The following Program and Learning Outcomes and Assessment are guidelines for both MS and PhD students of the Department of Chemical Engineering. Since the PhD program is administered by the College of Engineering (COE), specific Outcomes that the CHE Department desires to articulate are listed here for the PhD. These, however, are in compliance with all COE guidelines.

I- Program Outcomes:

a- Develop and maintain a competitive graduate student body in the range of 3-4 graduate students per faculty member with more than half of them pursuing a PhD.

b- Maintain a diverse graduate student body consisting of domestic and foreign students including minorities and individuals of underrepresented groups.

c- Provide a rigorous, interdisciplinary, and current training through both course work and research projects in relevant areas of modern chemical engineering.

d- Provide a meaningful environment for student growth in cultural, professional and academic aspects including opportunities to develop as a future faculty member in an academic department.

e- Demonstrate faculty scholarship through peer-reviewed/archival publications, externally sponsored projects and presentation in national and international scientific meetings.

f- The average MS student is expected to graduate within two years, i.e. complete a Fall, a Spring, a Summer, a Fall and a Spring term, then graduate.

II- Learning Outcomes:

a- All students must demonstrate knowledge and proficiency in the method of scientific inquiry.

b- All students must demonstrate proficiency on the fundamentals of transport phenomena (including fluid dynamics), chemical thermodynamics, kinetics, and applied and computational mathematics. The PhD students, in addition, must show proficiency in advanced methods related to these topics.

c- All students must show knowledge and applied proficiency of ethics in research approaches.

d- All students must show knowledge of current and relevant areas of research and must demonstrate a commitment to the process of life-long-learning.

e- All MS students are expected to have submitted, at the time of thesis defense, at least one article based on his/her thesis project for submission to a peer-reviewed journal. PhD students are expected to have submitted at least two articles. Program of studies must reflect these expectations properly. All students are expected to present at international/national scientific meetings and each advisor to act as a mentor in this effort.

III- Assessment of Program Outcomes:

a- Develop a competitive student body.
   a.1. Efforts to attract qualified domestic and international students will be documented for further improvement
SACS Graduate Program:

- Develop a diverse student body.
  The diversity and student body demographic will be monitored.

- Provide rigor throughout the course offerings.
  Yearly review of the graduate program course of study, offerings and course content will be used to monitor and continuously improve the rigor and relevance of the programs’ formal course-related aspects.

- Provide a meaningful environment for student growth.
  a. Activities such as mentored classroom and laboratory teaching, participation in national/international meetings with presentations and the Chemical Engineering Graduate Research Association (CEGRA) seminars (both Departmental and student organized) will be monitored by the graduate committee for further improvement and feedback.
  b. A graduate student database will also be used to track the post graduate careers of students in an effort to demonstrate that our graduates are engaged as well-balanced professionals in the field. An interactive element of this database will be used to solicit feedback from our graduates regarding this Learning Objective.

- Demonstrated faculty scholarship.
  The Annual Report Highlights will reflect number of publications, presentations (both invited and by contribution), research dollars, and any other faculty and student accomplishments during each academic year. Data collected will be assessed by the graduate committee and faculty for further improvement.

- Duration to completion of the MS degree.
  The time to complete the MS degree will be monitored and corrective actions taken to maintain an average of two years to completion.

IV- Assessment of Learning Outcomes:

- Proficiency in the method of scientific inquiry.
  Student proficiency in the process of scientific inquiry will be assessed by the MS research committee through review of the written MS thesis and oral MS thesis defense. Proficiency in the process of inquiry will be assessed by considering elements of the student’s research including the ability to: identify and define a research topic through proposal; articulate the relationship between prior research in the field and the proposed research; design and conduct some form of laboratory or computational experiment; analyze the data from either a laboratory or computational experiment; and articulate the findings in both written and oral forms. Written feedback by the academic committee and advisor are suggested and will form part of the student monitoring for progress. MS students, being at a transitional point between the BS and either professional careers or the PhD, are expected to require considerable mentoring and guidance. Assessment, however, will emphasize the student’s level of maturity as a researcher and development towards independent creative thought. PhD students are expected to be largely independent when entering the program of study and must make a unique independent contribution to their chosen area of research. PhD students will be assessed further (in topics related to research methods) by following the guidelines written by the College Graduate Committee during the various steps required for successful completion of the program of studies. Each student graduate committee may select additional tools for the assessment of student performance in the various aspects included in the student program of studies.

- Proficiency on fundamentals.
Proficiency on fundamentals will be assessed throughout the different graduate level courses and guided studies performed by the graduate student in addition to the presentations given by the student. A periodic “internal presentation” schedule is suggested for all the graduate students for practice and feedback purposes from faculty and students. Proficiency in course work will also be assessed using one or more of the following tools: examinations; projects; written reports; and oral presentations. These will generally be evaluated by the responsible instructor, but may be assessed by a panel chosen by the instructor. The program of study must include course work or, alternatively, guided studies on specialized topics related to the student’s areas of research.

c- Understanding of ethics in research and engineering.
   This is achieved by taking an advanced research seminar of 1 credit hour.

d- Knowledge of current topics in CHE and commitment to life-long-learning.
   This may be achieved by attending a reasonable percentage of presentations in the research seminar series of the CHE Department. The program of studies must reflect this item properly. In addition, students will be encouraged to periodically organize informal “student seminars.” Attendance at the Research Seminars will be monitored by the Graduate Seminar Coordinator and the report will be part of the student file for the student academic committee assessment during every semi-annual report. A standardized form is suggested to be developed for feedback purposes. The CEGRA may coordinate the internal seminars with the guidance of the graduate committee.

e- Publication.
   The MS and PhD degrees will not be granted unless students have met these learning outcomes.

