Institutional Effectiveness
2024-2025

Program: Chemical Engineering MS
College and Department: College of Engineering, Chemical Engineering
Contact: Dr. Kevin West and Dr. Robby Sanders
Mission:

The Department of Chemical Engineering at Tennessee Technological University strives to develop the 21st Century Renaissance Engineer through development and implementation of novel learning environments anchored by the award-winning Renaissance Foundry Model. The foundation of this platform is rooted in the guidelines provided by the National Academy of Engineering's Vision for the Engineer of 2020. Educational protocols within the department are consistent with the mission and vision statements given below:

The Mission of the Department of Chemical Engineering is to prepare relevant and adaptive chemical engineers in state-of-the-art areas by emphasizing real world problem solving and critical thinking skills.

The Vision of the Department of Chemical Engineering is to be a recognized leader in chemical engineering education through excellence in teaching, research, and service.

The Department of Chemical Engineering at Tennessee Tech blends scholarship and research with advanced course work, providing excellent opportunities to graduate students to work towards solving some of the many global challenges faced by society. Our program offers an MS in Chemical Engineering. The relatively small size of the program and friendly campus atmosphere promote close interaction among students and faculty. Research is sponsored by federal agencies (such as NSF) as well as state and private sources among others. Faculty members work closely with colleagues in Electrical and Computer Engineering, Civil and Environmental Engineering, Mechanical Engineering, Chemistry, Biology, and Manufacturing and Engineering Technology at TTU, as well as maintain strong collaboration with TTU's Centers of Excellence and other leading institutions and national laboratories to build a unique and effective environment for graduate student research, learning, and well-rounded training.

These activities are consistent with the TTU mission and vision which are posted at the following website (https://www.tntech.edu/about/mission.php)

Attach Curriculum Map (Educational Programs Only):
Attached Files: See Appendix 1

PO1: Competitive Graduate Student Body

Define Outcome:

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.

Assessment Methods:

1. CHE Department Graduate Student Admissions and Success Database: These databases are maintained in Excel spreadsheets that are located on a shared drive accessible by the Graduate Program Coordinator and CHE office staff. The department is also leveraging Microsoft Teams for sharing and archiving information related to the program. These spreadsheets include a collection of applicant data (e.g., GRE Scores, BS GPA, TOEFL scores, BS Institution, etc.) for all students applying for admission to the program as well as decisions made by the CHE graduate committee. Upon admission and entry to the graduate program, a separate spreadsheet is used to track each student's entry time, projected graduation date, research advisor, funding status, completion of required courses, and other measures of student success. Data are entered upon entrance of a student into the program and periodically updated.
    a. Upon entrance of student into program and then periodically throughout the year
2. External and Internal Funding Generated/Obtained: Reports are periodically requested from the TTU Office of Research (or obtained from its website) to provide details on external funding to faculty in the department. In addition, the department maintains a summary of funding status of graduate students in the program and frequently re-assesses this information in efforts to ensure that as many graduate students as possible are supported.
    a. Annually
3. Graduate Student Enrollment Data: Graduate student enrollment data is maintained in the Student Success Database, and this information is periodically checked using enrollment data provided via the TTU Office of Institutional Research.
    a. Annually

Criteria for Success (Thresholds for Assessment Methods):

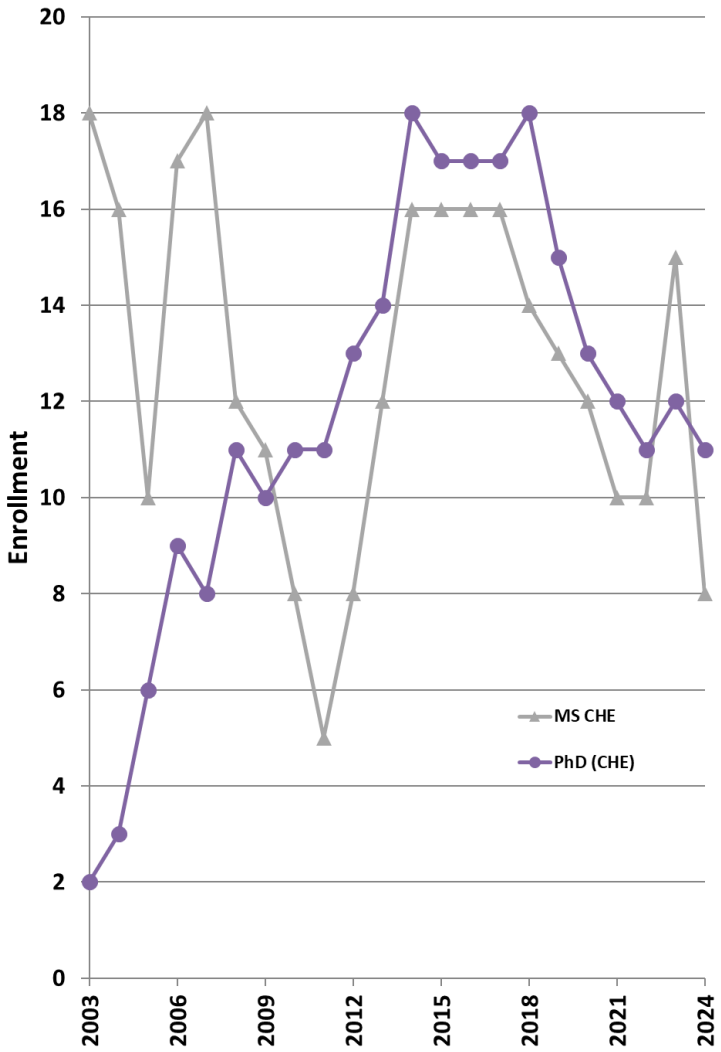
1. CHE Department Graduate Student Admissions and Success Database: Documentation of students admitted and progress towards degree
2. External and Internal Funding Generated/Obtained: Documentation of internal/external grant funding that is used to support faculty research and graduate students
3. Graduate Student Enrollment Data: Maintenance of a graduate student enrollment to faculty ratio of at least 3-4

Link to 'Tech Tomorrow' Strategic Plan:

1.A Experiential Learning,2.A Technology Infused Programs,2.B Research, Scholar, Intellect, and Creativity

Results and Analysis:

Per Fall 2024 census for the MS-CHE program and departmental data for the PhD program, the program shows 42% (8 students) of CHE graduate students are enrolled at the MS level and 58% (11 students) at the PhD level. Total enrollments in the MS-CHE and PhD (CHE concentration) programs over the last two+ decades are provided in the figure below which illustrates a cyclical nature of enrollment (particularly in the MS program) that is aligned with a similar pattern for the department's BS program enrollment as well as national trends in CHE enrollment. The relatively low number of graduate students in the department over the last few years is a concern representing an area in need of improvement.



