Assessment of Teaming, Writing, and Speaking Instruction in Chemical Engineering Courses

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A multidisciplinary faculty team at North Carolina State University has been iteratively designing and implementing teaming, writing, and speaking instructional modules to be implemented within a junior-level chemical engineering laboratory course and a senior level capstone design course. The laboratory course is the first course in the curriculum to require collaborative writing and oral presentations, so team management and interpersonal dynamics within the team structure are integral parts of the instructional material. The senior capstone design course in chemical engineering provides students with a realistic experience of industrial practice in process design. At NCSU, this often involves industrial sponsorship and mentoring of projects that require a multidisciplinary student team. This presents the students with unique teaming, writing and speaking challenges as they attempt to transcend genre-specific communication norms to produce coherent and effective documents and presentations. The paper will report the research findings and assessment results of this three-year effort, with a focus on the performance of the most recent year's courses. These represent the first offerings of fully developed teaming, writing and speaking (TWS) instruction in each class. The results indicate that while TWS instruction does contribute to enhanced performance in the laboratory class, senior design has so many confounding factors, such as the presence of team members from different disciplines, the possible receipt of previous TWS instruction, and the different levels of project mentor involvement, that TWS instruction did not significantly improve teaming, writing and speaking performance. Future curricular implementation issues and instructional recommendations will be proposed, based on these results.

Description of Instruction

Junior Level Unit Operations Course

The junior-level Teaming, Writing, and Speaking (TWS) instruction series was designed to complement a junior-level chemical engineering laboratory survey course (CHE 330). As a part of CHE 330, students meet one morning a week for hour-long lectures on statistics and experimental design. In addition, they have one three-hour afternoon period reserved every week for experiments. Students who enroll in the course attend four two-hour TWS modules, which take place during their allotted lab time on weeks when there is no experiment scheduled. As a team, they also schedule four one-hour appointments throughout the semester with a writing and speaking consultant.

The junior-level TWS module focuses on developing collaborative oral and written technical communication skills. Module content addresses how members of teams prepare oral and

written laboratory reports and identify and resolve issues related to writing, speaking, and interpersonal interaction. The four modules cover the following areas:

Module Session #1: Introduction to Teaming
Module Session #2: Collaborative Writing and Editing
Module Session #3: Interpersonal Aspects of Teaming
Module Session #4: Preparing and Delivering Collaborative Presentations

The content of these modules can be found at the project web site (http://www2.ncsu.edu/unity/lockers/project/actionagenda/pages/revisecourse/tws_instructional_materials/jr_lab_instruct_materials.html.) The target learning proficiencies are listed in Table 1.

Table 1: Junior-level TWS proficiencies and corresponding skills

Proficiency	*Corresponding skills*
Collaborative technical writing	• write collaboratively • function as a peer editor
Collaborative technical presentation	• convey technical material orally as a team in a way appropriate to the audience • work collaboratively to design and conduct a technical presentation
Teaming	• identify and fulfill team roles • create, use, and revise team ground rules • recognize and manage conflict in teams • recognize and manage decision making in teams • provide frequent and productive feedback to team members regarding teaming, writing, and speaking skills

Using in-class activities and discussions, the TWS module applies topics in technical and small-group communication to real engineering teams and projects within the context of the course. Students are encouraged to develop a casual and productive inter- and intra-group rapport and are frequently asked to work in teams to discuss situations or perform tasks and then share their findings with the class. The instructor has structured activities and prepared lecture material to facilitate the instruction.

Individual team consultations, on the other hand, are unscripted—although they frequently explore themes such as graphic communication, effective style, mechanics, or academic integrity. The primary focus of these sessions, however, is to allow students to bring the consultant a work-in-progress for discussion in a workshop setting. The consultation sessions emphasize the importance of developing and implementing a systematic writing and editing team process. Often the consultant facilitates the integration of the collaborative writing, presenting, and editing skills that students were exposed to in the module by helping them apply these skills to creating the reports and presentations required by the laboratory portion of the course.

