Rose-Hulman Institute of Technology
Foundation Coalition of the National Science Foundation
Five Year Summative Report
1993 – 1998

I. INTRODUCTION

A. Charge and purpose of RHIT A/E with FC activities

The RHIT A&E activities over the past five years have focussed on continued assessment of the first and second year curricula. This included the gathering of baseline data from all incoming, first-year students and post-testing of sophomore and senior students in each of the cohort groups. In addition to these efforts, the local A&E team interfaced with faculty who were writing proposals for FC funding of upper division curriculum projects. The results of the assessment efforts on the first and second year curricula were reported to the team leaders. In addition to the program assessment, the local A&E team worked on bringing assessment resources to campus and embedding assessment in the Institute culture.

B. Summary of Five Year Activities

The table in appendix VI illustrates the tasks that were completed by the local A&E team over the past five years. However, the table below illustrates the assessment activities for the past year. The use of a matched comparison group for each cohort in post-testing has continued. During the past two years we also expanded our testing to include a random sample of cohort students who were not in the FC or matched comparison group. Efforts were also begun to get more faculty engaged in the assessment process by having a seminar on portfolio development. Additional seminars are being planned during the 1998-99 academic year.

	Fall 1997	Winter 1997	Spring 1998
Baseline Data – First Year Students			
Sophomore Post-Testing			
Senior Post-Testing			
Focus Group Reports			
IFYCSEM Assm't			
Sophomore Assm't			
Metaevaluation			
In-Service			
Prototype RosE-			

Portfolio			

C. Report Description

The five year report will be presented in relation to each of the thrusts: integrated curriculum, cooperative learning, and technology-enabled education. The first section contains information on the longitudinal assessment of **curriculum integration.** The Integrated First Year Curriculum in Science, Engineering and Mathematics (IFYCSEM) information reported includes: demographics (gender and race), retention, grade point average, Mechanics Baseline, Force Concept Inventory, and post-test information on IFYCSEM. Information from spring 1996 and 1997 focus groups of IFYCSEM students is also reported. The Sophomore Engineering Curriculum Program (SEC) assessment results will include testing results, focus group information, and SEC questions on the senior survey. The results of the senior survey will also be reported on the questions relating to curriculum integration. The assessment of **cooperative learning** will be the focus of section two of the results. This section will include focus group analysis by comparison groups, SEC course evaluations, and senior survey responses for both IFYCSEM and SEC students. The section on **technology-enabled learning** will focus on the responses of students finishing the IFYCSEM, senior surveys, and faculty survey results. Section IV of the report will focus on general assessment activities. A brief report will be given on the in-service session on portfolios and the results of the prototype activities of the RosE-Portfolio project.

II. CURRICULUM INTEGRATION

A. Integrated Freshmen Year Curriculum in Science, Engineering and Math (IFYCSEM):

Rose-Hulman's Integrated First Year Curriculum in Science, Engineering, and Mathematics (IFYCSEM), has been implemented since the1990-1991 academic year. The RHIT integrated curriculum became the model for the other institutions in the Foundation Coalition. The curriculum assessment process has taken place since the first year of implementation. The program is based on the concept that there are common themes, ideas and concepts that are applied in science and engineering, as well as common mathematical, logic and analytical techniques that are needed to solve problems. By melding ideas and laboratory data from a range of disciplines with problem solving tools, students learn that the boundaries of chemistry, physics, mathematics and the engineering disciplines are seamless interfaces which are becoming less distinct.

Retention and Grade Point Average:

This analysis was performed to investigate if there were any statistically, significant differences in the mean grade point averages (GPAs) for the students who had completed the IFYCSEM program (IFYCSEM "Completers") and the students who had been chosen at the end of the freshman year based on several matching criteria (Matched Comparison

Group)[1]. In an effort to reduce variation while making these comparisons, only those students who had experienced a "similar learning environment" were included in this study. For cohorts 1990 through 1994, since the majority of the students graduated in four years, the comparisons were made only for the students who went through the 12-regular quarters sequence (Fall, Winter and Spring). The comparisons began in the Fall Quarter of the Second Year (SO1). The final cumulative grade point averages (CGPAs) were also tested in an attempt to detect any statistically, significant differences in the overall grade performance between the groups at the time of graduation. For cohorts 1995 through 1996, the same approach applied with the most recent CGPAs (Spring Quarter of 1998) tested. The cohorts under study include 1990 through 1996. Female students are included in the study since Fall Quarter of 1995 (Cohort 1995) when Rose-Hulman officially became a co-educational institution.

Test results for Cohorts 1990 through 1992, under the control of the "learning environment," indicate that IFYCSEM "Completers" had higher grade point averages than the Matched Comparison Group in at least 4 or more quarters, as well as the overall grade performance upon graduation. The graduation and retention rates were also noticeably higher for the IFYCSEM "Completers" in Cohorts 1990 through 1994.

