Department of Chemical Engineering Plan for Discipline-Specific Visual Expression, Written and Spoken (ViEWS) communication

I. Introduction and Program Goals

The primary goal of the Chemical Engineering departmental plan for Discipline-Specific Spoken, Visual and Written Communication is to prepare B.S. graduates with the necessary communication skills to function effectively in either an industrial/business environment, or in a graduate/professional school setting. Our B.S. Chemical Engineering graduates will be able to communicate clearly and effectively to technical audiences. Students will be able to employ a wide variety of written and oral communication techniques with accompanying visual communication tools appropriate to their intended audiences. Our specific objectives must also meet the requirements of our accrediting agency, ABET Inc., and demonstrate that our graduating seniors have “an ability to communicate effectively” (ABET Objective G) and “function on multidisciplinary teams.”¹ (ABET Objective D) This second requirement involves a significant communications component.

Our department believes that past requirements for the writing-intensive components of the curriculum adequately address the issues of written communications. While no formal university requirements for verbal and visual communications have existed in the past, these issues have been addressed previously in the chemical engineering curriculum in response to suggestions from industrial representatives, our external advisory board, and in response to the ABET mandate to produce graduates that “communicate effectively.” We believe that the elements already in place in our curriculum constitute an acceptable requirement for discipline-specific spoken, visual and written communications. Elements of our current program are described. As a result of our curriculum review, additions to our current program (described below) will be implemented to improve verbal communication skills.

II. Learning Objectives

By graduation, ChE students should be able to:

1. Describe and explain scientific principles and results in a variety of technical formats including formal and informal technical reports, laboratory reports, and technical papers.²
2. Describe and explain scientific principles and results in a variety of nontechnical formats including abstracts, memoranda, and executive summaries.
3. Effectively portray data in tabular and graphical formats to support technical reports and publications.
4. Prepare and deliver effective presentations for technical audiences in oral and poster presentation formats.

5. Effectively utilize graphics to support oral and poster presentation formats.
6. Develop documents and presentations within a collaborative team environment.

III. Current Curriculum Plan

Freshman Year. Students do not enter degree granting engineering departments until the sophomore year. There are, however, some common communications experiences shared by freshman engineering students in addition to the freshman English requirements.

ENGE 1024 Engineering Exploration: Students complete three written reports and one oral presentation (PowerPoint® optional) based on three group projects (two "MacGyver" projects and one "Alice" programming project).

ENGE 1114 Exploration of Engineering Design: Students complete one written report and one oral report, including a PowerPoint® presentation, in collaboration with group members on a semester long design project.

In addition to the freshman engineering sequence, chemical engineering students also complete two chemistry laboratory courses during the freshman year: CHEM 1084 General Chemistry Lab and CHEM 2124 Analytical Chemistry Lab. Written lab reports are required in the general chemistry lab, and reports may be written in the analytical chemistry lab, depending on the instructor.

Sophomore Year. In the sophomore year, chemical engineering students primarily take courses in the physical sciences and mathematics along with three CHE core courses on basic engineering science and computational sciences. Communication experiences in the sophomore year are associated with laboratory courses in the physical sciences: two Organic Chemistry laboratory courses (CHEM 2545 and CHEM 2546) and one Physical Chemistry laboratory course (CHEM 3625). Laboratory reports are required in the organic chemistry labs, and a journal is kept with experimental results and written conclusion for the physical chemistry lab.

Junior Year. In the junior year, CHE students take the first courses specifically targeting their communication skills. These include required courses in English and Chemical Engineering.

ENGL 3764 Technical Writing: This course addresses principles and procedures of technical writing including organization of information, designing graphical aids, and writing abstracts, instructions and proposals. In addition, attention is paid to identification of the target audience and purpose of the communication. This course has been a requirement in our curriculum for a number of years, so no negotiations with the English department are required for its inclusion in our curriculum.

CHE 4014 Chemical Engineering Laboratory: This five credit hour laboratory course is required of all chemical engineering students during the summer of the junior year. A preliminary report in the form of an oral presentation with PowerPoint® graphics is required of each group prior to beginning each of eight experiments required for the course. These preliminary oral reports require the students to function as advocates in defense of a proposed experimental plan. Final reporting requirements vary for the eight

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experiments, and include one informal report, one formal report, two technical papers, one technical poster presentation, and three oral reports with written abstracts. Different components of these final reports require individual work and collaborative work between group members.

**Senior Year.** In the senior year, CHE students take the year long capstone Process Design sequence, CHE 4185 and 4186, previously designated as our writing intensive courses. Instruction in communications includes background on U.S. Government recommendations for the use of “Plain Language” 4 and instruction in the preparation of effective PowerPoint® presentations. Exercises in written and spoken communications are assigned throughout the academic year, and in all cases extensive instructor feedback is given and revisions are required both for written documents and for visual aids used in presentations. Assignments include the preparation of resumes, memoranda, research reports, project formulation reports, final project reports and executive summaries, and group presentations of design projects.

**Elective Experiences.** In addition to the required core CHE courses, undergraduate students also have the opportunity to participate in elective courses in undergraduate research and industrial design experiences. Participation in undergraduate research typically includes presentations of results at research group meetings and (in some cases) national conferences. Students receive feedback on their communications skills from their undergraduate research advisors. In the industrial design experiences, students typically produce final project documents and present their results to external industrial representatives. Feedback from these industrial projects, including the communications aspects of the presentations, comes directly from the participating industrial representatives.

**IV. Additions to Current Program**

The Chemical Engineering External Advisory Board was recently (November 2004) questioned about their experiences involving the communication skills of young engineers (not just VT alumni) in their organizations. Comments from our industrial representatives primarily centered on the public speaking skills of young engineers. The board suggested that most young engineers can recite the do’s and don’ts of a good oral presentation (do make eye contact, don’t stare at your feet, don’t repeatedly say “you know”), but they rarely have a clear idea of the impression they make on an audience. Two suggestions were made: (1) allow peers (classmates) to critique student presentations, and (2) use video so the students can judge their own performance in light of the comments made by their peers. The motivation for these two suggestions is simple. Students are accustomed to being graded by course instructors, so feedback from their friends and classmates may provide more motivation to work on their presentation style. As for the use of video, “seeing is believing”. These changes will be implemented for the next offering of CHE 4014 Chemical Engineering Laboratory in the summer of 2005. Peer evaluations will be completed by individual students in the audience following each group’s first two oral presentations. These evaluations will be reviewed by the faculty course instructor then passed onto the student groups under review. Student groups will prepare a general response to the reviews for submission to the course instructor suggesting improvements that can be made for subsequent oral presentations. Improvement in subsequent

presentations will be evaluated by course instructors as well as student peers. In addition, each oral presentation will be video taped, and the presenting groups will be allowed to view the video tapes in private so they can evaluate their own performances in light of the peer reviews and instructor comments.

A second deficiency identified by board members was the inability of many young engineers to give a very brief (1-2 minute), focused, impromptu talk (ex. a project update for a company executive passing in a hallway). It was suggested that any experience we could provide our undergraduates for giving an “elevator talk” or a “verbal executive summary” would be worthwhile. We will implement a program of unscheduled, unannounced visits by ChE faculty members as part of CHE 4014 Chemical Engineering Laboratory for the coming Summer 05 course offering. Faculty members not associated with the laboratory course will visit the laboratory and request a description of the experimental objectives and status from the acting group leader for each experiment. Faculty with a direct connection (either as course instructors or research backgrounds) to the subject matter associated with the experiments will participate. Since the number of students per group is less than the number of experiments performed by each group, each student is required to be the acting group leader for a minimum of one experiment.

V. Implementation

Since the majority of the components of the plan for Discipline-Specific Visual Expression, Written and Spoken communication are already included in our curriculum; no special plans are required for their phase-in and implementation. New program components will be initiated in Summer 05 as part of CHE 4014. Input for the peer evaluation forms will be sought from the communications specialist in the Engineering Education Department.

VI. Assessment

Outcomes assessment for the Discipline-Specific Visual Expression, Written and Spoken (ViEWS) communication requirements will be included as part of our current assessment efforts required by ABET and SCHEV. This effort includes several different types of assessment instruments as detailed below.

1. Student work on communication assignments is evaluated by the course instructor to assess the quality of individual work and group work. Feedback from the instructor is provided, and revision is required for many communications assignments.

2. ChE courses are continually reviewed and modified by the participating instructors. Course content and student performance related to the individual learning objective for each course are evaluated by the instructor following each offering of a course. Our departmental goal is to have a minimum of 80% of the participating students demonstrate proficiency (C or better) in the completion of work related to each learning objective in every course. Separate learning objectives related to communication are already included in ChE courses as described above. Annual curriculum reviews are conducted at a faculty retreat where experiences are shared and recommendations are made by the entire faculty for improving student performance in all areas of the curriculum. The evaluation processes involves the collection and review of examples of poor, average, and excellent student performance on work (assignments, exams, etc.) related to each learning objective in every course. When specific problems are identified, these materials are
reviewed by the faculty, and are used as a basis for recommending modifications to curriculum. All course objectives related to communications are subject to this same review process.

3. In the capstone design sequence, CHE 4185 and 4186, students are surveyed specifically about the impact of the course material on the development of their communications skills. The course instructor uses the feedback from these surveys to modify the course content.

4. Senior exit interviews are conducted in the department with each student prior to graduation, and questions concerning the effectiveness of the department’s efforts in communication are included. Feedback from these interviews is provided to the faculty by the Department Head at the annual faculty retreat and curriculum review.

5. Senior students also complete College of Engineering Exit Questionnaires and University Exit Questionnaires that include questions related to communication skills. Feedback from these questionnaires is provided to the faculty by the Department Head at the annual faculty retreat and curriculum review.

6. Alumni are surveyed periodically to on the quality of their preparation for a professional environment. Questions pertaining to the effectiveness of the communications component of the curriculum are included. Feedback from these surveys is provided to the faculty by the Department Head at the annual faculty retreat and curriculum review.

7. Employers are surveyed periodically to provide feedback on the skills of our alumni. Questions pertaining to the communication skills of our alumni are included. Feedback from these surveys is provided to the faculty by the Department Head at the annual faculty retreat and curriculum review.

8. External evaluations are gathered on our Co-op students from their industrial supervisors. These evaluations include feedback on the written communication skills of the students. Feedback from these reviews is provided to the faculty by the Department Coop Advisor(s) at the annual faculty retreat and curriculum review.

9. Feedback from exit interviews, exit questionnaires, surveys, and external evaluations (Co-op) evaluations are reviewed by the faculty at the annual retreat and curriculum review, and are used as a basis for recommending modifications to curriculum.

VII. Required Resources from Outside the Chemical Engineering Department

Courses outside the Chemical Engineering Department that are mentioned in the plan are already required courses in our curriculum. Inclusion of these courses does not represent a new requirement, and no new arrangements need to be made with the offering departments.

Implementation of new parts of the plan will require the purchase of a video camcorder for the recording and play back of student presentations. The Department of Chemical Engineering will cover the cost for this equipment.