Teams of 3-4 members each were selected based on the day of the week each team was scheduled for the course. TWS was taught Monday, Tuesday, and Wednesday, and not on Thursday or Friday. Subsequent analysis of the average GPA for each team in both groups indicated no significant differences between the two groups. Non-TWS students were aware of the TWS instruction, but since the instruction was offered during otherwise non-structured laboratory time, the non-TWS teams were free to use that time to perform additional experiments, analyze data collected, or meet to discuss other aspects of the laboratory report (writing assignments, proofreading, etc.).

Senior Level Capstone Design

In the spring of their senior year, students in the chemical engineering department take a two-semester, six-credit capstone design course. This course has projects that include students in departments across campus, providing them an opportunity to work on multidisciplinary projects and teams. Students who register find their own (or are assigned to) industrial problems and clients, conduct research, and design a complete engineering solution which may include a process simulation model, equipment sizing and costing, environmental and safety analysis, etc. Throughout the semester, teams communicate their findings to both the client and faculty advisors through written status reports and oral presentations.

Six of the twenty-one groups whose performances were analyzed were multidisciplinary, and involved students from Departments of Materials Science, Food Science, and Computer Science. Placement of teams into TWS and non-TWS cohorts was done following analysis of the average GPA of each team, and represented an effort to equally distribute high and low GPA teams between the two. While each student involved would have already completed a technical writing class, no attempt was made to form or distribute teams based on prior TWS instruction in the CHE laboratory class.

The target learning proficiencies are listed in Table 2. They are an expansion of the proficiencies stated for the laboratory course, anticipating that eventually all students will receive instruction at both levels. The form of the instruction, however, is changed. Because each team's project, composition, and issues are unique, and because students' major departments have different ways of scheduling senior design projects, the TWS instruction that accompanies senior design is entirely consultation based. The consultation sessions are scheduled by the teams before each of four major phase reports. The students, who are encouraged to view the sessions as contracted consultations between engineers and a professional writing and speaking specialist, discuss drafts of reports and practice presentations. Aside from treating documents and oral rehearsal directly, the consultant also advises students on the management of the issues inherent to writing, speaking, and participating multidisciplinary teams.

Table 2: Senior design TWS proficiencies and corresponding skills

Proficiency	*Corresponding skills*
Multidisciplinary collaborative technical writing	• collaboratively write and organize multidisciplinary reports • manage disciplinary conventions to produce unified documents • function as a non-technical peer editor
Multidisciplinary collaborative technical presentation	• convey technical material orally as a team in a way appropriate to an audience of diverse discipline and interest • work collaboratively to design and conduct a multidisciplinary technical presentation
Multidisciplinary teaming	• recognize and manage disciplinary conventions • recognize and manage task performance to utilize diverse expertise • recognize and manage decision making associated with designing multidisciplinary solutions • provide frequent and productive feedback to team members regarding teaming, writing, and speaking skills

The grading of the senior design course is predominantly dependent upon the four project reports and two oral presentations. The mid-semester oral presentation and class attendance each represent 10% of the final grade. Each of the first three project reports and the final oral presentation represent 15% of the final grade, while the final project report is worth 20% of the final grade.

Instructional portability and integration

The transfer of teaming, writing, and speaking instruction to other universities was a primary consideration when designing the TWS modules. The module format employs interchangeable, independent discussions and exercises that can be assembled in a variety of ways to suit the needs of institutions with a variety of demands and resources. Likewise, the consultation format allows for flexible scheduling and targeted, personalized team attention. The two formats can be used alone or in combination, allowing an instructor to devote as much time as is desired. Customization and implementation support materials were created that highlight these curricular features; the website (http://www2.ncsu.edu/unity/lockers/project/actionagenda/index.html) offers reflective questions, anecdotal case material, and experience-based suggestions for customizing and implementing an effective version of the curriculum.

Taken together, the junior- and senior-level instruction represents an attempt to take the students from genre-specific collaborative written and oral communication to multidisciplinary teaming, writing and speaking. By directly integrating technical communication and project management concepts into the assignments and requirements of associated engineering courses, students are encouraged to develop a perception of themselves as communicating professionals. Instructional time in the series functions independently of the laboratory and lecture courses, affording students opportunities to work with a consultant, to experiment with communication, and to develop their own understanding of and ways of applying technical communication concepts. In this way, students witness directly the value added by developing technical communication skills.

