Session Number 1566

The Development of the Procedures for Our ABET Visit in Mechanical Engineering

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The Mechanical Engineering Department at Rose-Hulman Institute of Technology was visited By ABET the last two days of October 2000. A description of the steps that led to our ABET visit will be described in the paper. The paper has the following areas that describe the different parts of the ABET accreditation process that was developed at Rose-Hulman.

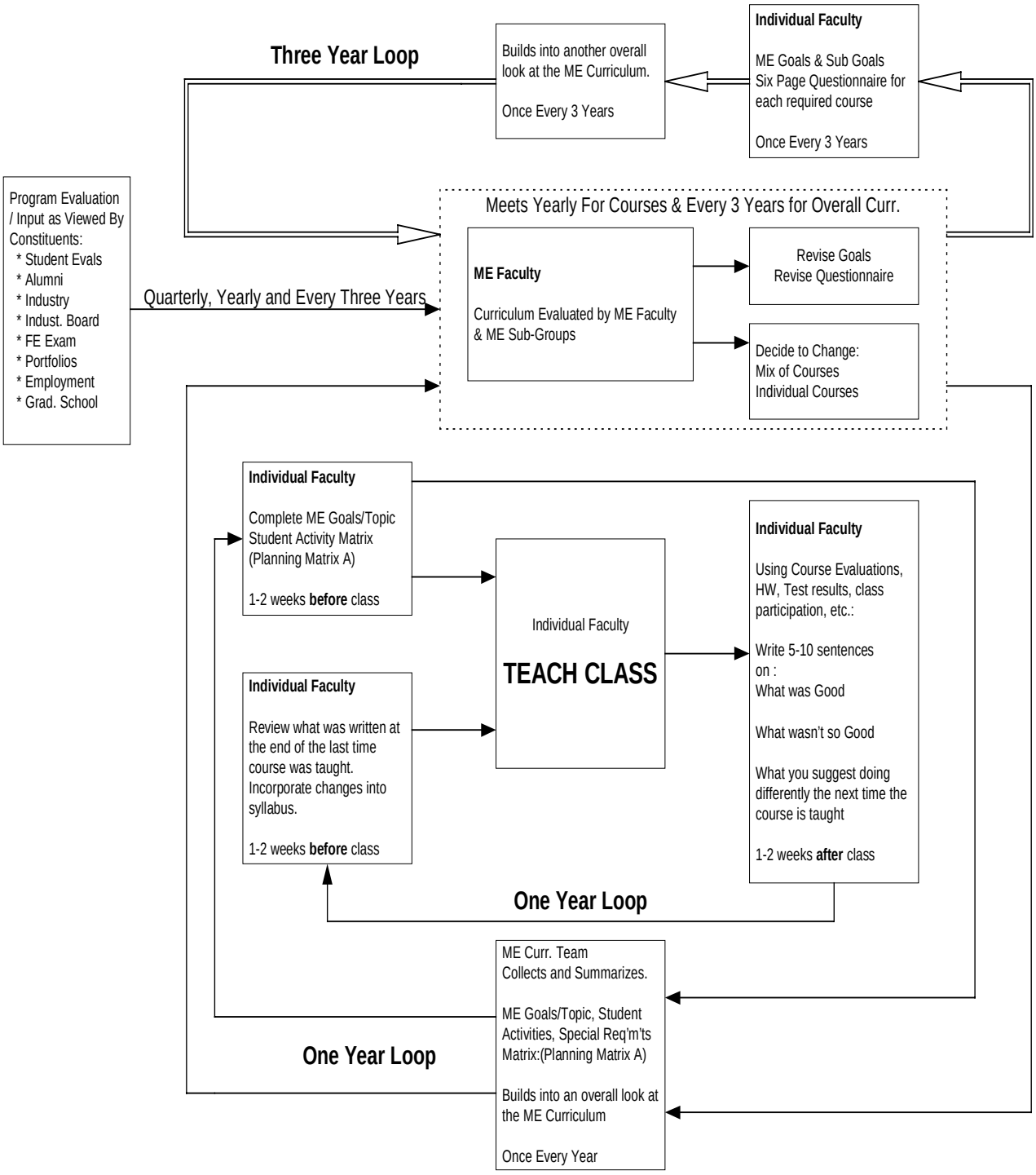
1 Establish Goals and Objectives
2 Annually Measure the "Coverage" of the Objectives (A Matrix)
3 Formally Document Subjective Impressions and Ideas for Improvement (Every-Course-Every-Year)
4 Measure the "Coverage" of the Objectives in Greater Detail Every 3 Years (3 Year Matrix)
5 Alumni Survey

Over the last several years, a plan was developed by the members of the department to provide a framework for continuous improvement of our curriculum. The first step was the articulation of departmental goals. This was a key factor in the rest of the process. Overall there are three forms that faculty must fill out, an ongoing alumni survey, information from the Fundamentals of Engineering Exam, and placement information. A flow chart showing the departmental curriculum review process is shown in Figure 1. Since the main goal of the faculty at Rose-Hulman is to teach classes well, notice that this is capitalized at the center of the flow chart.

Departmental Goals

During the 1993-94 academic year we began to define goals for the M.E. graduates. We worked on these goals for about two years before we were satisfied with them. These departmental goals preceded ABET's "a through k" goals. However, there is a lot of overlap in that all of the "a through k" items are included in our goals. The six major headings of the Rose-Hulman M.E. Goals are: (1) Use Problem Solving in an Effective Manner, (2) Design Effectively, (3) Continue to Learn and Educate Themselves, (4) Communicate Effectively, (5) Work Responsibly, and (6) Work Effectively. There are objectives under each of these divisions. A complete listing of the M.E. Goals and objectives are shown in Appendix A.

Figure 1. Mechanical Engineering Curriculum Review Process



Final ABET Tools

During the 1999-00 year, three different tools were developed by the subcommittee. These tools are an "A Matrix", an "Every Course Every Year" continuous improvement form, and a "Three Year Matrix". These are discussed below.