However, the same pattern did not persist in terms of the grade performance comparison for Cohorts 1993 through Cohorts 1996. Only a few quarters (2 to none) showed any statistically significant differences in the mean GPAs for these two groups, and none of the most recent CGPAs were tested as being significantly different. In terms of retention comparison among male and female students in the two groups, the pattern was not the same for Cohorts 1995 and 1996. For Cohort 1995, the retention rate (as of Fall 1998) of the female IFYCSEM "Completers" is the same as the male Matched Comparison Group (87.5%), which is higher than the female Matched Comparison Group (85.7%). The lowest (82.6%) is the male IFYCSEM "Completers." For Cohort 1996, the retention rate of the female Matched Comparison Group is the highest (100%). It follows by the male IFYCSEM "Completers (95.6%)," which is higher than the male Matched Comparison Group (90%). The lowest is the female IFYCSEM "Completers (84.2%)."

In summary, it appears that if student grade point averages are observed on a cumulative basis the 1993 through 1996 IFYCSEM cohorts do not appear to differ from other students who do not complete the IFYCSEM program. However, if grade point averages and retention are observed on a quarterly basis, data for the past years show that IFYCSEM students do better at the sophomore level than matched comparison and traditional groups. Since students are more apt to leave college or a university during their sophomore year, it is worth noting that this crucial point in a student's academic career has proven to be positively influenced by completion of the IFYCSEM program.

The full report of student retention and grade point average prepared by Timothy Chow is located in Appendix I.

[1] A description of rationale for choosing comparison groups can be found in Appendix VI.

Testing and Surveys of FC Freshmen Students:

Rose-Hulman Institute of Technology's Integrated First Year Curriculum in Science, Engineering, and Mathematics (IFYCSEM) is assessed at the end of the freshmen year for those students who have completed the curriculum. A matched comparison group is not selected until the freshmen cohort completes the first year. Post-test data are collected on Force Concepts Inventory and Mechanics Baseline Test as well as attitudinal information gained through a Sophomore Survey. This same information is collected on a matched comparison group to evaluate students' experiences in their freshmen year (FC and Non-FC).

Overall, the Foundation Coalition (FC) has received a positive evaluation from the IFYCSEM completers over the years. More specifically, of the 1997 IFYCSEM cohort, eleven of the seventeen items surveyed were endorsed positively by more than 50 percent of the students who completed the IFYCSEM program.

Methodology: During the 1997-98 academic year, there were a total of 95 students enrolled in the IFYCSEM program. Of those students beginning in the Fall of 1997, 84 completed the curriculum in the spring of 1998 and 33 students participated in the end of the year survey (FC Exit Survey) given in the spring of 1998. (See Table 1, Appendix III)

Students responded to seventeen survey items on a five point scale: 1=Strongly Disagree, 2=Disagree, 3 Neutral, 4=Agree, and 5=Strongly Agree. For the purpose of this summary, the responses of disagree and strongly disagree were collapsed into one response, and likewise for the responses of agree and strongly agree.

Results: The FC survey sample consisted of 88 percent White (non-Hispanic), six percent Asian, three percent Pacific Islander, and three percent American Indian/Alaskan Native students. Of the 33 students, 70 percent were male, 27 percent were female, and three percent did not indicate their gender. A majority of these students (85%) reported high school grade point averages between 3.51 and 4.00. During the time of enrollment in the FC curriculum, 36.4 percent of the students reported studying between 0-10 hours, 36.3 percent of the students reported studying between 11-20 hours, and 27.3 percent of the students reported studying 21 or more hours per week. Also, 67 percent of the students reported working 10 or fewer hours, and 30 percent reported working 11-20 hours per week during their enrollment in the FC curriculum.

In regard to gender differences, significant differences were found between male and female students with the amount of time spent studying while enrolled in the FC curriculum with women reporting studying more hours per week than men. The time spent studying was divided into 7 categories: 1) 0-5 hrs, 2) 6-10 hrs, 3) 11-15 hrs, 4) 16-20 hrs, 5) 21-25 hrs, 6) 26-30 hrs, and 7) more than 30 hrs per week. A mean of 4.67 for women refers to the response number 4 which refers to 16-20 hours per week.

During the time you were enrolled in the IFYCSEM curriculum, how many hours per week did you study?	Mean		Std. Dev.	
	Female	Male	Female	Male
	4.67	3.17	1.5	1.97

In response to future plans as RHIT students, 52 percent of the students intended to remain at RHIT as an engineering student in the FC curriculum, 33 percent planned to remain at RHIT as an engineering student but not in the FC curriculum, and 12 percent intended to remain at RHIT in a different degree program.

Overall, the students reported that the FC program was a positive learning experience (60%=agree and 15.15%=neutral). Additionally, working in teams was reported to be a favorable experience for the students (63.64%=agree). Students reported receiving encouragement and help from faculty (63.63%=agree) and instructors were available to help with course work (75.76%=agree). Students reported that peers were also very helpful and cooperative (87.88%=agree) and that their confidence and ability to apply their engineering knowledge in problem solving methods increased (48.48%=agree). There was also high agreement regarding the usefulness of computers and other technology in the FC course (78.78%=agree).

Although students recognized that the overall experience of the FC program was positive, more than half the students expressed that the FC course material was too heavy (63.63%=agree and 24.24%=neutral). Forty-two percent of the students reported the course material was presented too fast, and 27.3 percent responded neutrally. There was also a significant difference between women's response to the speed of material being presented with women expressing higher agreement than men that IFYCSEM material was presented too fast.