Assessment Protocol

Five assessment mechanisms were used to evaluate writing, speaking, and teaming performance of students in the lab and design course. Assessment protocols included grades on writing and speaking assignments, student peer evaluations of team performance, and external evaluations of writing and speaking products (see Table 3 for a summary of data collected). For the purpose of the assessment, students were grouped into two subpopulations for each course; those receiving TWS instruction (TWS) and those who did not receive TWS instruction (nTWS).

Table 3: Summary of Data Collected

Data	*Competency*	*nTWS*		*TWS*	
		Lab	*Design*	*Lab*	*Design*
Student Grades	WS	25	35	46	42
External Evaluations of Speaking	S	11 teams	10 teams	8 teams	9 teams
External Evaluations of Writing	W	5 teams	8 teams	7 teams	13 teams
Peer Evaluations	T		8 teams		13 teams

Teaming, Writing, and Speaking Assessment

Student Pre/Post Surveys

Pre- and post-surveys were given to students enrolled in the laboratory and design courses. This survey tested students' attitudes toward their major, their experiences with writing, speaking, and teaming, and their self-report of prior grades received in other communication courses (Appendix A).

Writing and Speaking Assessment

Student Grades on Writing and Speaking Assignments

To determine whether the instructional interventions in the lab and design course contributed to students' success in writing and speaking, academic grades were gathered from students enrolled in the courses. For each laboratory course, grades were collected on 4 writing assignments and 2 speaking assignments. In the design course, grades were collected on 4 writing assignments and 2 speaking assignments. With regards to data analysis, only final grades for oral and written presentations were analyzed for the design course.

External Evaluation of Writing and Speaking Products

For the laboratory and senior design course, external evaluations were completed of final writing and speaking products. To evaluate speaking competence, two external evaluators were trained using sample students presentations and a holistic rubric (1-5) to achieve inter-rater reliability. Raters evaluated student presentations separately and evaluations were compared for consistency. Students' final design and laboratory presentations were videotaped in each course. Evaluations were completed on 21 written presentations in the design course and 19 oral presentations in the laboratory course (See Appendix B for evaluation rubric for oral presentations and Appendix C for evaluation rubric for written reports).

Teaming Assessment

Peer Evaluations of Team Performance

Student in the design course filled out peer evaluations on their teammates' performance as a team member. Peer evaluations were used to gather data on student perceptions of their peers' teaming abilities. These evaluations were used to create an index of internal consistency among team members and were compared with student performance on mid-semester and final written and oral projects. While there were no statistically significant differences in the teams internal consistency scores and performance, anecdotal evidence suggests that some teams completed the assessments together and gave each other the same grades and that there were teams where the efforts of a few students carried the success of the entire group. Further refinements of team data collection methods should address these issues. (See Appendix D for Peer Evaluation form).

Assessment Results

CHE 330 Laboratory Course

Student grades on the writing and speaking assignments are presented below. Two professors teach the course, each with responsibility for grading reports on specific experiments. Oral presentations are graded jointly. The report grade progression indicated in the table is typical for

this course because of the involvement of two professors. Students receive feedback from one professor on their first report, and make adjustments for the second report, which is usually graded by the other professor. The second report is often graded lower than the first because of differences in technical expectation and writing style between the two professors. Subsequent reports tend to receive higher grades as the students incorporate grader-specific feedback and gain insight into experimental design and execution.

Table 4: Comparison of TWS and non-TWS teams in the laboratory course

	Report 1	Report 2	Report 3	Report 4	Presentation 1	Presentation 2
TWS	84.54	74.91	86.27	88.57	85.13	88.84
Non-TWS	82.5	78	83.96	85.8	82.56	85.14
STD DEV	7.7	8.9	3.2	3.8	6.3	5.3
Z-test score	1.84	2.25	**4.89***	**4.94***	2.77	**4.74***
* statistically significant at the .01 level						

While student performance improved across the board as the semester progressed, there are statistically significant differences (indicated in bold) between the TWS and non-TWS groups. These results suggest that TWS student teams more effectively used the feedback they received to improve both writing and speaking performance.