"A Matrix" Form

The A Matrix allows an instructor to determine the percentage of course topics that address each of the objectives. For each academic quarter the total coverage across all courses can be summed to get the overall picture. It was decided to use the detailed ME Goals instead of the ABET "a thru k". The "A Matrix" is shown in Appendix B and lists "course topics and student activities". The instructor enters a zero or a one in the appropriate box. For example, if a course has a required oral presentation then the instructor would put a one in the box under "Oral Communication Skills". This form is completed for required courses. Then, this information can be summed to show how all of the required courses "cover" the M.E. Goals. This "coverage" can be shown by the quarter and year as well as for the entire curriculum. The value on the vertical axis is normalized because all courses and instructors have different numbers of "Course Topics, Student Activities, and Special Requirements" from the "A-Matrix". Each course is normalized by dividing the totals by the number of "topics & activities". The values for courses are then added and this total is divided by the number of courses to give a maximum value of one. Since the maximum is determined this way it is completely arbitrary. The maximum could be ten or "one" for each quarter, making the normalized value for the entire school year three. An example of this coverage is shown in Figure 3.

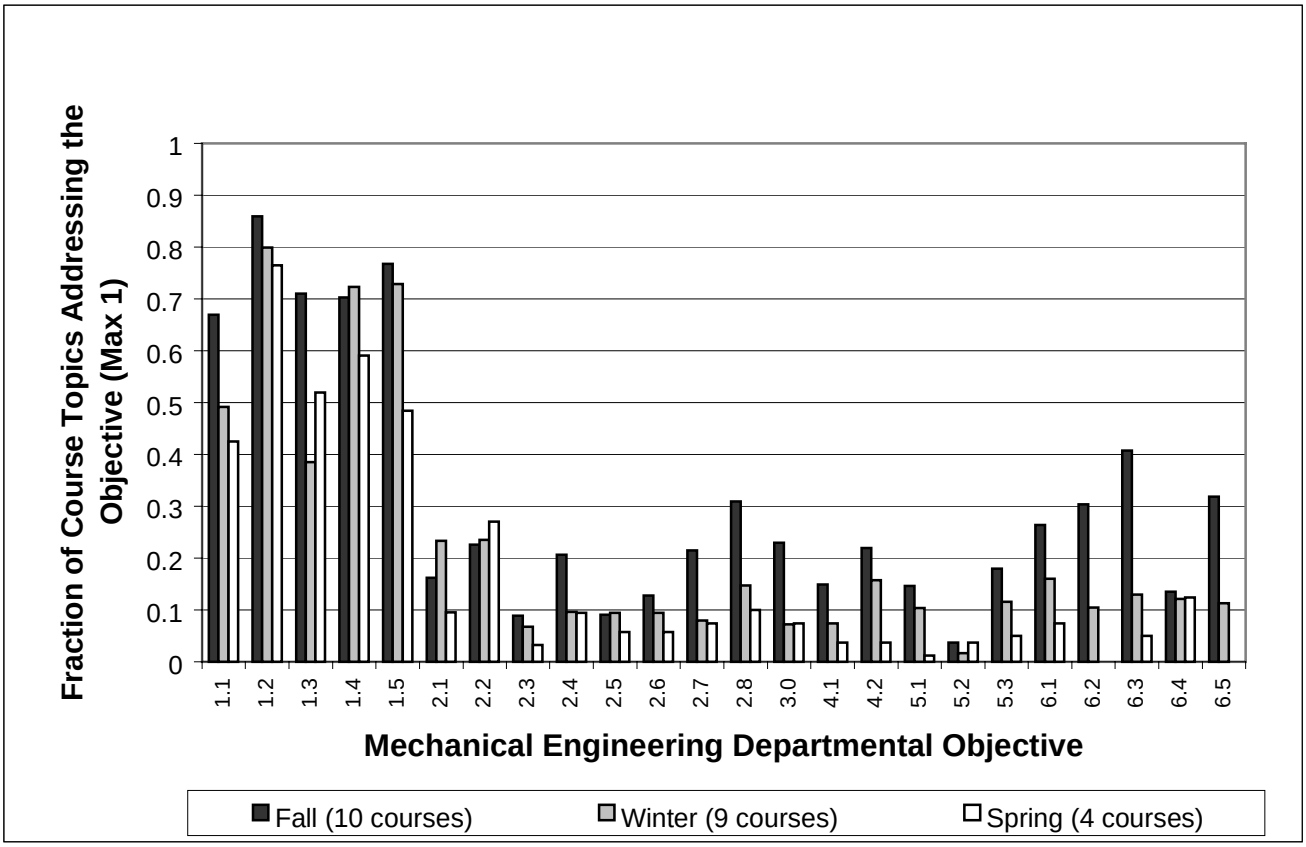


Figure 3. Normalized Coverage for 1999-2000 as shown by Matrix A

"Every Course Every Year" Form

The "Every Course Every Year" form requires that each instructor record, at the beginning of each term the book used, syllabus, topics covered, and generally the boiler plate for the course. This way we can track what textbooks were used and when they were changed. The major addition to this is that the instructor makes a record of continuous improvement in the course. To this end the "Every Course Every Year" form requires that each instructor record, at the end of the quarter, what was good about the course, what wasn't so good and what should be tried the next time that course is taught. This provides a formal way to record and archive what has been tried and tested. This information should be especially helpful when someone new teaches the class. Also this form documents what we all do. We gather information from our experience in class, from the student evaluations, from homework results and test results, and from subjective "feelings" we have about the class throughout the quarter. This information is all summarized in five to ten sentences on this form. An example of the "Every Course Every Year" form is shown in Appendix C.