IFYCSEM course material was presented too fast	Mean		Std. Dev.	
	Female	Male	Female	Male
	3.7	2.9	.95	.87

Dramatic differences between men and women scores have been consistent throughout the years that women have been at Rose-Hulman. For example, Fall 1995 freshmen scores on the Forced Concept Inventory revealed that out of 26 possible correct answers females averaged 11.5 while male students averaged 16.2. Likewise with the Mechanics Baseline Inventory, female freshmen students averaged 8.6 out of 29 possible correct answers and male freshmen students averaged 10.2. Today, female scores continue to lag behind their male counterparts. This information has been provided to the physics department and they are reviewing their curriculum and pedagogy to address areas of weakness.

Senior Survey of IFYCSEM:

A longitudinal view of the FC program was also provided by surveying seniors who were both IFYCSEM and Non-IFYCSEM students. The seniors were selected from both the traditional curriculum and from IFYCSEM participants. There was a comparison group of 35 students who completed the 1994/1995 IFYCSEM program and 26 students who were among the original matched comparison group. This survey examined how the seniors viewed their freshman experience. Interpretation of the results must be made carefully due to the influence of the FC Sophomore Engineering Curriculum (SEC) program. It is not quite clear as to which of the FC programs, or other RHIT related influences, impact any of the differences between the two groups. A summary of the results regarding the four objectives of cooperative learning, curricular integration, life-long learning and use of technology are provided in the individual sections.

Focus Group Summary:

A focus group session with FC freshmen was conducted during the spring of 1996 and 1997 in order to get feedback on how aspects of their first-year experience affected their education at Rose-Hulman. The 1996 focus groups were broken down by gender (see Appendix II). Students in the 1997 focus group session were randomly selected and invited to participate. There were multiple sessions both years.

When asked about their reason for volunteering to be a part of the FC program, students conveyed that the ultimate deciding factor for many of them was information on the future success of students who go through Integrated Curriculum (IC). The students expressed that the differences between IC and the traditional curriculum were that students perceived IC as having a stronger emphasis on group work and collaboration among students and faculty. Students also reported having received team training during the first two weeks of the first two quarters and submitting team evaluation reports periodically. Additionally, students perceived IC as having some "irregularities" not found in the traditional curriculum. These included course subject matter and exposure to IC faculty, which varied from quarter to quarter and was spread throughout the entire year. This contributed to a perception of fluctuations in the degree of difficulty as the year progressed (i.e. overall course work was easier by spring, but grading was perceived to be much tougher).

Eight out of nine students reported being involved in various **co-curricular activities** during their enrollment in IFYCSEM. Students reported that lack of time (i.e. IC workload/group work) was an obstacle to being more involved in extracurricular activities. Despite a desire to have been involved to a greater extent throughout the year, students believed that the "homework first" mentality instilled in them through their participation in IC will benefit them in the long run.

A summary of the focus group responses of 1996 Coed Cohort, 1996 Women-only cohort, and 1995 women-only cohort is located in Appendix II.

Changes in IFYCSEM as a Result of Assessment:

The information in this section of the report is an excerpt from "Five-Year Report on the Integrated, First-Year Curriculum in Science Engineering, and Mathematics" by Jeffrey E. Froyd, Professor of Electrical and Computer Engineering, Rose-Hulman Institute of Technology.

Formative Assessment:

Formative assessment efforts include a student-elected IFYCSEM student council, student evaluation polls at the end of each quarter, and a focus group assessment and end of term surveys.

IFYCSEM Student Council:

After two or three weeks in the Fall Quarter, students in IFYCSEM elect a student council. Typically, 6-9 students serve on the council. Two to three members from each section are elected by students and additional members are selected by faculty so that all students are represented (especially students of average ability). The student council meets every two weeks on Wednesday afternoon with faculty members to discuss ways in which IFYCSEM operations can be improved. A new student council is elected at the beginning of each quarter to allow students to select new representatives.

Through the student council, faculty can listen to student concerns and suggestions for improvements. Student suggestions which faculty have implemented over the years include the following.

1. Homework should generally be due at least two days after it is assigned. This provides an opportunity to review the assignment and meet with a faculty member if they anticipate having trouble with the assignment.

2. Students indicated that action was needed to make sure the physics laboratory experiments were working on the first scheduled physics laboratory. Action was taken and the laboratory experiences improved.

3. Students indicated the need for the faculty to maintain a document showing the due dates and turn-in locations for all assignments. Faculty created and maintained the document.

4. Students indicated the need for a document showing courses in the traditional curriculum for which they would receive credit if they transferred from IFYCSEM at the end of Fall and Winter Quarters. The Curriculum Committee created the requested document.

5. Students recommended a social evening with pizza to meet with the faculty in an informal setting. Informal, social meetings have been held.

Students serving on the council take their appointment seriously. By surveying other students in their residence halls they identify issues which should be presented at the bi-weekly council meeting. These issues serve as the agenda for the meeting and the results of the discussions are reported back to other students.