External reviewers evaluated the oral presentation of the material, as well as the introductions to the first and third lab report of the semester. Table 5 summarizes the results. Surprisingly, there was no statistically significant difference between these groups regarding oral performance, or regarding the writing of the report introduction.

Table 5: External evaluations of oral and written presentations in the laboratory course

	Oral		Written 1		Written 3		I□□□□□□□□□□	
	TWS	nTWS	TWS	nTWS	TWS	nTWS	TWS	nTWS
Avg	2.68	2.69	2.74	2.70	2.79	2.39	0.04	-0.31
St dev	1.09	1.20	0.498	0.575	0.477	0.479	0.730	0.690
N	11	8	7	5	7	5	7	5
Z-test	0.01		0.129		1.422		0.863	

CHE 451 Design Course

One faculty member graded specific written reports in the design course for the entire semester, as opposed to the multiple graders employed in the laboratory course. Both faculty members grade oral reports. Teams received feedback on three progress reports and one mid-semester oral report prior to receiving the grades shown in the table below. The final course grade included their performance on these earlier reports and classroom attendance, as well as the final reports.

Two axes of influence were identified; TWS instruction and multidisciplinary team composition. These influences were analyzed individually and in tandem. The cohort was split into 4 distinct groups - those that were multidisciplinary and received TWS instruction (TWS/MD), those that were single disciplinary and received TWS instruction (TWS/SD), those that were multidisciplinary but received no TWS instruction (nTWS/MD), and those that were

single disciplinary and received no TWS instruction (nTWS/SD). This was done in an attempt to clarify the effect of multidisciplinary involvement on student performance.

Table 6: Comparison of TWS and non-TWS teams in senior design

	Final Oral Report	Final Written Report	Final Course Grade
TWS (n=42)	87.48	91.14	84
Non TWS (n=35)	83.32	91.29	87
STD DEV	8.15	5.52	8
Z-test score	**3.32**	0.176	2.44

Students in the TWS group had statistically significant (indicated in bold) higher scores on the final oral report than non-TWS students.

Table 7: Comparison of MD and SD teams in senior design

	Final Oral Report	Final Written Report	Final Course Grade
MD (n=35)	92.63	93.8	89
SD (N=62)	83.33	90.05	85
STD DEV	8.82	5.51	7.72
Z-test score	**6.24**	**5.36**	**4.044**

Holding the TWS experience constant, students in multidisciplinary teams (MD) had statistically significant (indicated in bold) higher grades on the final oral and written reports as well as final course grade.

Table 8: Comparison of average final grades for the four cohorts

	Final Oral Report	Final Written Report	Final Course Grade
TWS/MD (n=16)	93.19	95.75	86
TWS/SD (n=26)	83.96	88.31	83
nTWS/MD (n=19)	92.16	92.16	92
nTWS/SD (n=36)	82.86	91.34	87
STD DEV	8.48	5.45	7.92
	Z-test scores		
TWS/MD vs TWS/SD	**4.87**	**3.23**	0.51
TWS/MD vs nTWS/MD	0.66	2.83	2.58
TWS/MD vs nTWS/SD	**4.78**	0.656	2.75

As indicated in Table 8, the TWS/MD group scored significantly better than their counterparts in TWS/SD and nTWS/SD groups on the final oral reports, and better on the final written report than the TWS/SD group. Non-TWS/MD groups also had significantly higher scores on their final oral presentation. These results suggest that for senior design, the disciplinary composition had a larger influence on performance than the presence or absence of TWS instruction. Since many of the CHE students received TWS instruction previously, and since students from other disciplines may have received separate TWS instruction in their

curricula, the particular challenges presented by confronting disciplinary communication may have spurred greater attention or effort to communication issues for MD teams, resulting in improved performance.

External reviewers were employed to evaluate written and oral presentations. The results of these analyses are presented in Table 9. It is clear that the multidisciplinary aspect of the design team is the dominant influence on the quality of the project report. The MD influence on student performance was not the initial scope of this project. However the reality of multidisciplinary skills for success in the workforce raises new questions and opportunities to prepare students for greater success after graduation.