"Three Year Matrix" Form

The "Three Year Matrix" is a much more detailed listing of the ME Goals, and is only completed every three years. Because the "Three Year Matrix" is so much more detailed it is useful for improving teaching as well as giving an indication of coverage. It gives many ideas for ways to include writing in technical courses. This form is shown in Appendix D. If, later, our experience shows that the "Three Year Matrix" and the "A Matrix" indicate similar coverage, the "Three Year Matrix" will probably be dropped. An example of the results from the "Three Year Matrix" information is shown in Figure 4

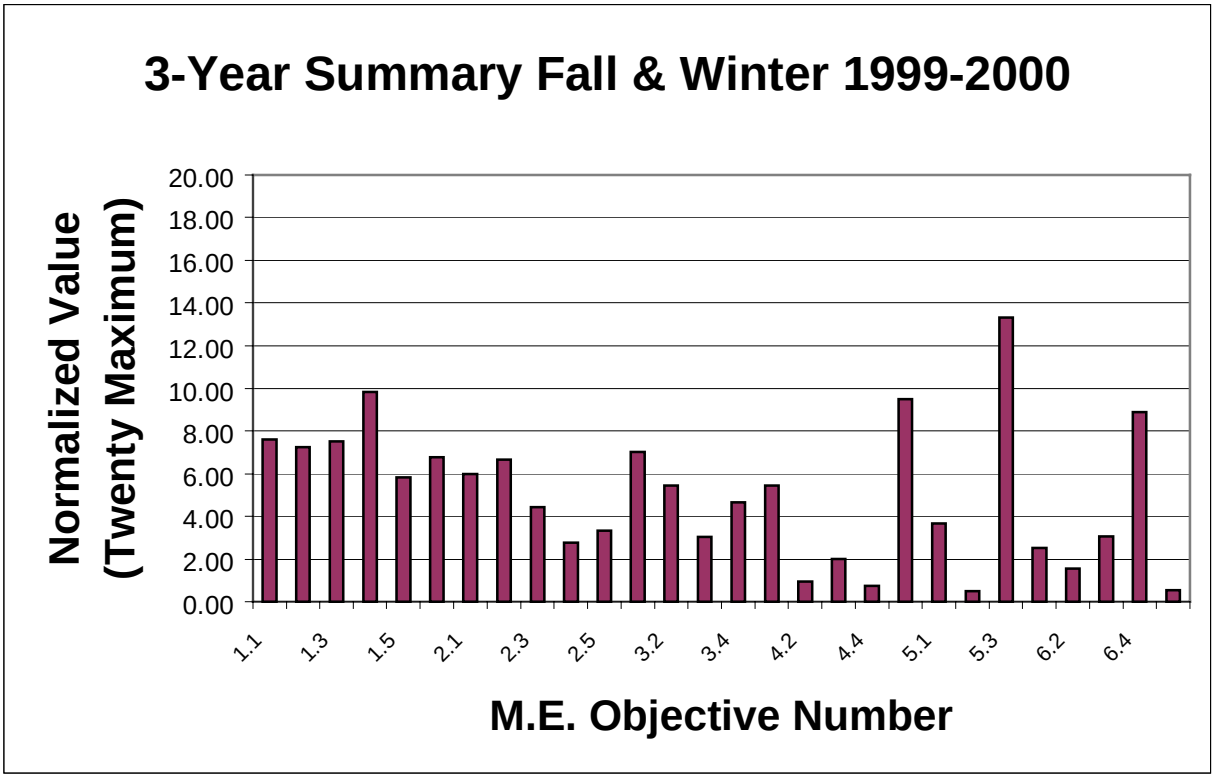


Figure 4. Coverage as shown by the "Three Year Matrix" for 1999-2000

In addition to this presentation, it is perhaps more useful to look at the coverage based only on the six goals. As a reminder these six goals are: (1) Use Problem Solving in an Effective Manner, (2) Design Effectively, (3) Continue to Learn and Educate Themselves, (4) Communicate Effectively, (5) Work Responsibly, and (6) Work Effectively. This is shown in Figure 5.

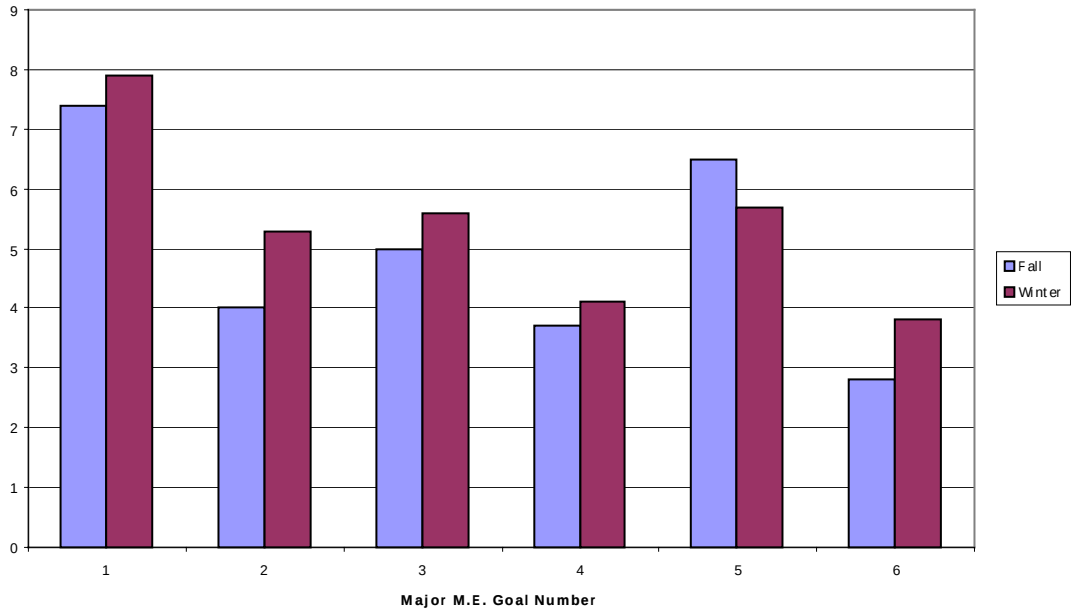


Figure 5. Coverage as shown by the "Three Year Matrix" for Fall and Winter 1999-2000, for the Six Major Categories.