Based on the data, far more students elected to transfer from IFYCSEM to the traditional curriculum than fail IFYCSEM. Reasons for voluntary transfers are numerous, but the primary issue appears to be relative workload. IFYCSEM students who voluntarily transfer believe they are working much harder than their counterparts in the traditional curriculum and don't believe that additional time required for IFYCSEM is sufficiently balanced by perceived benefits in learning. The relative workload difference has been a challenge for IFYCSEM since the curriculum was offered in 1990-91.

In subsequent years, faculty have faced the workload issue directly and made significant improvements in matching faculty expectations with student capabilities. In the first year, overzealous faculty expected far too much from the students, particularly in the first two weeks. Based on 1990-91 experiences faculty have significantly tempered their expectations, especially early, and increased support for students in the learning environment. For example, faculty now introduce all students to computer hardware and software in over seven hours of instruction in freshman orientation. IFYCSEM faculty offer a gentler, more extended introduction to the computer algebra system which the students will use. IFYCSEM faculty have now moved to a cooperative learning environment with base groups. One reason for the change is that the base groups provide another support mechanism for the students as the make the transition from high school to college. Faculty and students have recognized the improvements, but the relative workload difference is still the biggest single reason for students voluntarily transferring from IFYCSEM.

Competency Matrix Changes in the 1996-97 Academic Year[2]:

Of the changes that occurred as a result of IFYCSEM assessment, changes in the competency matrix have been most prevalent. Student feedback offered during the 1995-96 academic year indicated three areas which required improvement. First, faculty needed to hand out the entire competency matrix near the beginning of the quarter instead of distributing pieces of the matrix throughout the quarter. Students indicated that they were more comfortable when the expectations were clear. Receiving pieces of the competency matrix throughout the quarter muddied expectations as the students perceived being required to learn an increasingly larger body of material. In 1996-97, faculty prepared and distributed almost the entire matrix by the second week of the

[2] Information in this section is an excerpt from "Competency Matrix Assessment for First-Year Curricula in Science, Engineering, and Mathematics and ABET Criteria 2000" courtesy of Dr. Jeffrey E. Froyd Department of Electrical and Computer Engineering, Rose-Hulman Institute of Technology

quarter. Feedback to date indicates that students are more comfortable with this approach.

The second area of improvement was helping students clarify where they stood during the quarter with respect to a letter grade. Although students could keep their matrix current and see areas in which they had demonstrated strength and areas in which further work was necessary, it was difficult for them to understand their position with respect to a letter grade. To address this challenge faculty indicated that if students earned ninety percent or more of the available blocks, they would earn an "A" for the course. If students earned eighty percent or more of the available blocks, they would earn a "B" for the course and so on. Faculty then attempted to keep the on-line matrix current to show which blocks had been made available and the total number of blocks which had been made available. It was difficult for the faculty team to keep the on-line matrix and the available block count current. Further work is required to meet this challenge.

The third challenge was student concern about cheating by falsifying a matrix. Since each student kept his or her own matrix, students expressed concern that one or more students could falsify competency matrices in an attempt to receive a higher grade. To date, faculty on the IFYCSEM team have expressed confidence in the process of each student maintaining his or her own competency matrix accurately. Faculty audits have revealed no documented attempts to falsify the count. Where errors were found, it appeared that students did not correctly implement specified processes for recording competencies.

Several team members have expressed reservations about the processing of translating the data contained in a competency matrix into a single letter grade. Currently, faculty use percentages of available blocks as markers to help assign letter grades. There is some concern, for example, that seventy percent of the available blocks sets the bar too low for earning a "C." One way to explore this question is to examine how well students who complete IFYCSEM perform in subsequent classes. Data is already being accumulated to address this issue. For example, students who completed IFYCSEM in the 1995-96 academic year received in the Fall Quarter of their sophomore year a higher grade point average than a carefully matched comparison group. The process of translating a properly maintained matrix into a letter grade needs to be examined and improved in the future.

B. Sophomore Engineering Program

During the 1995-96 academic year, Rose-Hulman offered a new sophomore engineering curriculum as part of its participation in the National Science Foundation which funded the Foundation Coalition. This section will briefly describe the curriculum and discuss the assessment of the first year of the program.[3] The Rose-Hulman/Foundation-Coalition Sophomore Engineering Curriculum consists of two parallel course streams—applied

[3]For a complete description and discussion of the Foundation Coalition Sophomore Curriculum at Rose-Hulman, see, "A New Sophomore Engineering Curriculum -- The Rose-Hulman Experience, "*Proceedings,ASEE Conference, 1996 Session 1230.*

mathematics and engineering–and integrates material both across and within these streams. This curriculum is required of all electrical and computer engineering majors and is an option for mechanical engineering and civil engineering majors. Assessment served as an important part of the first year program with emphasis on providing information to faculty for improving the effects of the curriculum on student learning and continues to serve in the capacity to date.

A fifteen member team met during the summer of 1995. This team finished the details of the Rose-Hulman/Foundation-Coalition (RH/FC) Sophomore Engineering Curriculum (SEC). The team included faculty from each of the engineering disciplines, mathematics, physics and chemistry. This team also included three students.