Table 9: External evaluation of final oral presentation and final writing samples for senior design

	Oral presentation		Written report	
	Average	**Std dev**	**Average**	**Std dev**
TWS/SD	3.43 (n=14)	0.938	3.28 (n=10)	0.555
TWS/MD	4.50 (n=4)	1.00	3.09 (n=4)	0.904
nTWS/MD	4.00 (n=6)	0.894	2.38 (n=6)	0.335
nTWS/SD	3.14 (n=14)	0.663	3.43 (n=16)	0.278
TWS/SD vs.	**z-test scores**		**z-test scores**	
TWS/MD	1.916		0.374	
nTWS/MD	1.29		**4.042**	
nTWS/SD	0.930		0.82	
nTWS/MD vs. nTWS/SD	2.112		**6.871**	

The external reviewers also evaluated the improvement made in writing over the course of the semester for each group by scoring the same section of the report taken from the first and last reports of the semester. The results, summarized in Table 10, further support the conclusion that MD teams face particular challenges regarding the writing of collaborative reports.

Table 10: External evaluation of improvement of written report samples for senior design

	Avg. Improvement	**St dev**
TWS/SD	0.63 (n=16)	1.06
TWS/MD	0.25 (n=6)	1.55
nTWS/MD	-0.27 (n=6)	0.47
nTWS/SD	0.73 (n=16)	0.72
TWS/SD vs.	**z-test scores**	
TWS/MD	0.660	
nTWS/MD	**2.640**	
nTWS/SD	0.298	
nTWS/MD vs. nTWS/SD	**-3.808**	

Peer evaluations were collected from all senior design students. There was a distinct dissatisfaction among the MD groups that did not have explicit teaming training as part of the TWS instruction, as indicated by the statistically significant difference between peer evaluations for the nTWS/MD and nTWS/SD groups shown in Table 11.

Table 11: Peer evaluation of teamwork for senior design

	Average	St dev
TWS/SD	88.33 (n=60)	13.97
TWS/MD	90.63 (n=72)	15.24
nTWS/MD	80.74 (n=37)	20.33
nTWS/SD	91.77 (n=117)	11.97
TWS/SD vs.	**z-test scores**	
TWS/MD	-0.90	
nTWS/MD	2.00	
nTWS/SD	-1.63	
nTWS/MD vs. nTWS/SD	**-3.13**	

Conclusions

Statistically significant differences in student performance were found between the TWS and non-TWS groups in both the laboratory and design courses. In the case where there are no confounding variables (single disciplinary lab course), TWS instruction significantly improved student performance in oral and written communication. While oral communication was also improved with TWS instruction in the design course, the presence of additional influences, such as prior TWS instruction, personality conflicts between teams and the TWS consultant, and unique communication challenges of multidisciplinary teams, masks the impact of TWS instruction on performance.

Furthermore, it is clear that further instructional development is required to address more explicitly the issues surrounding multidisciplinary collaborations, most importantly in collaborative writing efforts. A fuller exploration of genre norms for each discipline involved is warranted.

BIOGRAPHICAL INFORMATION

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Chris M. Anson received his Ph.D. from Indiana University and is Professor of English and Director of the Campus Writing and Speaking Program at North Carolina State University, where he teaches graduate and undergraduate courses in language, composition, and literacy and works with faculty in nine colleges to reform undergraduate education in the areas of writing and speaking. He has published widely.

PAULA BERARDINELLI
Paula Berardinelli received her Doctorate of Education in Training and Development from North Carolina State University and a Master's in Health Education and a Bachelor's in Health Planning and Administration, both from The Pennsylvania State University. She is currently an Assistant Professor of the Training and Development Program at North Carolina State University and has worked as a consultant in a variety of industries.

LISA BULLARD
Lisa G. Bullard received her BS in ChE from NC State and her Ph.D. in ChE from Carnegie Mellon. She served in engineering and management positions within Eastman Chemical Co. from 1991-2000. At N.C. State, she is currently the Director of Undergraduate Studies in Chemical Engineering.