Alumni Survey

The alumni survey was developed within the department during the 1998-99 school year and consisted of sending it to six different classes but with different questions. For example, each class would be asked detailed questions about one of the six major M.E. Goals, and then just a general question about the other goals. Examples of the survey form are shown in Appendix E. The survey was designed to be short, so that it would not take a lot of time to fill out, but the respondents then spent a lot of time writing comments! That was one really surprising result. The alumni were asked to rank (from 1 to 5, with 5 being most important) the current importance of an item for their job and then rank how well their degree prepared them. These results are summarized in Figure 6. It is a little hard to interpret since zero difference is good! That is, they were prepared just exactly as well as they needed to be on the job. The results of the survey show that we hit "problem solving" right on the head. The categories "Design Effectively" and "Continue to Learn and Educate Themselves" were very close. However, it is clear that the alumni feel that it is important to communicate effectively and they didn't feel they were as well prepared as they could have been. This is shown by the "-0.82" number on the "Mean Difference" table in the "Average" column

Current Importance

	1989	1992	1994	1996	1997	1998	Average
Problem Solving.	4.19	4.48	4.36	4.53	4.17	4.17*	4.32
Design Effectively.	3.38	3.80 (n=25)	3.91	4.00	3.84*	3.32 (n=22)	3.72 (n=129)
Continue to learn & educate themselves.	4.19	4.11	4.50	3.98*	4.39	4.57	4.29
Communicate effectively.	4.81	4.81	4.23*	4.90	4.65	4.74	4.69
Work Responsibly.	4.50	4.08*	4.45	4.57	4.43	4.43	4.39
Work Effectively.	4.33*	4.74 (n=26)	4.76	4.71	4.57	4.52	4.33

RHIT Developed

	1989	1992	1994	1996	1997	1998	Average
Problem Solving.	4.06	4.48	4.32	4.67	4.30	4.24*	4.36
Design Effectively.	4.00	3.96 (n=26)	4.18	3.86	3.83*	3.77 (n=22)	3.93
Continue to learn & educate themselves.	4.00 (n=15)	3.93	4.23	3.73*	4.43	4.26	4.10
Communicate effectively.	3.56	3.93	3.52*	3.86	4.17	4.04	3.89
Work Responsibly.	4.00 (n=15)	3.81*	3.95	4.14	4.17	4.35	4.07
Work Effectively.	3.45*	4.04 (n=26)	4.14	4.33	4.43	4.43	4.17

Mean Difference

	1989	1992	1994	1996	1997	1998	Average
Problem Solving.	-.13	0	-.04	.14	.13	.07*	.03
Design Effectively.	.62	.16	.27	-.14	-.01*	.45	.21
Continue to learn & educate themselves.	-.19	-.18	-.27	-.25*	.04	-.31	-.19
Communicate effectively.	-1.25	-.88	-.71*	-1.04	-.48	-.70	-.82
Work Responsibly.	-.50	-.27*	-.50	-.43	-.26	-.08	-.33
Work Effectively.	-.88*	-.70	-.62	-.38	-.14	-.09	-.45

*Average of Detailed Questions

Figure 6. Results of the Alumni Survey indicating the Current Importance of the Six Major M.E. Goals, How well RHIT Developed these M.E. Goals and the Mean Difference between the Current Importance and the RHIT Developed Goals

Conclusions:

It is important for a department to agree on goals for both themselves and their students. Once this is done, it is possible to develop a plan which will provide a positive framework for continuous improvement. With good planning, it should be possible to do this without burdening the faculty with a tremendous amount of additional work. In addition, the faculty can concentrate on their teaching and not have to become experts in assessment techniques. The Rose-Hulman ME plan is both sustainable and does not take a lot of extra faculty time. The A-Matrix basically follows from the course syllabus. The Every-Year-Every-Course form provides a record and documents good things that were tried and worked and things that didn't work in the classroom. The 3-Year Form is a more extensive version of the A Matrix that enables faculty to think more in depth about the topics and student activities that are occuring inside and outside the classroom.

Appendix A: M. E. Departmental Goals

RHIT ME Curriculum Goals

Curriculum (literally to run) is a complex process, not a fixed, isolated state. In a general sense an individual's curriculum begins at birth and ends at the death of the intellect. Restricted to academic life as we know it, curriculum means a movement or running through a sequence or, better yet, a matrix of learning experiences. Students run through the Mechanical Engineering curriculum. To the extent that the Mechanical Engineering faculty manage this "passing through", we expect to produce graduates who can be effective engineers.

This first section below presents the goals which guide the ME curriculum. The second section shows how the goals sit in the context of ABET criteria.

ME GOALS

ME graduates should be able to solve problems and design effective systems, i.e., graduates must:

1. USE PROBLEM SOLVING PROCESSES IN AN ITERATIVE MANNER

1.1 Inspect & define problems, i.e., formulate a problem, no matter how vaguely posed, in a format that allows an appropriate solution to be found. This implies the ability to:

Identify and formulate the goals, objectives and constraints for the solution and to deal with ambiguity in the possible multiplicity of right answers;

Understand that the definition and solution of complex problems are iterative tasks. Although the problem must be defined at the beginning, this is precisely the time when the problem is least clearly understood and a satisfactory problem definition is difficult. The problem definition and the solution will progress together;

Realize that an appropriate answer must accurately incorporate the client's needs and desires as well as those of the employee's organization.

1.2 Identify and understand basic principles and fundamental concepts

Identify the basic principles and concepts which are involved in the solution of a problem. Relatively few basic principles and concepts are involved. These include, but are not limited to:

- Conservation (mass, momentum, energy, charge, etc.)
- Accumulation
- Rate-of-Change

- Dimensional Homogeneity
- Material Properties

Most principles and concepts considered "basic" in specific applications are derived from those above, or are definitions.