Research funding: The NSF NRT grant referenced in the previous years' reports is near the end of year three of the five-year funding period. A new cohort of NRT trainees is currently being selected which is expected to bring the cumulative number of stipend-supported trainees to 15 including students from graduate programs in chemical engineering, electrical engineering, environmental science, biology, and education. The interdisciplinary features of the program are supported through the work of faculty colleagues likewise from multiple departments with the efforts centering on the expansion and refinement of the Renaissance Foundry Model to the graduate program and the completion of research projects at the food-energy-water nexus. Graduate students are periodically “immersed” (through coursework or other program-related activities) in various communities throughout Appalachia and in Native American communities (particularly, Cherokee) with whom they are working to identify problems in those communities. Such problems serve as the basis for projects completed by students in the program. An extensive evaluation plan is on-going to inform the decision-making process and ensure that program deliverables are met.

Use of Results to Improve Outcomes:

The department has been active in recruiting students to join its BS/MS Fast-Track program, and new procedures have been put into place to communicate details regarding this opportunity and streamline the process. Five undergraduate students have already declared their interest in participating for the upcoming academic year. *To support these Fast-Track students, the department's Graduate Program Coordinator will coordinate meetings to support student's transition into research projects and other aspects of the graduate program.*

PO2: Diverse Graduate Student Body

Define Outcome:

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

Assessment Methods:

1. CHE Department Graduate Student Admissions and Success Database: These databases are maintained in Excel spreadsheets that are located on a shared drive accessible by the Graduate Program Coordinator and CHE office staff. The department is also leveraging Microsoft Teams for sharing and archiving information related to the program. These spreadsheets include a collection of applicant data (e.g., GRE Scores, BS GPA, TOEFL scores, BS Institution, etc.) for all students applying for admission to the program as well as decisions made by the CHE graduate committee. Upon admission and entry to the graduate program, a separate spreadsheet is used to track each student's entry time, projected graduation date, research advisor, funding status, completion of required courses, and other measures of student success. Data are entered upon entrance of a student into the program and periodically updated.
    a. Upon entrance of student into program and then periodically throughout the year
2. Diversity of Program Demographics: The diversity and student body demographics are routinely examined with this information being maintained in the Student Success Database.
    a. Periodically throughout each year
3. Graduate Student Enrollment Data: Graduate student enrollment data is maintained in the Student Success Database, and this information is periodically checked using enrollment data provided via the TTU Office of Institutional Research.
    a. Annually

Criteria for Success (Thresholds for Assessment Methods):

1. CHE Department Graduate Student Admissions and Success Database: Documentation of students admitted and progress towards degree
2. Diversity of program demographics: Balanced representation from different demographics
3. Graduate Student Enrollment Data: Maintenance of a graduate student enrollment to faculty ratio of at least 3-4

Link to 'Tech Tomorrow' Strategic Plan:

1.C Diversity,2.D Diverse Faculty and Staff

Results and Analysis:
Per 2024-2025 enrollment data, 47% overall (25% at the MS level) of the graduate students are female graduate students, and there are students from the USA, Chile, Honduras, India, Iran, Iraq, Nepal, and Nigeria.

Use of Results to Improve Outcomes:
The department continues to participate in recruiting-related efforts including those led by the College of Engineering and also recruitment efforts associated with the NRT grant program.

PO3: Training in Modern Chemical Engineering

Define Outcome:

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

Assessment Methods:

1. CHE Department Graduate Student Admissions and Success Database: These databases are maintained in Excel spreadsheets that are located on a shared drive accessible by the Graduate Program Coordinator and CHE office staff. The department is also leveraging Microsoft Teams for sharing and archiving information related to the program. These spreadsheets include a collection of applicant data (e.g., GRE Scores, BS GPA, TOEFL scores, BS Institution, etc.) for all students applying for admission to the program as well as decisions made by the CHE graduate committee. Upon admission and entry to the graduate program, a separate spreadsheet is used to track each student's entry time, projected graduation date, research advisor, funding status, completion of required courses, and other measures of student success. Data are entered upon entrance of a student into the program and periodically updated.
    a. Upon entrance of student into program and then periodically throughout the year
2. Periodic Review of Graduate Coursework and Curriculum: Progress made towards completion of required and elective courses is assessed using a variety of approaches. All graduate students are expected to file a program of study not later than the end of the semester in which they will have earned 15 credits towards their degree, and generally they are not allowed to register for subsequent semesters if this is not done. Additionally, a review of graduate courses and the curriculum is periodically completed through meetings between the Department Chair and the Graduate Program Coordinator (currently the same individual) to ensure that courses are offered in a time frame consistent with the program goal for time to graduation. Faculty advisors meet routinely with their advisees to discuss progress in courses and plans for follow-up courses. The Graduate Program Coordinator meets with all new students in the program to discuss courses, the program, and other critical matters. Additions, deletions, and/or changes to the graduate curriculum are first approved via the CHE Graduate Committee and subsequently via the College of Engineering's Graduate Executive Committee (of which the CHE Graduate Program Coordinator is a member), and then the Graduate School Executive Committee.
    a. Periodically, or as the need arises
3. Thesis Presentation and Defense, Publications, and Other Presentations: All students in the thesis-based MS program are required to complete a thesis presentation and defense. The presentation is completed in a public, seminar-type format at the end of the students' program with the student's thesis committee and others in attendance. Upon completion of the presentation, a question/answer session ensues, and then, with the audience dismissed, the committee discusses the presentation and defense and the student's

overall performance in the program and decides whether the student has “passed.” As the comprehensive exam is integrated with the thesis defense for MS students, questions may also be asked regarding coursework completed and student knowledge in his/her area. A non-thesis MS degree is also possible for students who desire a more course work intensive graduate degree and for students who are directly admitted to the PHD program. During their program, students are encouraged and provided the opportunity to be involved in development of manuscripts for submission for peer-reviewed conference proceedings and journal articles and to present at conferences and the on-campus Student Research and Creative Inquiry Day event.

a. End of the student's program and presentations at Student Research Day

Criteria for Success (Thresholds for Assessment Methods):

1. CHE Department Graduate Student Admissions and Success Database: Documentation of students admitted and progress towards degree.
2. Periodic Review of Graduate Coursework and Curriculum: Courses provide relevant training in advanced chemical engineering concepts. Required courses offered at a frequency to support timely progression towards degree completion. In general, these courses should be offered annually.
3. Thesis Presentation and Defense, Publications, and Other Presentations: Thesis documents are published in the ProQuest Dissertations & Theses database. MS-thesis-based students are encouraged to submit a manuscript to a peer-reviewed journal though such submission is not required for graduation. Non-thesis students submit a "binder" that provides documentation of the work completed for their non-thesis project. All MS students in the department present the outcomes from their thesis-related research or non-thesis project, as applicable.

Link to 'Tech Tomorrow' Strategic Plan:

1.A Experiential Learning,1.D High Impact Practices,2.A Technology Infused Programs,2.B Research, Scholar, Intellect, and Creativity

Results and Analysis:

Students’ programs of study (on file in the CHE office and accessible via Degree Works) reflect comprehensive course work within and beyond CHE. Successful thesis/project defenses, publications, and presentations at research-related events (e.g., conferences, TTU Student Research and Creative Inquiry Day, etc.) reflect relevance of the research efforts to contemporary and more modern problems. The frequency of offering core (required) courses over the last seven years is provided in the table immediately below.

Schedule of Core Courses Offered by the CHE Program (Fall 2018- Spring 2025)														
Core Courses	**F '18**	**Sp '19**	**F '19**	**Sp '20**	**F '20**	**Sp '21**	**F '21**	**Sp '22**	**F '22**	**Sp '23**	**F '23**	**Sp '24**	**F '24**	**Sp '25**
MATH 5510	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CHE 6010			X		X		X			X		X		X
CHE 6140	X		X		X				X		X		X	
CHE 6210		X		X				X		X		X		X

In addition to these core courses, there were 14 graduate elective courses offered in the Fall 2024 or Spring 2025 semester including three dual-listed 4000/5000 level courses, four special topics courses, one non-thesis project course, the CHE graduate seminar course, two directed studies courses, and three courses (one of these being new) associated with the NRT program and required as part of the department's graduate certificate option in interdisciplinary training.

Use of Results to Improve Outcomes:

With a continued emphasis on helping graduate students identify challenges that affect communities at the food, energy, water nexus and to develop sustainable solutions, the CHE 6100 and CHE 6130 courses that are associated with the NRT grant were modified for the Fall 2024 and Spring 2025 semesters, respectively, to integrate entrepreneurial mindset and to expand emphasis on the Engineering for One Planet framework.

PO4: Student Cultural, Professional, and Academic Growth

Define Outcome:
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.

Assessment Methods:
Chemical Engineering Graduate Research Association (CEGRA): The Chemical Engineering Graduate Research Association (generally referred to as CEGRA) is an organization led by CHE graduate students to provide a social and support network for graduate students in the CHE graduate programs. The organization has been in existence since 2003 with a constitution that is periodically reviewed by the membership. Monitoring of activities and updates from the CEGRA Faculty Advisor during departmental meetings and via discussions between the Faculty Advisor, CHE Department Chair and/or Graduate Program Coordinator occur periodically.

Criteria for Success (Thresholds for Assessment Methods):
Chemical Engineering Graduate Research Association (CEGRA): CEGRA maintains an active group of officers who lead regularly scheduled meetings and social events.

Link to 'Tech Tomorrow' Strategic Plan:
1.C Diversity,1.D High Impact Practices,4.C Network of Scholars

Results and Analysis:
All students in the CHE department's graduate programs are encouraged to participate in CEGRA (the Chemical Engineering Graduate Research Association) which provides extensive opportunities for personal enrichment by holding routine meetings, supporting social events, and coordinating the submission of requests to the TTU Student Monies Allocation Committee to support travel to national and international conferences and annual meetings of professional societies. CEGRA events from the last year aside from regular general body meetings include the following:

- Fall Research Symposium - 9/24
- Fall Potluck – 9/30
- Ultium Cell Plant Tour – 11/8
- Spring Potluck - 3/27
- Calfkiller Brewery Tour - 3/29
- Research Symposium - 4/24

As indicated in last year's report, the department supports a 13-credit hour graduate certificate option in "Cultural & Interdisciplinary Training at the Food-Energy-Water (FEW) Nexus" that is open to graduate students from across campus. The related courses have significant emphasis on cultural training, critical thinking, and research at the FEW nexus and leverage the Renaissance Foundry model as a guiding instructional platform. Teamwork (in many forms such as inter-, multi-, and cross-disciplinary) as well as collaboration comprise other key aspects of the activities associated with the classes.

Use of Results to Improve Outcomes:

During the 2024-2025 academic year, CEGRA leadership was successful in securing funds from the Student Monies Allocation Committee as well as from the department and College to support conference travel for graduate students. In addition, CEGRA hosted numerous meetings/gatherings during the year.

Three students have completed the requirements for the certificate with many others scheduled to complete the requirements during the upcoming year.

PO5: Scholarly Activities

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

Assessment Methods:
External and Internal Funding Generated/Obtained: Reports are periodically requested from the TTU Office of Research (or obtained from its website) to provide details on external funding to faculty in the department. In addition, the department maintains a summary of funding status of graduate students in the program and frequently re-assesses this information in efforts to ensure that as many graduate students as possible are supported.

Criteria for Success (Thresholds for Assessment Methods):
External and Internal Funding Generated/Obtained: Faculty make efforts to secure external and internal funding.

Link to 'Tech Tomorrow' Strategic Plan:
1.D High Impact Practices,2.B Research, Scholar, Intellect, and Creativity

Results and Analysis:
External and Internal Funding Generated/Obtained: Faculty pursue several efforts to secure external and internal funding to support graduate students in their research efforts. Four externally funded grants (three with CHE PI's and/or co-PI's and one from outside the department) that each supported one or two CHE graduate students were active during the reporting period. Multiple sources of internal support during this reporting period include Centers of Excellence, the CHE department, and the Office of Research. Further, the third cohort of graduate student NRT trainees (which includes two CHE graduate students) has been selected for the NRT program for the upcoming reporting period. This brings the total number of trainees from across campus to 15 (including four in CHE). Three of these 15 trainees will have graduated by the end of the Summer 2025 semester. This interdisciplinary program which is based in the CHE department seeks to support research at the food-energy-water nexus and in collaboration with communities throughout Appalachia, and it leverages an integrated focus on the following three pillars: the Renaissance Foundry innovation-driven learning model, critical thinking, and cultural/community training.

Student Presentations and Other Scholarly Activities: CHE students are actively involved in the on-campus Student Research and Creative Inquiry Day event and other presentation

opportunities. For the Spring 2025 Research Day event, two MS-CHE students participated (none participated in 2024), as did five BS students and six PhD students from the CHE department. Two graduate students presented at the Fall 2024 AICHE Annual Meeting, and four graduate students have submitted abstracts to present at the Water Professionals Conference to be held in Knoxville, TN during the Summer of 2025. A few CHE graduate students are co-authors on peer-reviewed publications (The current count shows five such publications.), but most CHE graduate students (especially at the MS level) have not published. Over the last three years of the 15 students graduating with the CHE-MS degree during the previous three "Summer-Fall-Spring" cycles, only one has co-authored a published paper.

Use of Results to Improve Outcomes:

Creating opportunities to guide scholars through the publication process is essential for advancing research outcomes. *This topic will be discussed in detail in the department with goals established regarding the publication and presentation expectations of all CHE graduate students (including thesis/dissertation-based and non-thesis based as well as BS/MS Fast-Track students).* One important mechanism to further support this effort is through CEGRA which held two research symposia sessions during the 2024-2025 reporting period in which students showcased their research projects. A similar activity will be pursued as related to publications.

PO6: Graduation within Two-Year Window

Define Outcome:

Optimize graduate student time to graduation by providing courses and advising that facilitates student completion of the MS degree within a desired two-year window.

Assessment Methods:

1. External and Internal Funding Generated/Obtained: Reports are periodically requested from the TTU Office of Research (or obtained from its website) to provide details on external funding to faculty in the department. In addition, the department maintains a summary of funding status of graduate students in the program and frequently re-assesses this information in efforts to ensure that as many graduate students as possible are supported.
2. Periodic Review of Graduate Coursework and Curriculum: Progress made towards completion of required and elective courses is assessed using a variety of approaches. All graduate students are expected to file a program of study not later than the end of the semester in which they will have earned 15 credits towards their degree, and generally they are not allowed to register for subsequent semesters if this is not done. Additionally, a review of graduate courses and the curriculum is periodically completed through meetings between the Department Chair and the Graduate Program Coordinator to ensure that courses are offered in a time frame consistent with the program goal for time to graduation. Faculty advisors meet routinely with their advisees to discuss progress in courses and plans for follow-up courses. The Graduate Program Coordinator meets with all new students in the program to discuss courses, the program, and other critical matters. Additions, deletions, and/or changes to the graduate curriculum are first approved via the CHE Graduate Committee and subsequently via the College of Engineering's Graduate Executive Committee (of which the CHE Graduate Program Coordinator is a member), and then the Graduate School Executive Committee.

Criteria for Success (Thresholds for Assessment Methods):

1. External and Internal Funding Generated/Obtained: Documentation of internal/external grant funding that is used to support faculty research and graduate students.
2. Periodic Review of Graduate Coursework and Curriculum: Courses provide relevant training in advanced chemical engineering concepts. Required courses offered at a frequency to support timely progression towards degree completion. In general, these courses should be offered annually.

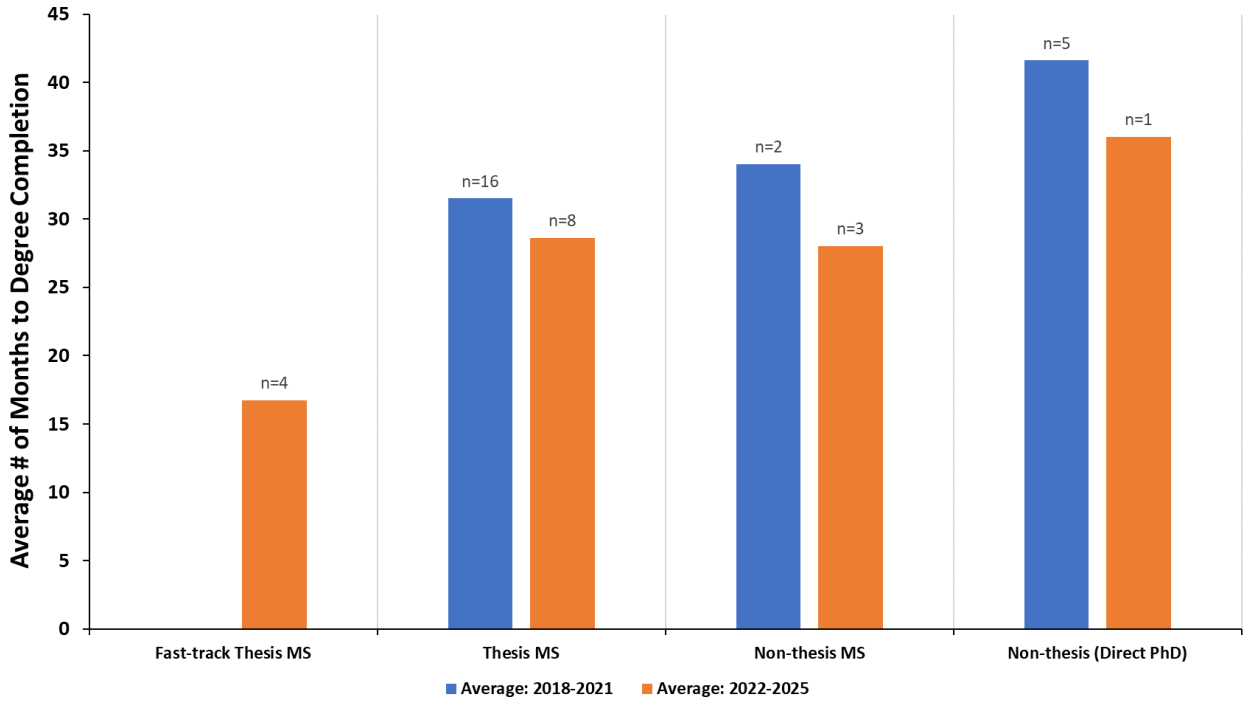
Link to 'Tech Tomorrow' Strategic Plan:

1.D High Impact Practices,2.B Research, Scholar, Intellect, and Creativity,3.A Efficiency and Effectiveness

Results and Analysis:

Several mechanisms (such as assistantships and the extent of availability of course offerings) are in place to help graduate students make timely progress towards their degree objective. For the 2024-2025 reporting period, five CHE graduate students were supported via externally-funded grants (which is up from three during the previous year). In addition, several other CHE graduate students were supported as teaching assistants or research assistants from a number of other sources on-campus including through the department, Centers of Excellence, and the university. Course offerings are routinely evaluated, and courses are offered at a frequency that provides the possibility for students to graduate within the department's goal for time to graduation (i.e., 15 months for BS/MS Fast-Track students and 24 months for other pathways (described below).

Prior years' reports have shown a slight overall reduction in the amount of time taken by CHE graduate students to complete the MS degree. For this year's analysis, we grouped the data in four-year bins corresponding to 2018-2021 and 2022-2025 and further subdivided this based on the pathway that each student took to achieve their degree (i.e., as part of the BS/MS Fast-Track program (eventually pursuing the MS thesis track), those who entered the thesis track directly, students who completed the non-thesis option to earn their degree as their final degree objective, and students who earned their non-thesis MS degree while still pursuing their PhD). The results of the analysis are shown in the figure below with the following key outcomes: 1) Participation in the department's BS/MS Fast-Track program is increasing with four such students earning their thesis-based MS degree in the 2022-2025 timeframe; 2) Students are taking about the same amount of time to complete a thesis- or non-thesis-based MS degree with the time to degree during 2022-2025 being slightly less than that during 2018-2021; 3) Students admitted "directly" to the PhD program and who earn their non-thesis-based MS degree "along the way" tend to take longer to complete the MS degree requirements, and 4) Participation in the Fast-Track program leads to a shorter time duration in completing the degree that is aligned with the department's goal for MS degree completion.



Use of Results to Improve Outcomes:

For the upcoming year, the department will discuss and seek to implement strategies to support students in reducing their time to degree completion while maintaining rigor.

SLO1: Proficiency in Scientific Inquiry

Define Outcome:

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

Assessment Methods:

1. Periodic Review of Graduate Coursework and Curriculum: Progress made towards completion of required and elective courses is assessed using a variety of approaches. All graduate students are expected to file a program of study not later than the end of the semester in which they will have earned 15 credits towards their degree, and generally they are not allowed to register for subsequent semesters if this is not done. Additionally, a review of graduate courses and the curriculum is periodically completed through meetings between the Department Chair and the Graduate Program Coordinator to ensure that courses are offered in a time frame consistent with the program goal for time to graduation. Faculty advisors meet routinely with their advisees to discuss progress in courses and plans for follow-up courses. The Graduate Program Coordinator meets with all new students in the program to discuss courses, the program, and other critical matters. Additions, deletions, and/or changes to the graduate curriculum are first approved via the CHE Graduate Committee and subsequently via the College of Engineering's Graduate Executive Committee (of which the CHE Graduate Program Coordinator is a member), and then the Graduate School Executive Committee.
2. Thesis Presentation and Defense, Publications, and Other Presentations: All students in the thesis-based MS program are required to complete a thesis presentation and defense. The presentation is completed in a public, seminar-type format at the end of the students' program with the student's thesis committee and others in attendance. Upon completion of the presentation, a question/answer session ensues, and then, with the audience dismissed, the committee discusses the presentation and defense and the student's overall performance in the program and decides whether the student has "passed." As the comprehensive exam is integrated with the thesis defense for MS students, questions may also be asked regarding coursework completed and student knowledge in his/her area. A non-thesis MS degree is also possible for students who desire a more course work intensive graduate degree and for students who are directly admitted to the PHD program. During their program, students are encouraged and provided the opportunity to be involved in development of manuscripts for submission for peer-reviewed conference proceedings and journal articles and to present at conferences and the on-campus Student Research and Creative Inquiry Day event.

Criteria for Success (Thresholds for Assessment Methods):

1. Periodic Review of Graduate Coursework and Curriculum: Courses provide relevant training in advanced chemical engineering concepts. Required courses offered at a

frequency to support timely progression towards degree completion. In general, these courses should be offered annually.

2. Thesis Presentation and Defense: Thesis documents are published in the ProQuest Dissertations & Theses database. MS-thesis-based students are encouraged to submit a manuscript to a peer-reviewed journal though such submission is not required for graduation. Non-thesis students submit a "binder" that provides documentation of the work completed for their non-thesis project. All MS students in the department present the outcomes from their thesis-related research or non-thesis project, as applicable.

Link to 'Tech Tomorrow' Strategic Plan:

2.B Research, Scholar, Intellect, and Creativity

Results and Analysis:

As indicated in the prior years' reports, all MS-CHE students must demonstrate knowledge and proficiency in the method of scientific inquiry. Development of these skills is demonstrated via numerous means including: (1) satisfactory progress towards completion of the thesis research project as measured by grades posted during semesters in which a graduate student signs up for the CHE 6990 (Research and Thesis) course or, for those pursuing the non-thesis MS degree, satisfactory performance in the CHE 6970 project course; (2) completion of a written thesis (or for the non-thesis MS degree, submission of an organized project binder with synthesized material) with appropriate content and presentation format that is accepted by the student's advisor, the thesis/project advisory committee, and the Dean of the College of Graduate Studies; (3) oral presentation and defense of the thesis research (or non-thesis) project in front of the student's thesis committee, student peers, and the general chemical engineering faculty, and (4) remediation of any issues raised by either the committee at the time of signing of the program of study or at the time of completing the thesis/defense (or project).

Use of Results to Improve Outcomes:

As reflected in grades, in written work products (e.g., theses, binders, etc.), and through thesis/project-related presentations, graduate students perform satisfactorily in all of these areas. *All SLO's will be discussed in the department during the upcoming year.*

SLO2: Proficiency in Graduate Level Chemical Engineering Coursework

Define Outcome:
All students must demonstrate proficiency in graduate level transport phenomena (including fluid dynamics), chemical thermodynamics, kinetics, and applied and computational mathematics. Indicators of content knowledge gains are reflected by consistent progress towards completion of required courses as shown in the programs of study as well as high grades in those courses.

Assessment Methods:
Periodic Review of Graduate Coursework and Curriculum: Progress made towards completion of required and elective courses is assessed using a variety of approaches. All graduate students are expected to file a program of study not later than the end of the semester in which they will have earned 15 credits towards their degree, and generally they are not allowed to register for subsequent semesters if this is not done. Additionally, a review of graduate courses and the curriculum is periodically completed through meetings between the Department Chair and the Graduate Program Coordinator to ensure that courses are offered in a time frame consistent with the program goal for time to graduation. Faculty advisors meet routinely with their advisees to discuss progress in courses and plans for follow-up courses. The Graduate Program Coordinator meets with all new students in the program to discuss courses, the program, and other critical matters. Additions, deletions, and/or changes to the graduate curriculum are first approved via the CHE Graduate Committee and subsequently via the College of Engineering's Graduate Executive Committee (of which the CHE Graduate Program Coordinator is a member), and then the Graduate School Executive Committee.

Criteria for Success (Thresholds for Assessment Methods):
The four core courses in the MS-CHE graduate program focused on development of advanced skills in mathematics, thermodynamics, transport, and kinetics are given as follows:

a. MATH 5510: Advanced Math for Engineers
b. CHE 6010: Advanced Chemical Engineering Thermodynamics
c. CHE 6140: Physics of Transport or ME 6040: Intermediate Fluid Mechanics
d. CHE 6210: Advanced Kinetics

Link to 'Tech Tomorrow' Strategic Plan:
2.B Research, Scholar, Intellect, and Creativity

Results and Analysis:
Students in the CHE graduate programs almost always demonstrate proficiency in required courses as well as graduate electives. This proficiency is reflected in consistent progress towards the completion of courses as shown in the programs of study as well as high grades in those courses. In the limited cases where this is not so, the Graduate Program Coordinator works with the student in efforts to support their progress towards the degree.

Use of Results to Improve Outcomes:
The core courses for the MS-CHE degree continue to be offered at a frequency to ensure timely progress towards degree, and student performance in these courses as well as elective courses within and outside the department continues to be good. In the limited cases where this is not so, the Graduate Program Coordinator works with the student in efforts to support their continued progress towards the degree. *The department will revisit the listing of core graduate courses in the department during the upcoming year and at the same time discuss content and any necessary adjustments. Such changes will be monitored for impact.*

SLO3: Proficiency in Ethics in Research Approaches

Define Outcome:

All students must show knowledge and applied proficiency of ethics in research approaches (thesis-based) or other investigational approaches (non-thesis-based).

Assessment Methods:

1. Chemical Engineering Graduate Research Association (CEGRA): The Chemical Engineering Graduate Research Association (generally referred to as CEGRA) is an organization led by CHE graduate students to provide a social and support network for graduate students in the CHE graduate programs. The organization has been in existence since 2003 with a constitution that is periodically reviewed by the membership. Monitoring of activities and updates from the CEGRA Faculty Advisor during departmental meetings and via discussions between the Faculty Advisor, CHE Department Chair and/or Graduate Program Coordinator occur periodically. CEGRA activities help create a culture for growing professional and other ethical behaviors.
2. CHE 6920 is a focused course offered each year. It includes research ethics, research methods, and professionalism in scholarly activities in addition to preparing students for proposal writing and presentations. It is required for students in the non-thesis-based MS program and an optional (often-taken) course for thesis-based MS students.
3. Thesis committee members provide input and guidance to students in class and research settings.

Criteria for Success (Thresholds for Assessment Methods):

1. Chemical Engineering Graduate Research Association (CEGRA): CEGRA maintains an active group of officers who lead regularly scheduled meetings and social events.
2. CHE 6920: Topics related to ethics and safety are covered in this course.
3. Guidance of thesis committee members: Students meet routinely with graduate research advisors and make satisfactory progress towards degree objectives.

Link to 'Tech Tomorrow' Strategic Plan:

1.D High Impact Practices

Results and Analysis:

All students must show knowledge and applied proficiency of ethics in research and other inquiry-based approaches. A focused course (CHE 6920) is offered each year to support students with these aspects which are reflected in the following course objective from the Fall 2024 syllabus, "To expose students to various topics of relevance in chemical engineering research (experimental design, ethics, technical writing, research presentations), introduce students to

proposal development practices, and create an environment for learning that fosters innovation and creativity." The vast majority of graduate students in the program take this course, including four of the five students who graduated with the MS-CHE degree during this reporting period. Further, input and guidance from advisory committee chairs and other thesis committee members to students in class and research settings provide additional points for ensuring ethical behaviors.

Use of Results to Improve Outcomes:

While CHE 6920 is not required for completion of the MS-CHE thesis-based degree, it is required for students in the non-thesis MS-CHE option. Most students in the program do take this course, and discussions are still on-going to perhaps make this a required course for the thesis-based option as well which would increase the number of credits required from 30 to 31. *In addition, during the upcoming year, a discussion will be initiated towards the identification/development of a rubric for assessing ethics in research.*

SLO4: Knowledge of Current Research and Commitment to Lifelong Learning

Define Outcome:

All students must show knowledge of current and relevant areas of research and must demonstrate a commitment to the process of lifelong learning.

Assessment Methods:

1. Research Seminar Series broadens the students' exposure to current topics of relevance for the profession. The series seminars are offered every semester.
2. Student Thesis and Non-Thesis Committees include graduate faculty in CHE at TTU as well as committee members from outside the department and sometimes from outside the College of Engineering.
3. Non-thesis binders contain both original work and resources leveraged.
4. Chemical Engineering Graduate Research Association (CEGRA) provides opportunities for students to see the breadth and depth of knowledge associated with their discipline through participation in conferences and increased familiarity with other researchers' work.

Criteria for Success (Thresholds for Assessment Methods):

1. Research Seminar Series: Graduate student and faculty participation in on-campus seminars.
2. Student Thesis and Non-Thesis Committees: Programs of study are submitted and approved by student's committee. Changes are likewise reviewed and approved.
3. Non-thesis binders: Binders are received and held by student's faculty advisor.
4. Chemical Engineering Graduate Research Association (CEGRA): CEGRA maintains an active group of officers who lead regularly scheduled meetings and social events. The CEGRA leadership also facilitates the process for obtaining funding to support graduate student travel to and presentation at conferences.

Link to 'Tech Tomorrow' Strategic Plan:

1.A Experiential Learning,1.D High Impact Practices,2.B Research, Scholar, Intellect, and Creativity

Results and Analysis:

As indicated in prior years' reports, all students must show knowledge of current and relevant areas of research (or other forms of inquiry for the non-thesis option) and must demonstrate a commitment to the process of lifelong learning. The Department has not offered its “Research Seminars Series” during the reporting period, but offerings outside the department continue to provide opportunities for participation in seminars to broaden student exposure regarding

current topics of relevance for the profession. In addition, though the Chair of the student's thesis (or non-thesis) committee must be a graduate faculty in CHE at TTU, many graduate students have other thesis committee members who are from outside the department and in many cases outside of the College of Engineering. "Certificates of Approval" which are required to be signed by the thesis committee and included in the record for each student's thesis reflect this composition. Further, for students pursuing the non-thesis option, a binder containing content (both original work and resources that students reviewed during their project such as copies of peer-reviewed literature) must be submitted by the student for review and approval.

Use of Results to Improve Outcomes:

A discussion regarding whether or not to reinitiate the department's seminar series will be a topic for discussion in the upcoming year as this did not occur during the 2024-2025 reporting period.

SLO5: Scholarly Writing

Define Outcome:

All thesis-based MS-CHE students are encouraged to have submitted, at the time of thesis defense, at least one manuscript based on the thesis project to a peer-reviewed journal. Graduate students also often author or co-author abstracts and conference proceedings. Further, MS-CHE (thesis-based) students are required to submit a thesis approved by their thesis advisory committee and the College of Graduate Studies. Non-thesis MS-CHE students submit a binder containing original material including (for example) written work, computer codes, presentation materials, copies of peer-reviewed literature, etc.

Assessment Methods:

1. Thesis Presentation and Defense, Publications, and Other Presentations: All students in the thesis-based MS program are required to complete a thesis presentation and defense. The presentation is completed in a public, seminar-type format at the end of the students' program with the student's thesis committee and others in attendance. Upon completion of the presentation, a question/answer session ensues, and then, with the audience dismissed, the committee discusses the presentation and defense and the student's overall performance in the program and decides whether the student has "passed." As the comprehensive exam is integrated with the thesis defense for MS students, questions may also be asked regarding coursework completed and student knowledge in his/her area. A non-thesis MS degree is also possible for students who desire a more course work intensive graduate degree and for students who are directly admitted to the PHD program. During their program, students are encouraged and provided the opportunity to be involved in development of manuscripts for submission for peer-reviewed conference proceedings and journal articles and to present at conferences and the on-campus Student Research and Creative Inquiry Day event.

Criteria for Success (Thresholds for Assessment Methods):

1. Thesis Presentation and Defense, Publications, and Other Presentations: Thesis documents are published in the ProQuest Dissertations & Theses database. MS-thesis-based students are encouraged to submit a manuscript to a peer-reviewed journal though such submission is not required for graduation. Non-thesis students submit a "binder" that provides documentation of the work completed for their non-thesis project. All MS students in the department present the outcomes from their thesis-related research or non-thesis project, as applicable.

Link to 'Tech Tomorrow' Strategic Plan:

2.B Research, Scholar, Intellect, and Creativity

Results and Analysis:

All thesis-based MS-CHE students are encouraged to have submitted, at the time of thesis defense, at least one article based on the thesis project to a peer-reviewed journal. For the 2024-2025 reporting period, none of the four thesis-based MS-CHE graduates is a co-author on a peer-reviewed article. MS-CHE (thesis) and PhD students continue to meet the requirement that theses and dissertations be submitted and approved by the student's advisory committee and the College of Graduate Studies for inclusion in the ProQuest Dissertations and Theses Database. Non-thesis MS students submit a binder containing original material including (for example) written work, computer codes, presentation materials, copies of peer-reviewed literature, etc.

Use of Results to Improve Outcomes:

As also discussed in the "Results: PO5: Scholarly Activities" section, strategies to further enable student-focused preparation and completion of manuscripts prior to graduation will be a topic for discussion during a department meeting in the 2025-2026 reporting period.

SLO6: Presentations at Scientific Meetings

Define Outcome:

All students are expected to present in international/national scientific meetings, and each advisor is to act as a mentor in this effort. As part of research group meetings, students often present findings from their research and/or from journal articles in the field.

Assessment Methods:

1. CHE Department Graduate Student Admissions and Success Database: The department collects information from all students applying for admission to its graduate programs and records several related items (e.g., GRE Scores, BS QPA, TOEFL scores, etc.) in a spreadsheet database. A separate spreadsheet is maintained in which metrics regarding student success (such as completion of core courses, time to completion, grades, indicators of funding, and other indicators of student progress) are tracked.
2. Chemical Engineering Graduate Research Association (CEGRA): The Chemical Engineering Graduate Research Association (generally referred to as CEGRA) is an organization led by CHE graduate students to provide a social and support network for graduate students in the CHE graduate programs. The organization has been in existence since 2003 with a constitution that is periodically reviewed by the membership. Monitoring of activities and updates from the CEGRA Faculty Advisor during departmental meetings and via discussions between the Faculty Advisor, CHE Department Chair and/or Graduate Program Coordinator occur periodically.
3. Diversity of Program Demographics: The diversity and student body demographics are routinely examined with this information being maintained in the Student Success Database. The departmental culture is inclusive, and the faculty and staff wholeheartedly seek to include diverse perspectives and experiences throughout curricular and extracurricular activities.
4. Thesis Presentation and Defense, Publications, and Other Presentations: All students in the thesis-based MS program are required to complete a thesis presentation and defense. The presentation is completed in a public, seminar-type format at the end of the students' program with the student's thesis committee and others in attendance. Upon completion of the presentation, a question/answer session ensues, and then, with the audience dismissed, the committee discusses the presentation and defense and the student's overall performance in the program and decides whether the student has "passed." As the comprehensive exam is integrated with the thesis defense for MS students, questions may also be asked regarding coursework completed and student knowledge in his/her area. A non-thesis MS degree is also possible for students who desire a more course work intensive graduate degree and for students who are directly admitted to the PHD program. During their program, students are encouraged and provided the opportunity to be involved in development of manuscripts for submission for peer-reviewed conference proceedings and journal articles and to present at conferences and the on-campus Student Research and Creative Inquiry Day event.

Criteria for Success (Thresholds for Assessment Methods):

1. CHE Department Graduate Student Admissions and Success Database: Students' efforts related to scholarly activities including thesis and non-thesis topics, presentations, and publications are documented.
2. Chemical Engineering Graduate Research Association (CEGRA): CEGRA maintains an active group of officers who lead regularly scheduled meetings and social events. The CEGRA leadership also facilitates the process for obtaining funding to support graduate student travel to and presentation at conferences.
3. Diversity of Program Demographics: Shared office space provides an opportunity for exchanging of ideas and ways of thinking.
4. Thesis Presentation and Defense, Publications, and Other Presentations: Students' efforts related to scholarly activities including thesis and non-thesis topics, presentations, and publications are documented.

Link to 'Tech Tomorrow' Strategic Plan:

1.A Experiential Learning,1.C Diversity,2.B Research, Scholar, Intellect, and Creativity

Results and Analysis:

All thesis-based MS-CHE students are expected to present in national/international scientific meetings and/or the university's Student Research and Creative Inquiry Day, and each advisor is to act as a mentor in this effort. While all four of the thesis-based MS graduates from the current reporting period presented/defended their thesis in a public forum and received significant support from graduate faculty mentors, it does not appear that any of these students presented their research findings at a conference. This said, as indicated earlier, two current CHE-MS students presented at this year's Student Research Day event (none participated in 2024), as did five BS students and six PhD students from the CHE department. Two graduate students presented at the Fall 2024 AICHE Annual Meeting, and four graduate students have submitted abstracts to present at the Water Professionals Conference to be held in Knoxville, TN during the Summer of 2025.

Use of Results to Improve Outcomes:

An increased emphasis will continue to be placed during the upcoming reporting period on CHE graduate students presenting at the Student Research and Creative Inquiry Day event and at off-campus conferences.

Summative Evaluation:
Graduate students in the department continue to perform well in course work and on thesis and non-thesis projects. The number of BS/MS Fast-Track students is increasing, and along with our faculty and staff, our Chemical Engineering Graduate Research Association continues to serve as a critical resource for graduate student success. There continues to be concern regarding the overall number of graduate students in the program (which for the 2024-2025 reporting period was 19, including 8 MS students) and also concern regarding the number of MS degrees earned which currently has a five-year rolling average of 4.4 (down from 5.2 the year before). There are currently 11 prospective students admitted to our graduate programs with potential for joining the department in the Fall 2025 semester (including five MS applicants, three of which fully participated in our BS/MS Fast-Track program during their senior year), and t*o ensure a smooth transition,* a*ll of these admitted students who enroll will participate in an orientation during the first week of the Fall 2025 semester and follow-up activities facilitated by the Graduate Program Coordinator during the academic year that will further contribute to our commitment to student-centered, society-focused scholarship and dissemination of research results.*

As indicated in last year's report, per Program Outcome 1, the intent is to 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. To contribute to this goal, the department is exploring both an MS degree in Biomedical Engineering, and as indicated in last year's report, an on-line pathway to a CHE-MS degree.

Assessment Plan Changes:
The department will discuss the current assessment tools used for the graduate program and will update our current strategy during the upcoming year as necessary. A similar set of activities is underway for our undergraduate program, providing an ideal time to synergize the efforts towards the continued improvement of our programs.

List of Appendices:
Appendix 1: Curriculum Map

Appendix 1: Curriculum Map

Table 1. Mapping of Assessment Approaches to Program and Student Learning Outcomes

	Program Outcomes						Student Learning Outcomes					
Assessment Approach/Tool	1 Sufficient Enrollment	2 Diverse Students	3 Rigorous Training	4 Meaningful Environment	5 Publications, Presentations	6 Time to Graduation	1 Research Skills	2 Content Knowledge	3 Ethical Behaviors	4 Research Depth	5 Writing Skills	6 Presentation Skills
Graduate Student Admissions and Success Databases	X	X				X					X	X
Chemical Engineering Graduate Research Association (CEGRA)				X	X				X	X		X
Diversity of Program Demographics		X								X		X
External and Internal Funding Generated/Obtained	X				X	X						
Graduate Student Enrollment Data	X	X										
Periodic Review of Graduate Coursework and Curriculum			X			X	X	X	X			
Thesis Presentation and Defense			X				X				X	X