Curriculum Goals and Structure

During the third phase of the development process, goals were established for the new curriculum. These are listed in Figure 1. Course goals and objectives that supported the seventeen curriculum goals were developed for each course in the curriculum. The curriculum is organized into two course streams—applied mathematics and engineering science—that are taught in a coordinated fashion. The material in each course stream has been selected and sequenced to enhance student learning by reinforcing and revisiting topics both across and within the two streams. The structure of the curriculum is illustrated in Figure 2.

Assessment

The assessment process for the first year of implementation focused on providing faculty with feedback information on the curriculum, which could be used to improve both course content and delivery. During the Fall quarter, a survey was developed based on input from faculty to be given to students at the end of the quarter and at mid-term of the second quarter. During the third quarter focus groups were held with about 30 percent of all students who were completing the three quarter sequence of courses. At the end of the third quarter, students who were in the curriculum and students taking comparable courses in the traditional curriculum were invited to take a shortened version of the FE exam.

Course Survey

The course survey asked students to respond to items related to their preference for and/or satisfaction with the coordination of courses, course delivery, workload, and computer usage. This survey was given to students who were enrolled in the MA211 and ES201 sequence. As one might expect, responses covered the full range of possible answers. However, there was general agreement among the respondents on specific items. Students generally reported that the connections made between MA211 and ES201 were both clear and helpful to their learning. They also reported a preference for class discussion and small group discussion as helping them to learn over lecture and individual problem solving. The use of computers was seen as beneficial in MA211 and

homework was viewed as enhancing their learning in both courses. A majority of the students did not perceive the workload during the first quarter as being any greater than their classmates who were taking comparable classes. In preparing for class, students reported seeking help primarily from other students or the text.

Students who participate in the RH/FC Sophomore Engineering Curriculum should:

- Develop a strong background in engineering science,
- Develop an understanding of modeling,
- Be able to apply a common problem-solving approach built around the application of conservation and accounting principles and constitutive relations,
- Continue t develop effective communication skills,
- Be proficient in applying standard statistical procedures and quality control concepts,
- Develop a strong background in mathematics,
- Be encouraged to be inquisitive and self-motivated learners,
- Develop an appreciation for engineering as a professinoal and begin to develop an identity as an engineer.
- Be able to work effectively in teams and recognize the importance of individual responsibility in team efforts,
- Be able to apply computer tools appropriately,
- Be comfortable working with ambiguity,
- Be familiar with the overall design process,
- Be able to locate and retrieve both technical and non-technical information,
- Be introduced to safe and effective use of instruments,
- Appreciate the role of creativity in engineering
- Develop a recognition of the benefits of the new curriculum, and
- Be encouraged to have fun learning.

Figure 1 – Curriculum Goals

	Sophomore Year Courses		
	Fall	**Winter**	**Spring**
Applied Mathematics	Applied Mathematics I MA 211	Applied Mathemat-ics II (MA 212)	Applied Mathematics III (MA 213)
Engineering Science		Fluid & Thermal Systems (ES 202)	
	Conservation & Accounting Principles (ES 201)	Electrical Systems (ES 203)	Analysis & Design of Engineering Systems (ES 205)
		Mechanical Systems (ES 204)	

Figure 2 - RH/FC Sophomore Engineering Curriculum

IFYCSEM and SEC Surveyed:

It is necessary to view the responses of SEC students in comparison to those who were or were not a part of the IFYCSEM program. Fifty-five students in the 1996-97 freshmen cohort were sophomores at the time of the Fall 1997 sophomore survey. Of those, 32 were selected from both the traditional sophomore curriculum and 23 were selected from the Sophomore Engineering Curriculum (SEC). A matched comparison group was also surveyed. This matched group consisted of 53 sophomores who had not participated in IFYCSEM. Of those, 10 participated in SEC and 43 had not participated in SEC. Students responded to survey items on a five point scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, and 5=Strongly Agree.

The curriculum integration (FC Pedagogy) objective produced several significant differences. The IFYCSEM students in the SEC agreed more strongly than the Non-IFYCSEM students not in the SEC on the following responses "Faculty emphasize and show how concepts covered in their courses are related to concepts from other mathematics, science, or engineering courses (mean difference = .42)" and " My professors formally monitor and assess my ability to related ideas from mathematics, science or engineering to each other (mean difference = .83)." The IFYCSEM/SEC also rated the latter question higher than the IFYCSEM students not in the SEC (mean difference = .53). Within this objective those students not in the IFYCSEM program but in the SEC rated all three curriculum objectives with more agreement than those students who were not in either IFYCSEM or SEC.

Student views regarding the curricular integration objective, revealed that the students who were not in either the IFYCSEM or the SEC programs agreed to a greater degree that "Bringing in topics to a math, science or engineering class from other classes should be avoided (mean difference = .36)."

In summary, the data show that students who were in both IFYCSEM and SEC responded in stronger agreement regarding curriculum integration and the ability to relate ideas from mathematics, science, and engineering. Students who completed at least one of the FC curricula programs (IFYCSEM or SEC) were also more likely than students who did not complete either of the FC programs to respond in agreement regarding curriculum integration.