1.3 Can build appropriate models

All solutions are based on models, that is, on simplifications of reality. The engineer must be able to identify and abstract the important features of the problem and construct workable models by making appropriate simplifications, approximations and assumptions.

1.4 Can choose appropriate tools

Select and apply the best tools to effect an appropriate solution, e.g.:

- Analysis (mathematical, closed form, empirical or semi-empirical, etc.)
- Synthesis (design and/or assemble ideas)
- Computation (may be computer-based)
- Estimation
- Experimentation
- Simulation
- Information retrieval (e.g., literature search)
- Back-of-an-envelop calculations

1.5 Evaluate the solutions and interpret results

The solution to a problem is not complete until the results of the analysis are interpreted or evaluated with respect to the original goals, constraints, and assumptions.

- What does the answer mean?
- Is it dimensionally correct?
- Does the order of magnitude make sense?
- Is it relevant to the original problem as defined?
- Is it practical?
- Can it be implemented?
- Is the problem solved to the satisfaction of the customer?
- Is additional work necessary?

2. DESIGN EFFECTIVELY

Design challenges are usually ill-defined and have many potential solutions but no solution that is clearly the "best." The designer must create a product or process that satisfies a "need" that is not fully defined. The phases of design, which are visited iteratively, include

- Identify the need
- Understand the problem
- Develop specifications
- Generate potential solutions
- Prepare preliminary designs
- Select the "most likely to succeed" configuration
- Detail the design
- Document the work

Throughout the design process the designer must consider many other important factors which include:

- Assembly
- Testing
- Production
- Manufacturing
- Distribution
- Maintenance
- Disposal

and

- Applicable standards
- Ergonomics
- Recyclability
- Life-cycle issues

The Department of Mechanical Engineering emphasizes the skills and abilities required for all stages of the design process and provides opportunities for the student to practice these skills and develop these abilities.

The designer must also be creative to develop an original solution. The Department cultivates an environment in which students are free to take risks and possibly fail during the development of creative ideas.

3. CONTINUE TO LEARN AND EDUCATE THEMSELVES

Students must appreciate that not only do they need to know current technology, they must learn new technologies and become familiar with related disciplines. They must have basic

learning skills which will allow them to learn from traditional written learning media as well as to learn to use new computer programs and yet to be developed media. The student must know where to go for sources of information such as the traditional sources like the library and colleagues, as well as the non-traditional: e.g. CD-ROM and computer searches.

The curriculum provides the basic fundamentals and practice at mastering new materials. The graduate must, however, develop and maintain motivation to learn new materials based on a continual and honest evaluation of individual deficiencies.

4. COMMUNICATE EFFECTIVELY

There are many aspects to effective communication. The visual "engineering languages" include graphs, sketches, engineering drawings and posters. Communication, as commonly understood, makes use of both the spoken and written language. Oral communication ranges from one-on-one conversations between individuals, through many-to-many conversations among team members, to one-to-many lectures to large groups. Oral communication requires a significant investment of listening just as written communication requires an investment in reading. Our students should learn to listen and read empathetically, openly, creatively and critically. Writing includes designing many different type of documents, e.g., memos, letters, progress reports, proposals, formal reports, and technical reports.

In addition students should begin to appreciate that the medium is as important as the message. The non-technical aspects of communications, such as politics, aesthetics, style, and technique should be recognized.

5. WORK RESPONSIBLY

5.1 Responsibility in engineering practice

Graduates must be prepared to practice engineering responsibly, i.e., make decisions based on personal and professional codes of ethics with the understanding that they are accountable for the outcomes of these decisions. Graduates must be sensitive to local and global issues in order to act ethically in their particular society and for humanity in general.

5.2 Responsibility to become a good role model

The curriculum should provide opportunities for students to be role models while they are at Rose-Hulman. This can be accomplished, for example, through courses like "Vertical Integrated Design" where students of all classes work together.

5.3 Practice in responsible decision making

Responsible decision making comes about by seeing the "big picture", collecting information necessary to make an objective and careful decision, not hiding or obscuring information to make the outcome move in a desired direction, being objective, and not letting selfish personal consideration sway decisions.

Responsible decision making means weighing the decision with care, taking an appropriate amount of time on the decisions.

Finally it means being willing to accept the consequences of the decision.

6. WORK EFFECTIVELY

Graduates should be able to work effectively in five areas:

6.1 Management

Management includes working as an effective team member as well as working effectively as an individual. It also includes utilizing resources and understanding constraints.

6.2 Concentration/focus

The concentration/focus includes sticking to priorities, recognizing the "Law of Diminishing Returns", knowing the objective and moving toward it.

6.3 Process

Process includes establishing priorities, using the right tool for the right job, dividing large problems into smaller ones, and learning during the process, especially from failures.

6.4 Interpersonal skills

Interpersonal skills include working in teams, accepting compromise, considering societal constraints and considering physiological constraints. Other interpersonal skills include risk taking, helpful criticism, objectivity, active listening, giving the benefit of the doubt, support and recognizing the interests and achievements of others[1].

6.5 Personal skills

Personal skills include time management and stress management.

[1]See Katzenbach, J. R. and D. K. Smith, *The Wisdom of Teams*

Appendix B: "A-Matrix"

Mechanical Engineering Deparmental Goals **(Planning Matrix A)(1/1/2000)**

Course #: _____	1						2								3	4			5			6					
Course Name: _____	Use Problem Solving Processes in an Iterative Manner						Design Effectively									Comm-unicate Effectively			Work Respons-ibly			Work Effectively					
Faculty: _____																											
Course Topics, Student Activities, and Special Requirements	1.1 Inspect & Define Problems	1.2 Identify & Understand Basic Principles and Fundamental Concepts	1.3 Build Appropriate Models	1.4 Choose Appropriate Tools	1.5 Experiment	1.6 Evaluate Solutions & Interpret Results	2.1 Identify the Need	2.2 Understand the problem	2.3 Develop Specifications	2.4 Generate Potential Solutions	2.5 Prepare Preliminary Designs	2.6 Select the "most likely to succeed" configuration	2.7 Detail the Design	2.8 Document the work	3.0 Continue to Learn and Educate Themselves	4.1 Present visually using drawings, graphs, and sketches	4.2 Oral Presentations, Listening, Small Group Communications5	4.3 Writing memos, letters, reports, proposals, and technical reports	5.1 Responsibilty in Engineering Practice	5.2 Responsibility to Become a Good Role Model	5.3 Practice in Responsible Decision Making	6.1 Management: working effectively both as an individual and as a team member	6.2 Concentration/Focus: sticking to priorities	6.3 Process: Establishing priorities, using the right tool for the right job	6.4 Interpersonal Skills: Working in teams, accepting compromise, active listening	6.5 Personal Skills such time management and stress management
Enter a check mark (or a "1" if you are doing this on a computer) into the appropriate box where items match. Leave others blank.																											
1																											
2																											
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Appendix C: Every Course-Every Year Form

ME 201 Thermodynamics I

1999-2001 Catalog Data: (4R-0L-4C) Covers first law of thermodynamics, second law of thermodynamics, concept of entropy, simple process analysis, properties of pure substances, equations of state, and state diagrams. Stresses use of property tables and charts and application of the first and the second laws to open and closed systems undergoing changes.

Textbook: Wark, Kenneth and Richards, Donald, (1999). **Thermodynamics**. 6th Edition. McGraw-Hill: New York.

Reference: None.

Professor: L. W. Sanders

Goals: To introduce:

- First law of thermodynamics
- Second law of thermodynamics
- Work and heat transfer
- Concept of entropy
- Properties of pure substances
- Equations of state

Objectives: To provide the background and basic skills for:

- Use of property tables and charts
- Application of first and second laws to open and closed systems
- Problem analysis and solving

Prerequisites By Topic: None.

Course Topics:

- First law of thermodynamics
- Properties of substances
- Ideal gas
- Control-volume energy analysis
- Second law and entropy

Computer Use: No.

Laboratory Projects: No.

Please check the departmental goals that this course covers.
(For more detail, refer to ME Goals which are listed at the top of "A" Matrix):

__X__1.1 Inspect & Define Probs
__X__1.2 Basic Prin & Concepts
_____1.3 Build Approp Models
_____1.4 Choose Approp Tool
_____1.5 Experiment
__X__1.6 Evaluate & Interpret
__X__2.1 Identify Needs
__X__2.2 Understand Prob
_____2.3 Develop Specs
__X__2.4 Generate Solns
_____2.5 Prelim Designs
_____2.6 Select "best" Des
_____2.7 Detail the Design
_____2.8 Document Work
_____3.0 Continue to Learn
_____4.1 Present Visually
_____4.2 Oral Presentations
_____4.3 Written Present
_____5.1 Engineering Pract
_____5.2 Role Model
_____5.3 Decision Making
_____6.1 Effective Indiv & Team
_____6.2 Concentration/Focus
_____6.3 Establish Priorities
_____6.4 Interpersonal Skills
_____6.5 Personal Skills

Instructional Items are in italics. These are for information only, and you do not have to fill anything in this part of the form.

We Change Our Courses by information learned by grading, adding new subject matter, Feedback from Industry & Alumni, Student Evaluations, departmental discussions, and other ways. Based on these inputs, you may decide to make some changes in the course. This is a type of ***continuous improvement*** *and should be documented. Please indicate modifications you plan to make and the reasons why. (i.e. I plan to give more/less homework because the students indicated that they wanted more on the comments in the course evaluations.)*

End of this Fall quarter 1999-2000

Complete a week or two after the end of the quarter to prepare for the next time the course is taught. These can be completed by hand if it is easier for you.

Evaluation of the course:

What was good? Everything was good – pace, presentation, tests, and grading.

What wasn't so good? Availability outside of class due to teaching course at Crane and need for cardiac rehab.
Next Time I/We Plan to Modify the Course by Changing/Trying (five to ten sentences)
I don't believe anything needs to be changed. I will try to be more available next time.

Before teaching the course again: (Before Fall quarter 2000-2001)
Review what you wrote after completing the course the previous time. (COMMENTS?)
I would teach the course the same way. The thing the students did not like, my availability, is beyond my control. I have other courses to teach and other duties at Rose-Hulman.

At the end of fall quarter, 2000-2001, complete after the end of the quarter.
How Did the Modifications Work? _____
_____
_____
_____
_____
_____

Evaluation of the course:
What was good? _____
_____
_____
_____
_____
_____

What wasn't so good?
_____
_____
_____
_____
_____
_____

Next Time I/We Plan to Modify the Course by Changing/Trying---- (five to ten sentences)

_____
_____
_____
_____
_____
_____

Continue to use this format of recording what we currently do to improve our courses every time the course is taught

Appendix D: Three Year Matrix

Course Number: _____ **Course Name:** _____ **Reviewer:** _____ **Date:** _____

(Scale: 0 = rarely/never, 1 = sometimes, 2 = always/frequently)