V.- Assessment Results and Implementation for Program Outcomes

a- Develop a competitive student body.
   a.1. A graduate studies poster was sent to 59 domestic universities with Chemical Engineering B.S. programs and 57 Civil and Environmental Engineering B.S. programs. Similar information was sent to five major Chinese universities and posted via the web site <http://www.cmsce.zju.edu.cn/chinese/>. Prior to 2003, the ratio of PhD to MS students has been virtually zero. Recent efforts to attract PhD students has increased the ratio to 1 PhD to every 4 MS students. While this is good progress, we hope to have a 1-to-1 ratio within the next five years.
   a.2. Since 2003, the Department has been actively creating a research culture among its undergraduate students. This has resulted in attracting seven of our top students to the CHE MS program. To further this success, in 2004/2005, personalized letters were sent to all TTU Chemical Engineering seniors with at least a 3.0 GPA inviting them to consider graduate studies at TTU. In addition, personalized letters were sent to all TTU ChE juniors with an overview of the BS-MS Fast Track program offered. At this time, two students have chosen the BS-MS Fast Track option. In addition, the Distinction in the Major (DITM) program was implemented in 2004. This unique program engages top CHE students in research leading to an undergraduate thesis in hopes of encouraging these students to pursue graduate studies at TTU or elsewhere. So far, four students have graduated with the CHE Distinction in the Major.
   a.3. Progress of each graduate student has previously been monitored by individual faculty advisors. Procedures and report formats to effectively accomplish this assessment are currently being developed. Report formats for this assessment are being developed and will be implemented during the 2005-06 academic term.

b- Item (a.1) above describes efforts to recruit both domestic and foreign students. In addition, in 2004-05, the Department has worked closely with the Office of Graduate Studies and has admitted two minority students with funding through the Geier Fellowship program.

c- A formal process for review of the CHE graduate course offerings is being developed. By the end of the 2005-06 academic term, a process will be in place for the review of course content for each MS core course. A similar review process for electives will also follow.
d. Provide a meaningful environment for student growth.

d.1. In 2003, the CHE graduate student body created the Chemical Engineering Graduate Research Association (CEGRA). This student run organization cares for the needs of the CHE graduate students, organizes events and provides feedback to the CHE faculty concerning the graduate program. The CEGRA also organizes a yearly graduate student get-together. Since November of 2003 the CHE Department has been organizing the TTU CHE Seminar Series. Thus far 27 speakers have participated with 19 of these being invited from off campus. This important activity dramatically improves the academic environment and provides a way for the Department to showcase our students, faculty and research infrastructure to visitors from outside. Visitors present a seminar, meet with both the graduate and undergraduate students and interview with the faculty.

d.2. An on-line graduate student database is currently being designed and will come on line by mid 2006.

e. Faculty scholarship.

Faculty scholarship is summarized in the CHE Annual Report on-line.

f. Duration to completion of the MS degree.

The five-year average duration to completion of the MS degree is 2 ½ years.

VI. - Assessment Results and Implementation for Learning Outcomes

a. Proficiency in the method of scientific inquiry.

Program outcome (a.3) outlines a formal written assessment of student progress. This assessment will include elements of scientific inquiry. At this time, the student thesis is reviewed and the defense is heard by the thesis committee. The committee then signs a form stating that the student has passed the defense, with minimal notes regarding the student’s performance typically written on the reverse side in free form. This procedure will be further developed to provide a more useful form of feedback and record of performance.

b. Proficiency on fundamentals.

Proficiency on fundamentals is primarily assessed by the individual course instructor. Most MS-level graduate courses require written examinations, written projects and oral project reports and so a reasonable spectrum of assessment modalities are currently used. In the past five years there were 10 recorded grades of C for CHE core required courses and no students with a grade below C. This statistic will continue to be monitored and remediation of students who are scoring below B will be implemented as necessary.

c. Understanding of ethics in research and engineering.

All MS students are required to take CHE 6920, MS Seminar. This course covers ethics and has an ethics element as part of a project. Student performance on these elements has been satisfactory.

d. Knowledge of current topics in CHE and commitment to life-long-learning.

Anecdotal data suggests that MS our students are currently attending about one of every two of the CHE seminars. This term, Fall 2005, we will implement a program that requires students to attend eight of every ten seminars. This program will be tied to a curricular requirement, likely the MS Seminar, CHE 6920.

e. Publication.

At this time, about 80% of our MS students are included in one or more publication based on their thesis research. The newly implemented requirement of at least one submitted research manuscript prior to completion should improve on this already excellent outcome.

1 The faculty of the department reserve the right to waive the requirements of publication in specific cases pending approval by the entire CHE faculty and the student’s thesis committee. Such may be necessary where portions of the work are proprietary or where patent laws may apply, etc.