Since the inception of the SEC, continuous assessment and evaluation have resulted in the improvement of the program. The SEC faculty is committed to the value of the assessment process by providing valuable information for curriculum improvement. Although the assessment is generally performed through the Office of Institutional Research and Assessment, the faculty are involved in the decisions regarding the content of the assessment process and the evaluation of assessment results.

Changes in SEC as a Result of Assessment

SEC Year 1 – (1995-96 Academic Year):

During the first year of the SEC program (1995-96) a mid-term survey was provided to students to receive immediate feedback. The SEC faculty sponsored bi-weekly meetings with the SEC student council to receive feedback on a consistent basis. At the end of the first year the students were surveyed and focus groups provided end-of-year feedback as well.

During the summer of 1996, the faculty team looked at the assessment results from the first year to assist in continued improvement of the curriculum. As a result of the assessment information there were several curriculum changes.

- There were changes in the format of the winter quarter labs which included an adjustment in the student workload.
- The faculty changed the ES204 textbook as a result of student responses to curriculum materials.
- Student Fall quarter workload was equalized with the Winter quarter workload.

SEC Year 2 – (1996-97 Academic Year):

The following year (1996-97), the SEC faculty discontinued the student council, but continued to administer the end-of-year survey to the students. The data were analyzed, and the math curriculum was re-sequenced for the spring quarter of the program. The advantage to this curriculum change was that it provided students with a more realistic and effective process of building on mathematical and statistical-related skills. As a result of the effectiveness of this curriculum sequence, the math department has adopted this as the standard math curriculum sequence.

Sample EIT/FE Exam:

In order to collect comparison data on students' abilities to solve fundamental engineering problems it was decided to create a "mini" EIT/FE trial exam. The test was developed from a sample EIT exam. The number of items was reduced to allow students to complete the exam in a two hour period. Faculty who were NOT teaching in the SEC were asked to select items from the exam in the chosen areas. The items were not screened by the SEC faculty. The test was given on a "volunteer" basis and students were paid a stipend for their participation. All students completing the three quarter SEC sequence and all other engineering students currently enrolled in a fluids class were invited to participate. A total of 51 students actually took the test—23 from the SEC and 28 Non-SEC students. Of these students, 38 were sophomores (20 SEC and 18 Non-SEC). The results of the EIT/FE trial exam were inconclusive of how SEC impacted student performance.

SEC Year 3—(1997-98 Academic Year):

During the 1997-98 academic year there were no significant changes as a result of assessed data. However, the SEC faculty reviewed the curriculum separate from assessment analysis and changed the ES203 math textbook.

Plans to revise the assessment strategy and sophomore surveys continue to be an agenda item for the SEC faculty and local Foundation Coalition management team. Currently, there are plans to track and assess achievement of those students who completed the first year of the SEC curriculum and have graduated from Rose by surveying the faculty to capture the attitudes and perceived impact of SEC.

The SEC faculty reports a commitment to the value of the assessment process as providing valuable information for curriculum improvement. Although the assessment is generally performed through the Office of Institutional Research and Assessment, the faculty is involved in the decisions regarding the content of the assessment process and the evaluation of assessment results.

Further Observations of SEC:

In an effort to further observe SEC and the impact of the changes, there was a comparison of the SEC survey completed by seniors who were in the first SEC program and the sophomores who completed the SEC program spring 1998. The purpose of this comparison was to see if the 1998 senior responses from their experience in SEC during the 1995-96 academic year differed from the 1997-98 sophomore responses regarding their experience in SEC (see Appendix IV). Although the data do not provide explanations for any differences that may have occurred, generally, seniors (1995-96 SEC students) responded more positively toward team training in SEC courses as well as teaming and group work helping them to learn than did sophomores currently in SEC. However, in the area of SEC courses being fun and enjoyable, 1998 seniors (75%) responded in more disagreement than 1998 sophomores (47%). Overall, 1998 senior responses were similar to 1998 sophomore responses in all other areas.

C. Upper Division:

During the summer of 1996, 1997, and 1998 there were several projects funded by the Foundation Coalition for upper division course development. Although several proposals indicated some form of assessment the A&E team was not involved in the project assessment process and no data, changes, or improvements have been reported to include in this summary report. Therefore, a chart summary of projects that were funded by the local FC is provided in Appendix V.

III. COOPERATIVE LEARNING

A. Integrated First Year Curriculum in Science, Engineering and Mathematics:

Sophomore Survey: This section provides a summary of the differences in student responses regarding IFYCSEM and who were in the 1996/1997 freshmen class and were sophomores at the time of this survey. The following responses are from the same SEC and traditional matched comparison groups identified in the previous sections regarding the SEC. Each student rated each response on a five point scale with 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree. All results will be reported at the .05 significance level.