	1 Use Problem Solving Processes	0	1	2
1.1	**Inspect and Define Problems**			
*	Students are faced with poorly defined, vague problem statements			
*	Not all the information required to solve a problem is in the problem statement			
*	Students face problems where too much information is given			
*	Students encounter problems that are given entirely in words with no variables, equations or figures			
*	Students must identify constraints in a problem			
*	Students are required to list assumptions in all problems			
*	Students are required to rewrite the problem statement in their own words			
1.2	**Identify and Understand Basic Principles and Fundamental Concepts**			
*	Students are required to explicitly state what principle they are applying prior to writing down an equation			
*	Students are asked to explain a concept in their own words			
*	At the end of the course students are required to list the basic principles and fundamental concepts learned in the class			
*	Students are required to apply basic principles or fundamental concepts "out of context"			
	(In Bloom's taxonomy this is the "Application" level of learning)			
*	Students solve problems requiring the use of more than one principle or fundamental concept			
	(In Bloom's taxonomy this is the "Analysis" level of learning).			
1.3	**Build Appropriate Models**			
*	Students develop a mathematical representation of a physical system			
*	Students understand that many physical systems can be modeled with mathematical equations having the same form			
*	Students have used a simulation program, such as "Working Model", to represent a physical system			
*	Students have constructed a physical model of an analytical solution			
*	Students should be able to form block diagrams to represent complex systems			
1.4	**Choose Appropriate Tools**			
Note	For this discussion "tools" include the following: analysis (mathematical, closed form, empirical or semi empiracal, etc., synthesis,			
	design &/or assemble ideas), computation (may be computer based), estimation, experimentation, simulation, information retreival.			
*	Students are required to use a variety of "tools" to effect an appropriate solution			
*	Different "tools" are discussed in the class			
*	Students are not told what "tool" to use			
*	Students are taught how to choose a "tool"			
*	Students are required to use analysis to solve problems			
*	Students are required to use computation to solve a problem			
*	Students are required to use estimation to solve a problem			
*	Students are required to use simulation to solve a problem			
*	Students are required to explain the limitation of a "tool"			
*	Students are required to use information retrieval to solve a problem			
1.5	**Experiment**			
*	Students are required to use experimentation to solve a problem			
*	Students are required to design an experiment			
1.6	**Evaluate and/or Assess the solutions (interpret results)**			
*	Students are given problem that have no "right" answer			
*	Students are asked to explain what an answer means (such as its implications)			
*	Students must make a choice between a collection of acceptable solutions and defend their choice;			
	based on goals, objectives, and constraints of a problem			
*	Students are required to put dimensions on all answers (and are penalized if they do not)			
*	Student are required to briefly discuss their answers			
*	Students are asked to answer questions such as "does it make sense? and if it does not, to explain why"			
*	Students are asked to evaluate if their solution to a problem is practical			
*	Students are asked to evaluate the ethical nature of their solutions			
*	Students are asked to evaluate if their solution to a problem is reasonable			
*	Students are asked to evaluate if their solution to a problem is adequate or is more work necessary			
*	Students are asked to evaluate if their solution is economically feasible			
*	Students are asked to evaluate how their solution impacts other systems			

2	**Design Effectively**			
2.1	**Students are required to experience every stage in the design process**			
*	Identify the Need			
*	Understand the Problem			
*	Develop Specifications			
*	Generate Potential Solutions			
*	Prepare Preliminary Designs			
*	Select the "most likely to succeed" configuration			
*	Detail the Design			
*	Document the Work			
2.2	**Students are required to design something to solve a problem**			
2.3	**Students are required to build and test their designs**			
2.4	**Students are taught the design process**			
2.5	**Students are required to prepare a project plan/schedule**			
3	**Continue to Learn and Educate Themselves**			
3.1	**Know what to learn**			
*	Students are required to solve problems for which they have a deficiency of knowledge and are required to ameliorate the deficiency on their own			
*	Students are asked to identify what they need to know to solve a problem			
*	Students are introduced to (not necessarily taught) the latest technology in a discipline			
*	Material that was to be learned in prerequisite courses is not retaught but is expected to be relearned by the student on his or her own			
*	A statement of expectations of the course exists (list of skills and knowledge that the students should have from the prerequisite)			
*	A pretest is given (a self-rating with respect to knowledge and skills followed by a written/oral test of that knowledge and skills)			
3.2	**Know How to Learn - or How to Use Available Resources**			
*	Students are taught basic learning skills			
*	Students are required to read the book			
*	Students "Brief" (summarize, review, or abstract) an article or series of articles			
*	Students critically review articles, software, books, presentations according to specified criteria			
*	Students are held accountable for material presented in the book but never mentioned in class			
3.3	**Know Where to go for Sources of Information**			
*	Students are taught how to locate information			
*	Students complete a set of library exercises including Boolean searches on CD-ROM, use of Luis, interlibrary loan, engineering indexes (on-line, or hard copy)			
*	Students are required to locate information from sources other than the textbook for a course			
*	Students are required to use the library			
*	Students are required to use commercial sources, including Thomas Register, manufacturers info and catalogs, direct verbal communication			
*	Students are required 1) to use information from professional societies, and 2) to review information available through professional and enthusiast organizations			
3.4	**Know that they must continue to learn**			
*	Students are told about the importance of continual learning			
*	Students are told why they must continue to learn			
*	Students are required to explain why they must continue to learn			
*	At the end of a course students are aware of topics that were not discussed in class (they are aware of their deficiencies)			
*	Students are given open-ended projects that simulate projects they would have after graduation			

4	**Communicate Effectively**			
4.1	**Present Visually**			
*	Students are required to make graphs			
*	Students are required to make sketches			
*	Students are taught the proper way to graph data			
*	Students are taught sketching skills			
*	Students are required to produce engineering drawings			
*	Students are taught how to do engineering drawings			
*	Students are required to present information in a poster session			
4.2	**Communicate Orally**			
*	Students are taught the oral communication skills of topic outlining			
*	Students are taught the oral communication skills of using visuals			
*	Students are taught the oral communication skills of developing visuals			
*	Each student is required to give an individual oral presentation			
*	Students are required to make group oral presentations			
*	Students are taught to communicate with team members			
*	Students oral presentations are taped and the students are required to critically review their performance			

The following are examples of oral communication
(please make a check mark next to ones that students are required to do in the course)

*	Summarize the reading or previous lecture in one minute	
*	Explain the solution of a problem or text example in one or two minutes	
*	Other examples are shown below	
*	Explain a topic to one other person	
*	Formal lecture on a technical topic to a technical audience (with a specified time limit)	
*	Formal lecture on a technical topic to a non-technical audience (with a specified time limit)	
*	Present a proposal	
*	Defend a position orally	
*	Argue against a position	
*	Progress report to a supervisor	
*	Extemporaneous reports	
*	Outline/explain a problem solution for review by peers	
*	Interview a customer/client to identify the customer/client wants	
*	Take part in a mock interview as interviewer or interviewee)	
*	Oral peer review	

5	**Work Responsibly**			
5.1	**Develop awareness of levels of responsibility in engineering practice**			
*	Students are taught about ethics			
*	Students are given the code of ethics for engineers			
*	Students must consider the ethical, environmental, global considerations of their solutions			
*	Students are held to a minimum standard of expertise in a particular subject			
*	Students are required to continue to resubmit an assignment until it is satisfactory			
5.2	**Responsibility to become a good role model**			
*	Students are required to be a role-model for other students			
*	Students are taught the importance of being good role models.			
*	Opportunities are provided for students to be role models			
*	Students give review sessions			
*	Vertical Integrated Design where students of all classes work together			
*	Students give presentations to their peers on summer activities or other interesting activities			
5.3	**Practice in responsible decision making**			
*	Students are held accountable for decisions they make			
*	Deadlines are strictly enforced and missing one results in a severe penalty			
6	**Work Effectively**			
6.1	**Management**			
*	Students are taught how to be an effective team member			
*	Students are taught what it means to be a good manager			
*	Students are taught the main responsibilities of being a manager			
*	All students are given the responsibility of being a team leader			
6.2	**Concentration Focus**			
*	Students are taught the "laws of diminishing returns"			
*	Students are required to keep track of how they spent their time for some specified period			
*	Students are required to make a list of their priories			
*	Students are excluded from some extracurricular activities if their GPA is below a certain level			
6.3	**Process**			
*	Students are taught how to establish priorities			
*	Students are required to establish a list of priorities each week			
*	Students are given the opportunity to learn from their mistakes and to improve their performance			
	For example, students could be given several iterations on a paper or a project			
6.4	**Interpersonal Skills**			
*	Teamwork			
6.5	**Personal Skills**			
*	Students are taught time management skills			
*	Students are taught stress management skills			

4.3	**Communicate in Writing**			
*	Students are taught the written communication skill of organization			
*	Students are taught the written communication skills of "summary" and "focus"			
*	Students are taught the written communication skills of punctuation and grammar			
*	Students are taught about standard formats (e.g. business letters, department report standard)			
*	Students are graded on grammar, punctuation, and the quality of the writing			
*	Each student is required to practice written communication			
*	Students are required to make group presentation			

The following are suggestions for writing assignments
(please place a check mark next to the ones that students are required to do in the course)

*	Summarize the reading or previous lecture in one or two paragraphs	
*	Explain the solution of a problem or text example in one or two paragraphs	
*	Summarize a telephone conversation or other oral communication in one page	
*	Write a single page business letter	
*	Write a project specification in one or two pages	
*	Write a memo in support of a suggestion	
*	Write a memo presenting basic information	
*	Write a memo suggesting and evaluating possible solutions	
*	Write an analysis of competing products/systems/methods	
*	Summarize a technical article	
*	Report on an accepted professional procedure/conduct	
*	Prepare an annotated bibliography on a topic	
*	Do an assignment description/write-up	
*	Write an examination question	
*	Describe some "standard operating procedures" for the novice	
*	Describe a problem solution	
*	Describe a solution methodology used to solve a problem	
*	Write a paper for submission to a publication	
*	Write a letter to the editor presenting some technical fact	
*	Prepare an agenda for a meeting	
*	Write-up minutes for a meeting	
*	Prepare an abstract in response to a "call for papers"	
*	Write a performance evaluation of a co-worker or and employee	
*	Write a professional development plan	
*	Write a progress report for a superior	
*	Edit/review/referee/analyze/annotate someone else's written work	
*	Write a technical report	

4.4	**Read and Listen Openly and Critically**			
*	Students are taught active listening skills			
*	Students are tested on their listening skills			
*	Students are taught how to read a journal article, textbook, etc.			
4.5	**Appreciate that the medium is as important as the message**			
*	Students are taught about the importance of communication			
*	Students are held to the high standards of professional communication			
*	Students are severely penalized for poor writing skills			
*	Students are given examples of good communication (such as a well written lab book)			

Appendix E: Alumni Survey Form

Rose-Hulman Survey of 1998 Mechanical Engineering Graduates

1. Have you received an additional degree(s) since you graduated from RHIT? Yes No

   If yes, in what field(s)? _____

2. Do you have supervisory responsibilities? Yes No

   If yes, how many people do you supervise?_____

3. How many different job titles have you had since graduation? _____

4. How many different companies have you worked for since graduation?_____

The following list of attributes is from the Mechanical Engineering Department goals.

For each attribute, please use the scale provided and check the box to indicate:

- **A. how important the attribute is to your <u>current position</u>**
- **B. how well your Rose-Hulman education contributed to your development of the attribute.**

Written comments to items 5-14 may be made under item 17 below.

	A. How important is this attribute in your current position? (1=Unimportant, 2=Somewhat, 3=Moderately, 4=Important, 5=Very important)					B. How well was thi attribute develope at RHIT? (1=Not well, 2=Barely, 3=Moderately, 4=Well, 5=Very well)				
	1	2	3	4	5	1	2	3	4	5
5. Formulate a problem, no matter how vaguely posed, in a format that allows an appropriate solution to be found										
6. Identify the basic principles and concepts which are involved in the solution of a problem										
7. Identify and abstract the important features of the problem and construct workable models by making appropriate approximations										
8. Select and apply the best tools to effect an appropriate solution										
9. Evaluate the solutions and interpret results										
10. Design effectively										
11. Continue to learn and educate themselves										
12. Communicate effectively										
13. Work responsibly. That is, make ethical decisions and be accountable for the outcomes of these decisions										
14.Work effectively. This includes: teamwork, planning, setting priorities, and considering societal and global constraints										

15. What suggestions do you have that would improve your Rose-Hulman education?

16. What aspects of your Rose-Hulman education were the most meaningful to you?

17. Please provide written comments to items #5-14 below (use the back, if necessary).