DEANNA P. DANNELS
Deanna P. Dannels received her Ph.D. in Communication from the University of Utah and is currently an Assistant Professor in the Department of Communication and the Assistant Director of the Campus Writing and Speaking Program at North Carolina State University. She teaches courses on instructional theory and research methods and her research focuses on learning communication in technical disciplines, with a specific emphasis on engineering.

DAVE KMIEC
David Kmiec has an undergraduate degree in chemistry and English from University of North Carolina at Wilmington and is currently pursuing his MS in Technical Communication at North Carolina State University. He has worked in writing and speaking centers at both universities and is currently a technical consultant and trainer for Scriptorium Publishing in Research Triangle Park, NC.

STEVEN W. PERETTI
Steven W. Peretti is an Associate Professor of Chemical Engineering at North Carolina State University. A recipient of the NSF Presidential Young Investigator Award in 1991, he has directed research in bacterial protein synthesis, bioremediation, gene transfer in biofilms, and green chemistry applications of bioconversion processes. Recently, he has become active in the areas of cross-disciplinary education and service learning.

Appendix A: Pre-Course Survey for CHE 330

Name (Last, First) _____

*__Gender:__ ___ Female ____ Male

***Ethnicity:** ___ African American ___ Asian American ___ Caucasian ___ Hispanic

___ Native American ___ other: _____

What is your concentration?

_____ polymers _____ bioscience _____ pollution prevention _____ electronic materials

_____ standard CHE curriculum

Please list your grades in the following courses:

_____CHE 311 _____CHE 315 _____ ENG 111 _____ENG 112 _____COM 110 _____COM 301

Do you have co-op experience? Yes_____ No_____

Do you have internship experience? Yes_____ No_____

Have you had experience working in teams in college courses? Yes_____ No_____

Have you had instruction in teamwork skills? Yes_____ No_____

If yes, where? ____ in a university workshop _____ in an industry workshop

____ as part of a high school course _____ as part of a university course

____ other: _____

Please evaluate your ability to perform and confidence in performing the following tasks:

1	2	3	4	5
Novice		Average		Expert

	Score
Identify and fulfill team roles	_____
Create, use, and revise team ground rules	_____
Write collaboratively	_____
Function as a peer editor	_____
Recognize and manage conflict in teams	_____
Recognize and manage decision making in teams	_____
Convey technical material orally in a way appropriate to the audience	_____
Work collaboratively to design and conduct a technical presentation	_____
Provide frequent and productive feedback to team members regarding teaming, writing, and speaking skills	_____

* This information is used in ABET accreditation and other processes to demonstrate continuous improvement of different constituencies. We would be grateful if you answer every question, but if for any reason you wish to skip those on gender and ethnicity you may do so. All replies will be held confidential.

CHE 330 Post Course Survey

Name (Last, First) _____

Now that you have completed the 330 teaming, writing, and speaking module, please use the scale below to evaluate ability to perform and confidence in performing the following tasks:

1	2	3	4	5
Novice		Average		Expert

	Score
Identify and fulfill team roles	_____
Create, use, and revise team ground rules	_____
Write collaboratively	_____
Function as a peer editor	_____
Recognize and manage conflict in teams	_____
Recognize and manage decision making in teams	_____
Convey technical material orally in a way appropriate to the audience	_____
Work collaboratively to design and conduct a technical presentation	_____
Provide frequent and productive feedback to team members regarding teaming, writing, and speaking skills	_____

Please answer the following questions based on your experience in the TWS module.

