding	Good
Outstanding	Unacceptable-Good	Good/ Outstanding
	Outstanding	Outstanding

Evaluating Course Topics

Graded Performance

Unacceptable Avg < 1.5
Marginal $1.5 \leq \text{Avg} < 2.0$
Acceptable $2.0 \leq \text{Avg} < 2.7$
Good $2.7 \leq \text{Avg} < 3.5$
Outstanding Avg ≥ 3.5

**Use Dept
Method to
Combine the
Two**

Student Feedback

Rating	Min Avg	Min GB	Max LTA
Unacceptable			
Marginal	1.5		50%
Acceptable	2		35%
Good	2.7	50%	25%
Outstanding	3.5	75%	15%

Combining Grades and StFed

■ Graded Performance Dominates

Rating Based on Graded Records	Rating Based on Student Feedback	Overall Rating
Unacceptable	Any	Unacceptable
Marginal	Unacceptable	Unacceptable
Acceptable	Marginal - Outstanding	Marginal
	Unacceptable	Marginal
	Marginal-Good	Acceptable
Good	Outstanding	Acceptable/Good
	Unacceptable - Marginal	Acceptable/Good
	Acceptable- Outstanding	Good
	Unacceptable-Good	Good/Outstanding
Outstanding	Outstanding	Outstanding

Evaluation Results

Topic	W 08	Su 08	Test 1	Test 2	Only on Final
Metrology	G	G			
Mechanical Properties	A	A			
Mechanical Processing	A	A			
Casting	G/O	A			
Powder Processing	G	A			
Machining	A	A			
Electronic Manufacturing	G	G			
Joining	G	A			
Polymer Processing	G/O	M			
Design Methodology	A	A			
Manufacturing Planning	A	G			
Basic Cost Analysis	U	M			

Only Basic Cost Analysis Problematic

Key Questions

- **Can Freshmen Learn New Subject Matter? - Yes**
 - **Four of Five Topics Successful**
 - **Only Basic Cost Analysis Problematic**
- **Can Mfg. Concepts Be Learned with Reduced Materials? - Yes**
 - **All Manufacturing Processes Topics Successfully Taught**
 - **Only Polymer Processing in Summer was Low - 1 Question on Final Exam**
Sole Evaluation Item

Key Questions

- **Are Students Well Prepared for Practica? - Yes**
 - Performance on Prep Quizzes 3.8 in Winter; 4.0 in Summer
 - Feedback from Practica Instructor on Preparation on Only Lost Foam Casting, Machining and Gas Welding took more than 15-20 Minutes of Instruction

- **Student Feedback (Special Survey)**

	Avg	GB	LTA	Rating
Winter	2.84	68.4%	10.5%	Good
Summer	3.31	85.7%	2.9%	Good

Key Questions

- **Can the Students Combine Class Sessions and Practica? - Yes**
 - Homework, Tests, Final Required This
 - Interaction Between Class Session and Practica - Good Both Terms
 - Student Feedback (Special Survey)

	Avg	GB	LTA	Rating
Winter	2.71	65.8%	7.9%	Good
Summer	2.78	69.4%	11.1%	Good

Key Questions

- **Does Active Learning Improve Student Learning - Yes**
- **Student Feedback (Special Survey)**

	Avg	GB	LTA	Rating
Winter	2.14	42.9%	31.4%	Acceptable
Summer	2.6	65.7%	14.3%	Acceptable

Participating in the class sessions enabled me to complete at least half the HW's in 4-6 hours, through the experience answering concept questions, team problems and discussion questions. *I am not sure if I will better retain knowledge of the subject matter compared to what would have occurred in a more traditional format.*

Key Questions

- **Can the Students Learn at the Higher Levels of Bloom's Taxonomy?- Yes**
 - **HW, Tests and Final Required This**
 - **Student Feedback (Special Survey)**

	Avg	GB	LTA	Rating
Winter	2.3	43.2%	16.2%	Acceptable
Summer	2.74	71.4%	14.3%	Good

I was usually able to correctly, although not always confidently answer questions and solve problems which require correctly either tying together different concepts or apply what I learned in new contexts. I am pretty sure that this experience will allow me to retain the knowledge of the subject matter better than if the class were taught in a more traditional format.

Key Questions

- **Is the Integrated Approach Practical and Successful? -Somewhat**
 - **Class Sessions and Practica Interaction Rated as Good Both Terms**
 - **Design Studio Interactions Rated as Marginal Both Terms**
 - **Student Feedback (Special Survey)**

	Avg	GB	LTA	Rating
Winter	2.34	50.0%	15.8%	Acceptable
Summer	2.97	72.2%	8.3%	Good

The class-sessions and manufacturing practica usually (but not always) flowed together well. The instructors knew what each other was doing and tried to use this knowledge to enhance student learning. The design studio was only barely integrated into the class-sessions by the end of the term.

Strengths

- **All but One of the Suggested Topics Taught Successfully**
 - **Challenge can Be Addressed**
- **Pedagogical Changes Successful**
 - **Consistent with Mission and Vision of Kettering, Academic Affairs and Dept.**
- **Progress Made in DeModularizing the Course**
 - **Addresses a Key Complaint of Students**
 - **The Course is a Complete Package**

Areas for Improvement

- **Integration of Cost Analysis Challenging**
 - **Constant Reminders through Course**
 - **No Text Examples**
- **Design Studio Integration**
 - **More Tie In Needed**
 - **More Communication Between Instructors**
- **Subject Matter Taught After Second Test**
 - **Needs More Evaluation**

Insights

- **Students Need to Be Guided Through the Learning Process**
 - **Introductory Class Session**
 - **Basic Class Notes - Not PP Slides**
 - **In-Class Slide Shows - Laptops in Class**
 - **HW Tips (Critical Thinking) and Narrative Solutions**
 - **Test Prep Sheets (No Sample Problems) - Objectives and Outcomes**
 - **HW Reflection Questions**

All These Resources are Developed

Proposed ENGR 101

- **Cooperation With**
 - **COMM 101**
 - **CORTN 101**
 - **Math Faculty**
- **New Project**
 - **Funky Memory for Students**
 - **Assembled in Work Design Practica**
 - **Basis for Design Projects**

Community College Tie-In

- **Transferable Course**
 - **Technicians who Want/Can Become Engineers**
- **Co-op Working Student Compatabile**
- **Addresses Retention Challenges**
 - **Use COMM 101 to Enhance Interest and Knowledge of Discipline**
 - **Broad/Real Focus From Day One**
 - **Use ORTN to Ensure Success**

Collaborative Opportunities

- **Implementation / Adaptation at Other Schools**
- **Module Development**
 - **Use Modules in New Ways -Increasing Impact and Quality**
 - **Engineering Focused COMM 101 and ORTN 101 Modules**
- **Industry / Company Interaction**