Overall, the students in the IFYCSEM curriculum reported more positive responses on the cooperative learning objective. IFYCSEM and matched group comparison results revealed significant differences regarding curriculum integration. However, the differences are complicated by the exposure to the Sophomore Engineering Curriculum. One significant difference resulted between the two groups within the life-long learning objective. IFYCSEM students expressed higher agreement with the statement "I seek out activities related to my future profession" (mean difference = .33). A significant difference regarding the use of technology objective is also more difficult to interpret because of the influences of the Sophomore Engineering Curriculum, with the differences only seen within the FC pedagogy objective. (Appendix IV)

Items within the cooperative learning (FC Pedagogy) section of the survey were consistently rated higher for the sophomores who participated in the IFYCSEM program than those students who had not participated in the IFYCSEM program. IFYCSEM students stated they had received formal instruction (mean difference = .90), were regularly assigned to groups (mean difference = .50), and were formally monitored and assessed in team work skills to a greater degree than the Non-IFYCSEM students (mean difference = .53).

Gender differences were also observed. Male students who participated in the IFYCSEM program stated they received more formal instruction on basic team skills than both men (mean difference = .5) and women (mean difference = 1.02) in the Non-IFYCSEM group. Men in the IFYCSEM group also reported being assigned to groups on a regular basis more so than men in the Non-IFYCSEM group (mean difference = .50). Also, men and women in the IFYCSEM group reported more agreement than the Non-IFYCSEM women that working in teams helped them better understand the material presented in class (mean difference = .62 to .76).

In summary, IFYCSEM students reported having experienced more team training, formal instruction, assignment to groups, and more likely to seek out activities related to their profession than Non-IFYCSEM students. In light of gender differences, male students who participated in IFYCSEM were more likely to convey that working in teams helped them better understand class materials than Non-IFYCSEM and Non-SEC students.

B. Sophomore Engineering Curriculum (SEC):

The cooperative learning objective was assessed regarding FC pedagogy, student views, and student enhancements. Each student rated each response on a five point scale with 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree. All results were reported at the .05 significance level.

Within the Cooperative Learning (FC Pedagogy) objective, students who were in both the IFYCSEM and the SEC agreed to a stronger degree than those students who were not in either IFYCSEM or SEC for the responses "I have received formal instruction on basic team skills (mean difference =.94)," " I have been assigned to work in groups on a regular basis (mean difference = .54)," and "My professors formally monitor and assess my skills in team work (mean difference = .62)." The IFYCSEM and SEC students also had higher agreement than non-IFCYSEM students who were in the SEC on the following responses "I have been assigned to work in groups on a regular basis (mean difference = .58)" and "My professors formally monitor and assess my skills in team work (mean difference = .80)."

For the Cooperative Learning (Student Views and Enhancement) objective, the IFYCSEM students in the SEC rated the following responses higher than the Non-IFYCSEM students in the SEC: "Working in assigned teams with classmates helps me understand material presented in class (mean difference = .82)" and "Courses (at campus/year in program) have helped me learn how to apply knowledge from a variety of diverse disciplines when solving problems (mean difference = .43)."

Although this section provides extensive data analysis on survey responses from the most recent year, the results are representative of the past five years. In the case of gender difference, these differences have existed since the enrollment of female students at Rose-Hulman in 1995. Generally, students who complete FC curricula have consistently responded in greater agreement than Non-FC students regarding the amount of work assigned in teams, applying knowledge from a variety of diverse disciplines, and being formally assessed by faculty regarding their ability to work in teams.

Senior Survey of IFYCSEM and SEC**:**

The focus of this section of the report is on the students who were in the 1994/1995 freshman class and were seniors at the time of this survey which was conducted in year five. The seniors were selected from both the traditional curriculum and the IFYCSEM program. This study compared 35 students who completed the 1994/1995 IFYCSEM program, of those, 11 completed SEC and 24 had not participated in SEC. There were also 26 students who were chosen as a matched comparison, and of those, four had completed SEC and 22 had not participated in SEC. Information gained from this survey looked at how the seniors viewed their freshman experience. Each student rated each response on a five point scale with 1=strongly disagree, 2=disagree, 3=neutral, 4=agree and 5=strongly agree. All results were reported at the .05 significance level.

Overall, the students in the IFYCSEM curriculum did not significantly differ in their responses to the four FC objectives surveyed. Any differences that did occur were complicated by the influence of the Sophomore Engineering Curriculum (SEC).

Significant differences were found in regard to the question "I seek out activities related to my future profession." The IFYCSEM group who had participated in the SEC rated this question significantly higher (mean difference = .80) than those who were in the IFYCSEM group but had not participated in the SEC. They also rated this question higher (mean difference = 1.30) than those who were not in the IFYCSEM but who were in the SEC.

Other significant differences were found on the question "I have received formal instruction on basic team skills." The Non-IFYCSEM students who were involved in the SEC reported higher agreement than IFYCSEM students regardless of IFYCSEM students' participation in SEC (mean difference = .96). Additionally, those students who were not involved in either SEC or IFYCSEM also rated this question significantly higher than those students who completed IFYCSEM but were not in the SEC program (mean difference = .59).

In regard to the question "I have been assigned activities which require me to relate ideas from mathematics, science or engineering to each other," Non-IFYCSEM students who were not involved in the SEC rated this question higher than the IFYCSEM students who were not involved in the SEC (mean difference = .55).

In summary, FC students (IFYCSEM and/or SEC) report receiving a higher degree of teaming skills and activities which require integration of ideas from mathematics, science, or engineering. More specifically, students who complete the SEC program are more likely than any other group to report the ability to integrate ideas from multiple disciplines.

III. TECHNOLOGY-ENABLED LEARNING:

The use of technology and its impact on learning had a variety of responses. Students in the focus groups (IFYCSEM completers) reported that they felt there was importance in technology-enabled learning but also expressed concern that students were becoming too dependent on the technology. Students reported great benefits regarding the use of technology in IC: using Maple to solve extremely difficult or time consuming math problems; word processors for producing group reports; and the graphics in Excel for the creation of more impressive lab reports. Despite their enthusiasm for the utility of the technology available in IC, students disagree with the value of Maple as a learning tool. Some expressed the opinion that Maple gets in the way of learning the math behind the problem solving, while others believed that learning to apply the concepts is more valuable than "doing the math."

As indicated by the FC exit surveys, sophomore surveys, and senior surveys, students conveyed that students who had experience with technology-enabled learning would have an edge over students who did not. There was also high agreement regarding the usefulness of computers and other technology in the FC course (78.78% = agree). Students also reported increased confidence and ability in applying their knowledge in future courses.

The sophomore survey revealed differences in responses by gender. IFYCSEM men agreed more so than Non-IFYCSEM men that computer technology is an aid in understanding class material. IFYCSEM men rated higher than both Non-IFYCSEM men and women in their perception of whether they received formal instruction in computer technology. Non-IFYCSEM women and Non-IFYCSEM men also differed in receiving formal instruction in computer technology, with women in stronger agreement. IFYCSEM men also endorsed more agreement than Non-IFYCSEM men that faculty expected regular use of computer technology for course-work. (See Appendix IV for complete results)

IV. GENERAL ASSESSMENT PROCESSES

A. Faculty/Staff In-service

In the winter quarter, the local management team supported the visit of Barbara Olds, Colorado School of Mines, to give a seminar on the use of portfolios. This session was very well attended and received. While on campus, Dr. Olds also met with the Commission on Assessment of Student Outcomes (CASO) to review their work on the development of the RosE-Portfolio.

Prototype of RosE-Portfolio

CASO's development of the RosE-Portfolio as a technique for documenting and assessing Institutional student learning outcomes was supported through paying sophomore students to participate in the RosE-Portfolio prototype project that was held in the Spring of 1998. Thirty sophomore students were paid $100 each to participate in the testing of the electronic portfolio system and participate in its assessment. Each student was given ten weeks to select and deposit materials that they felt demonstrated their progress toward achieving student outcomes. After that period they participated in focus groups and questionnaires to assess their experience with the system. This process resulted in many improvements in the system that were implemented during the summer. This fall, all first-year students are participating in the RosE-Portfolio project. It is hoped that the RosE-Portfolio system will be the centerpiece of the engineering departments in meeting the requirements of *EC2000*, Criterion 3. There have been an overwhelming number of national inquiries into the exportability of the system. We are currently negotiating with a software development company to package and market the RosE-Portfolio.

V. CONTINUOUS IMPROVEMENT

A. Effectiveness of Assessment Tools/Methods

As we approached year five assessment activities, we performed an analysis of the effectiveness of the previous years' assessment instruments in providing useful data for evaluation and improvement efforts. In the context of that analysis decisions were made to discontinue the use of the Learning Environment Preferences test, the California Critical Thinking Appraisal, and the California Critical Thinking Dispositions tests. These decisions were based on the fact that the data did not discriminate among groups of students over time. Perhaps, even more important than the tools themselves, the most critical piece of the assessment for continuous improvement piece is the dissemination of findings. As the meta-evaluation report pointed out, there needs a mechanism in place that assures that assessment reports will be used and disseminated more broadly than what is currently taking place. It was not uncommon to find that assessment reports were given to team leaders only to have them "die" on their desk. Because there were no regular campus-based FC management team meetings, there was no forum for dissemination and exchange of assessment data that could be used in a meaningful way for decision making.

B. Lessons Learned

The most important lesson learned by the local A&E team is the need to be more aggressive in the marketing of assessment and the dissemination of assessment results and engaging faculty in the evaluation and recommendations efforts. Most reporting has been done informally without significant follow-up to encourage the critical review of the findings.

In the absence of A&E being involved in local management activities, there was often no way of knowing what FC programs were being funded and where there were assessment needs. The A&E team is committed to promoting the need of embedding the assessment process into the curriculum in such a way that faculty have ownership of the process and the results are credible. This is important to maintaining a continuous improvement loop for assessment. The feedback loop can only be effectively closed if the local management system, as a whole, is maintained.

C. Future Endeavors

The 1998-99 activity will focus on the year 6-10 strategic goals of the Coalition. Attempts will be made to engage the faculty in meaningful assessment processes and evaluation of outcomes. The A&E representative will also become engaged with the local FC management team in strategic planning for coalition activities. This will help to ensure that FC projects will have an appropriate assessment component that can be used for continually improving FC and RHIT processes.

The A&E team will press to develop a local evaluation team made up of faculty and key administrators. This group will be charged with the responsibility to evaluate the data and answer the "so what?" questions. They will also be responsible for making recommendations for improvement to the FC local management teams.