4. What class activities or assignments did you find most helpful?

5. What class activities or assignments did you find least helpful?

6. What comments do you have about the group writing/editing consultation sessions?

7. What suggestions do you have for improving TWS?

Appendix B: Evaluation rubric for oral presentations

ORAL REPORT -- GRADING CHECKLIST

Team: **Phase:**
Date: **Evaluator:**

	Possible Points	Score
Technical Content (60%)		
Topic mastery, including technical correctness	**20**	
All requested deliverables included	**15**	
Appropriate level of detail	**15**	
Completeness of analysis and interpretation of data	**10**	
Organization (15%)	**15**	
Introduction clearly identifies purpose, approach, and preview of main points		
Content is clearly organized and supports the purpose		
Conclusion provides clear, memorable summary of design		
Introduction and conclusion are tailored appropriately to the audience		
Presenters respond to questions clearly, sufficiently, and succinctly		
Presentation includes logical transitions from one presenter to another		
Presentation (15%)	**15**	
Presenters are professional in their dress, language, and style		
Movement, eye contact, & gestures enhance presentation and do not distract from it		
Vocal quality is varied and illustrates interest in topic and design work		
Presenters speak with appropriate pace & volume		
Presenters make reference to other parts of the presentation and connect their part to the whole		
Layout/Visuals (10%)	**10**	
Visuals are clear, consistent, readable and understandable		
Visuals accurately follow the oral presentation and provide "visual map" of presentation		
Total Score		

Appendix C: Evaluation Rubric for Written Presentations

WRITTEN REPORT -- GRADING CHECKLIST

Team: **Phase:**
Date: **Coach:**

	Possible Points	**Score**
Technical Content (60%)		
Topic mastery, including technical correctness	**20**	
All requested deliverables included	**15**	
Appropriate level of detail and thoroughness of documentation	**15**	
Completeness of analysis and interpretation of data	**10**	
Organization (15%)	**15**	
Clearly identified purpose and approach		
Content is clearly organized and supports the objective		
Transitions between topics		
Presentation (15%)	**15**	
Easy to read		
Grammatically and stylistically correct		
Uniform writing style		
Layout/Visuals (10%)	**10**	
Consistent presentation of graphics		
Uniform document design and layout		
Total Score		

Appendix D: Peer Evaluation Rubric

PEER RATING OF TEAM MEMBERS

Name_____ **Group #**_____

Please write the names of all of your team members, INCLUDING YOURSELF, and rate the degree to which each member fulfilled his/her responsibilities in completing the homework assignments. The possible ratings are as follows:

Excellent	Consistently went above and beyond—tutored teammates, carried more than his/her fair share of the load
Very good	Consistently did what he/she was supposed to do, very well prepared and cooperative
Satisfactory	Usually did what he/she was supposed to do, acceptably prepared and cooperative
Ordinary	Often did what he/she was supposed to do, minimally prepared and cooperative
Marginal	Sometimes failed to show up or complete assignments, rarely prepared
Deficient	Often failed to show up or complete assignments, rarely prepared
Unsatisfactory	Consistently failed to show up or complete assignments, unprepared
Superficial	Practically no participation
No show	No participation at all

These ratings should reflect each individual's level of participation and effort and sense of responsibility, not his or her academic ability.

Name of team member	**Rating**
_____	_____
_____	_____
_____	_____
_____	_____

Your signature: _____

_____

R.M. Felder, 1997. Each student fills out this form, instructor collects and uses to adjust team project grades for individual team members using procedure on following page.

Appendix E: Teaming Rubric

Teamwork—Grading Checklist		
Team:		
Date:		
Evaluator:		
	Possible Pts	Score
Team Project Management (30%)		
Team set and followed collaborative goals and ground rules	**10**	
Team set timelines for project completion and managed their work to met critical path requirements	**10**	
Entire team kept and participated in meetings with_____ (Pick appropriate one: faculty advisors, TWS consultant, industry sponsors)	**10**	
Productivity of Team (40%)		
Team delegated work among members responsibly and appropriately	**10**	
Individual team members contributed an appropriate amount of effort and time toward team	**10**	
Team coordinated effective information exchange between all members	**10**	
Team collaboratively addressed feedback from multiple sources and successfully incorporated it into subsequent deliverables	**10**	
Cohesiveness of Team (30%)		
Team members made efforts to understand, include, and respect other team member's perspectives and ideas	**10**	
Team addressed personality problems and conflicts as a constructive whole—not as separate individual members	**10**	
Team oral presentations and written reports reflected integration of different members' content into a coherent team voice	**10**	
Total Score (100%)	**100**	

Comments: