

Portfolio Assessment and Improvement for a First-Year Engineering Curriculum

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Abstract:

For the past five years, the South Dakota School of Mines and Technology has redefined its first-year engineering curriculum. The program, now required of all first year engineering students, incorporates curricular elements developed by the Foundation Coalition and elements from the EPICS program at the Colorado School of Mines. As part of the course, students are required to develop and maintain an electronic portfolio. Required postings are designed not only for student professional development but for ease of assessment of defined program outcomes. In this paper, we present a brief description of the program, defined program outcomes, and assessment processes currently in use along with results and current strategies for improvement. A discussion of the use of portfolios, sample rubrics, and improvement processes for portfolio development is included.

Introduction:

GE 115, Professionalism in Engineering and Science, is a first-year introductory engineering course taught at the South Dakota School of Mines and technology. The course is intended as an introduction to:

- engineering as a profession
- teaming
- problem solving
- engineering data analysis
- engineering ethics
- preparing and writing technical reports

Thus, the course contains no discipline-specific content. Rather, faculty from all 10 engineering programs on campus have taken part in the course instruction. Curricular materials have been prepared by several of the participating faculty and have been organized into chapters that make up a Student Manual that is available to the students on a CD ROM.

Curricular materials adhere to and follow recent trends in engineering education and incorporates project-based learning^{6,9,18}, cooperative learning^{6,8,14} and technology-enabled learning^{13,14}. Aspects of the curriculum have been taken and or modified from the EPICS program at Colorado School of Mines, Foundation Coalition, and the SUCCEED Coalition, (see, for example^{1,2,4,6-8,14,16}).

Course sections are limited to 25 students that are subsequently divided into five 5-member teams. All sections are taught in a common classroom that is equipped with tables and chairs (each team has a dedicated table), overhead LCD projection, and wireless notebook PCs. There is also a sixth table that is used as a common work space. The course is 2 credit-hours and is taught as a 1-hour lecture and a 2-hour laboratory session each week. In addition, several common 1-hour meetings are held each semester where all students come together for a required program activity. During a typical academic year, the program sees approximately 370 students.

Program Objectives and Outcomes:

The program incorporates 5 learning objectives and nine course outcomes (Table 1), which are contained on the syllabus for the students to purview and gage their progress. Further, course outcomes are mapped to ABET criterion 3:a-k (Fig. 1) and are used in the course assessment to make refinements to the curricula.

Assessment Processes and Tools

Program curricula are assessed using a variety of tools, including:

- personal web-based online electronic portfolios
- digital archiving of select documents
- rubrics for evaluating specific content
 - : webpages and electronic portfolio
 - : proficiency using Excel for problem solving
 - : proficiency in technical writing
- student opinion surveys
- student software surveys

Students are made aware of the assessment processes and tools that will be used early in each semester and all subsequent work is performed using assessment criteria as a guide.

Portfolios for Assessment: A portfolio is a valid means for students to gage their academic progress and growth and a means for them to become engaged and motivated about the learning process¹²⁻¹³. For the student, portfolios provide a sense of ownership for the completed work. For the instructor, it is a way to evaluate curricular content and effectiveness. At its most basic level, a portfolio is a simple but effective evaluation tool. At a higher level, portfolio's offer a method of motivation for each student; initial assignments are corrected, including suggestions for improvement, and returned to the student that then re-works the problem, correcting initial mistakes, and re-submits a better product. The work contained in the portfolio represents then, the minimum motivational and achievement level the student has chosen to operate in at any particular time, i.e., portfolio's always include the opportunity for the student to enhance their performance. Using the above definition, portfolio's are snap-shots of a

Table 1. Learning objectives and course outcomes for the GE 115 course.

Objectives: To make the most of this course, it is recommended that students adopt the following five learning objectives to guide their priorities and actions during this term.

1. Be able to use technology tools (World Wide Web, Excel, PowerPoint, analysis software) to analyze, solve, and present solutions to engineering problems.
2. Become an effective team member.
3. Develop the communication skills necessary to package acquired technical and professional abilities that are required to succeed in engineering practice.
4. Understand the engineering profession enough to commit to a major and create an education/career plan.
5. Develop motivation for self-responsibility, life-long learning, and self-development of a person of good character.

Course Outcomes: Upon completion of the course, students will be able to

1. Document a rationale for selection in their chosen major.
2. Author a web page and post to the Internet.
3. Incorporate the rules of significant digits when solving problems and check for dimensional consistency.
4. Incorporate the 7-step approach to solving engineering problems using engineering ethical standards.
5. Utilize Excel to solve fundamental problems in engineering.
6. Use a data acquisition system to collect experimental data.
7. Utilize Excel to analyze data and conduct a trend analysis on experimental data.
8. Utilize the fundamental principles of engineering design and team problem solving to design a rudimentary engineering system.
9. Utilize fundamental principles of technical writing to prepare a technical report, resume, and technical memorandum.

GE 115		ABET Criterion 3:a-k										
		a	b	c	d	e	f	g	h	i	j	k
Course Outcomes	1				2			1	1	2	1	
	2											3
	3	2										
	4					4						
	5	2										4
	6		4									
	7		3									4
	8	2	2	4	4	2	1					2
	9							4				

Figure 1. GE 115 program outcomes map for ABET criterion 3:a-k. Values are from 1 to 4 where a 4 represents significant emphasis.

point in time of a student's academic career and are fluid documents. Their use in assessment is, therefore, limited to timely evaluations after the close of each academic semester.

In addition, a portfolio provides a sense of continuity across disciplines. At SDSM&T, portfolios are used in GE 115, English 101, and several upper-level courses in many engineering disciplines. By the time a student graduates with a B.S. engineering degree, they will have compiled a complete record of their individual performance and growth in engineering analysis and writing that occurred throughout their academic career. These can become invaluable documents in searching for that first job where the prospective employer is now able to view the graduate's progression during their course work.

Portfolio assessment began in GE 115 with the new curriculum changes that occurred in 1999. For the first 2 years, paper portfolios were utilized where students collected samples of their work from several courses, organized them into a notebook, and submitted them for evaluation. Several problems were observed using this method including disorganized submissions, omitted documents, unprofessional appearance of the work, and arguably the most important, most students never returned at the beginning of the next term to collect their portfolio. This one fact alone implied that one of the main reasons for using a portfolio—to document academic progress and showcase student work—was being ignored. Contrarily, students who invested time in their portfolios did return to collect them and continued their cataloging documents in subsequent terms.

Electronic Portfolios and Digital Archiving: In an effort to eliminate problems that occurred using the paper portfolios, electronic portfolios (E-portfolios) began to be utilized in fall 2001. Webpage authoring and construction of an online E-portfolio page accessible from a student's WWW homepage is now an embedded part of the curriculum. Table 2 contains a list of the required posts that are to be placed online prior to the end of the semester. This list represents the minimum required E-portfolio content that is used in the assessment process and students may supplement this material with other documents and from other courses, as many do. However, past experience has shown that by the time assessment was performed, many E-portfolios were either not assessable (incomplete posting of the required materials) or that newer documents were already placed there between the completion of the course and the assessment. For example, assessment of E-portfolios for the fall 2002 semester involved initial evaluation of 257 URLs. At the time of assessment, 85 %, or 222, of the initial value remained active (contained at least some links to documents) and 15 %, or 35, were inactive (there was no portfolio at all). Of those that were active, only 131 had all required components, bringing the percentage of assessable E-portfolios to 51 %, or 131 of 257. This represents a significant reduction in assessment potential that faculty have no control over given the fluidity of E-portfolios and individual student control over maintenance and upkeep of the documents. In addition, 55 of the non-assessable E-portfolios failed to maintain a link to the technical project report and 19 had a web page but actually contained no assessable links to required posts. The remaining 20 were missing significant number of other components that made it impossible to assess.

Table 2. List of the required posts to student E-portfolios. Asterisks denote documents required to be posted to both the E-portfolio and the Digital Archive.

<u>Portfolio Element</u>
Web Page
Eng. Discipline Memo
Code of Cooperation
Resume
*Excel 1
*Excel 2
*Experimental Report
*Technical Report
*1 st Semester/year summary

Results such as these necessitated change to the way E-portfolios were maintained and used for assessment. Recognition of the fact that these are fluid documents requires evaluation to occur immediately after the end of the term, a process that is not always possible. Thus, a new tool, the Digital Archive, was initiated for the fall 2003 term. The Digital Archive was constructed using an Oracle database with a web-interface. The system was developed inside the High Priority Connections Network (HPCnet) on the campus of SDSM&T and is an internal campus-wide cataloging system that is used to collect permanent copies of select documents for assessment. Each student has their own personal Digital Archive that is password protected and is constructed with an open slot for specific documents that the students are required to post (Fig. 2). Throughout the term, any of the documents may be updated any number of times but they cannot be deleted. By the end of the term, the open window for posting expires and the Archive becomes dormant. The last document that was uploaded remains as the permanent 'archival' copy that is accessible by select faculty at any time allowing for complete evaluation and assessment of student work to be accomplished. It also has the advantage of allowing for longitudinal tracking of student progress throughout their academic career since all archived documents remain secure.

An additional feature of the Digital Archive is the ability for immediate assessment of a submitted document. For example, a student initially uploads a required document to the portfolio. The faculty has the option of evaluating that submission using say, a rubric, and then posting the completed rubric to the Archive that the student has access to. The student can utilize the comments and rating from the rubric to re-do the document and re-post it to the Archive. These assessments by a faculty would be posted to the column marked 'Assessment' in Figure 2 and can be multiple assessments.

Rubrics: A rubric is a simple guide that is used to evaluate content-specific criteria during an assessment of proficiency, or student mastery of a topic. Specifically designed for an intended use, a rubric contains the evaluation criteria to be used to assess mastery of the topic at various levels. Correctly designed and implemented, a rubric will provide very nearly the same results when used to evaluate one document by several evaluators.

Rubrics were designed following the work of the EPICS program at the Colorado School of Mines¹⁵ and were used to evaluate content and proficiency in three specific areas: 1) webpages and E-portfolios, 2) proficiency using Excel for problem solving, and 3) proficiency in technical writing. Each rubric contained more than one evaluation area. For example, the rubric used for proficiency using Excel included three topic areas: analysis, layout, and format. Each of these topic areas had content criteria for a rating of the work between ‘novice’, ‘apprentice’, and ‘proficient’. Each student was rated for each topic area and a composite score was determined for that rubric. Interested persons are referred to the Appendix for copies of the rubrics used in the GE 115 program assessment.



Digital Archive

[Digital Archive Portal](#) | [My Portal](#) | [SDSM&T Home Page](#)

Digital Archive Search Results

Results: 26-50 of 125 files

[Email Selected Students](#) | [Download Documents](#)

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Sort by: Major Ascending

Select	Student Name	Document	Assessment	Colleague ID#	Web Page
<input type="checkbox"/>	Geiger, Christopher	Excel Problem Solving	0	1296473	http://webpages.sdsmt.edu/~1296473
<input type="checkbox"/>	Geiger, Christopher	Excel Data Analysis	0	1296473	http://webpages.sdsmt.edu/~1296473
<input type="checkbox"/>	Geiger, Christopher	Coffee Pot Memo	0	1296473	http://webpages.sdsmt.edu/~1296473
<input type="checkbox"/>	Geiger, Christopher	Year-End Summary	0	1296473	http://webpages.sdsmt.edu/~1296473
<input type="checkbox"/>	Geiger, Christopher	Project Tech Report	0	1296473	http://webpages.sdsmt.edu/~1296473
<input type="checkbox"/>	Walz, Trevor	Excel Problem Solving	0	1062971	http://webpages.sdsmt.edu/~1062971
<input type="checkbox"/>	Walz, Trevor	Project Tech Report	0	1062971	http://webpages.sdsmt.edu/~1062971
<input type="checkbox"/>	Walz, Trevor	Year-End Summary	0	1062971	http://webpages.sdsmt.edu/~1062971
<input type="checkbox"/>	Walz, Trevor	Excel Data Analysis	0	1062971	http://webpages.sdsmt.edu/~1062971
<input type="checkbox"/>	Walz, Trevor	Coffee Pot Memo	0	1062971	http://webpages.sdsmt.edu/~1062971

Figure 2. Digital Archive faculty access page showing the 5 documents required to be posted by the student and if that document has been posted (marked by the active link). Student webpage addresses are also shown and are accessed by a simple click on the link. One button e-mailing to all students is also possible through this portal. For additional information on the Digital Archive, contact Dr. Kate Alley: Kate.Alley@sdsmt.edu.

Curricular components assessed using rubrics were subdivided into two primary topical areas: 1) technology (webpages, E-portfolios, Excel) and 2) technical writing. The technology component included separate rubrics for webpage design, required postings, and Excel for problem solving and data analysis. The technical writing component included two separate rubrics designed for assessing English vs. technical content.

Assessment Results:

Technology Rubrics: Student personal webpages and E-portfolios were assessed in 3 areas: format, layout, and content. The radar chart below (Fig. 3) shows the results of an analysis of 25 student webpages. In Figure 3, a score of 3 indicates a level of proficiency and a score of 0 indicates that which would be more consistent with that of a novice. All axis have a similar scale although only shown on one. Figure 3 would indicate that, for the most part, students had little difficulty designing and maintaining an effective web page (layout). Format (general appearance of the page and its professional look) and content (required postings present and accessible) were slightly more problematic, however, one should keep in mind that inconsistent student postings did not allow a truly random assessment of webpages to be made; i.e., only ‘complete’ pages were assessed. Consequently, scores may be somewhat inflated.

A fundamental technology topic in GE 115 was introducing students to Microsoft Excel. Although using Excel simply as a spreadsheet may have limited function for some engineering disciplines, it was a tool that all 10 engineering programs at SDSM&T agreed upon as a basic curricular component that had to be included in GE 115 for full campus participation in the program. The primary use of Excel in GE 115 remains two-fold: 1) to introduce students to using a spreadsheet for organizing and solving engineering problems in a methodical and logical format (similar to the old Fortran programming methodologies), and 2) to be able to perform data analysis including trend-lines and interpreting significance of a trend fit to the data. For solving engineering problems, we use the 7-step approach that is shown in Table 3. Student performances in using Excel were assessed using 2 specific assignments: Excel for solving engineering problems and Excel for performing engineering data analysis including fitting and interpreting trend lines. Results from this assessment are shown in Figure 4.

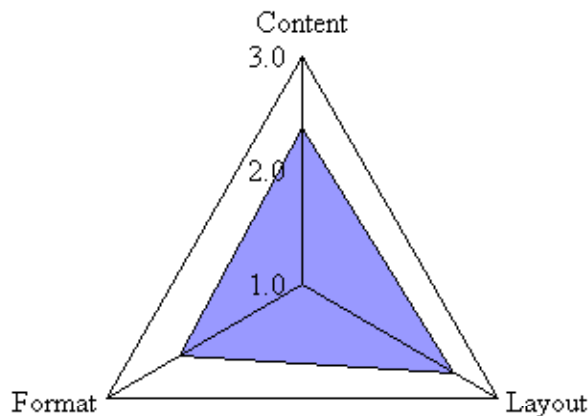


Figure 3. Results of webpage analysis for GE 115 in three topic areas.

Table 3. The 7-step approach to solving engineering problems used in GE 115.

Problem Statement
Diagram
Assumptions
Governing Equations
Calculations
Solution Check
Discussion

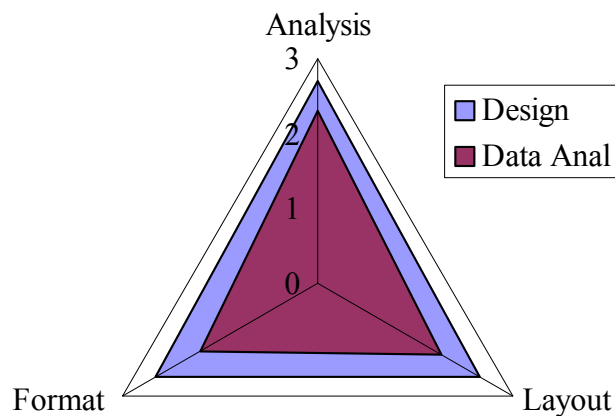


Figure 4. Ability to utilize excel to solve problems (design) and explore data (data analysis).

In Figure 4, a score of 3 indicates a level of proficiency and a score of 0 indicates that which would be more consistent with that of a novice. Figure 4 would indicate that students were relatively proficient at utilizing Excel to solve engineering problems. However, the specific assignment used for this assessment most likely skewed these results substantially as it was inadvertently designed not to provide significant challenge to the students. In this case, students completed a tank design that was very nearly identical to the problem covered in the student manual. It is not clear if students would do nearly as well if given a problem for which no template was available. Indeed, the inner area covering data analysis would indicate that students do not fair as well when a template is not available.

Technical Writing Rubrics: Technical writing was evaluated using two separate rubrics: 1) the campus-wide writing rubric (modified from Plumb and Scott ¹⁷ and 2) the GE 115 project rubric. The primary difference between the two rubrics was that the campus writing rubric did not provide adequate evaluation of technical aspects of a paper, such as problem solving, data analysis techniques and skills, and in evaluation of correct technical formatting. Studies are being made at SDSM&T ⁵ that addresses these inconsistencies between rubrics. For this analyses, both rubrics were utilized for comparative purposes (Fig. 5).

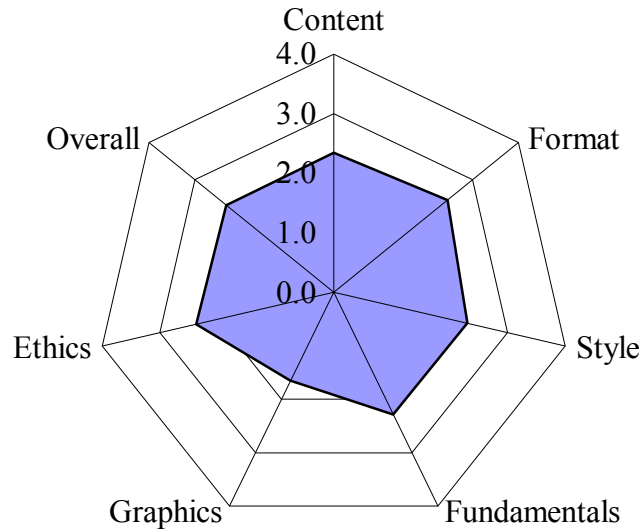


Figure 5. Results for technical writing in GE 115 using the campus-wide writing rubric.

In Figure 5, a score of 4.0 in any of the 7 assessed areas represents strong performance in that area. A score of 0 represents either a missing element or weak performance in a given area. In general, the data indicates that student writing at the freshman level was at an acceptable but not yet proficient level (average score of 2.0). The one exception to this was in the area of non-textual (graphics) elements which was rated as a 1.5. Students often failed to either effectively incorporate or label tables, figures, and equations into the project report. Given the timing of the course (1st semester of the 1st-year), this was perhaps not overly surprising and indicates areas for further emphasis.

Because of the manner in which project reports were posted, there were discussions on the way in which the assessment should be performed. Specifically, elements of the report, such as textual, data analysis components, and presentation elements were often separated and or scattered in the report making assessment more difficult. In these cases, faculty looked at all of the elements in order to assess problem solving and data analysis. With this caveat, Figure 6 shows the results of student performance on the technical project report using the GE 115 project rubric.

In Figure 6, a score of 3 indicates a level of proficiency and a score of 0 indicates that which would be more consistent with that of a novice. In general, student results on the team projects indicate that overall student performance was at the apprentice level.

Specifically, in the areas of organization and format, students often failed to effectively incorporate figures and tables, even after numerous examples were provided in class. On rare occasions when equations were incorporated in the text, variables were seldom identified and equations were almost always un-numbered. In the areas of problem solving and data analysis, students often failed to incorporate the 7-step approach to problem solving or excluded appropriate analysis from the report.

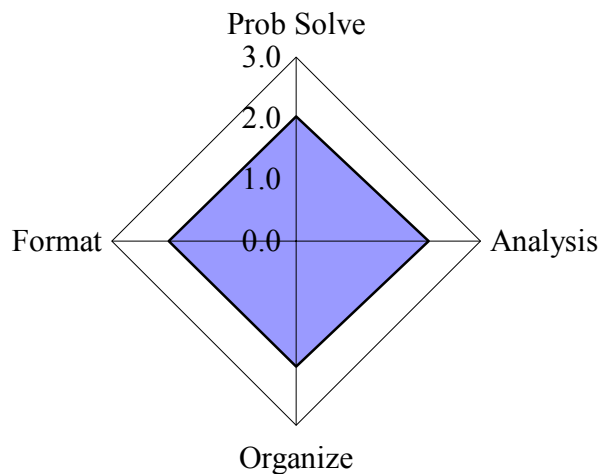


Figure 6. Assessment of technical writing using the GE 115 project rubric.

Assessment-Based Improvements:

There have been several curricular and/or evaluation changes made because of the results of the 2002 program assessment reported here. Primarily, the inclusion of the Digital Archive Tool that was utilized for the first time during the fall 2003 term, has provided a mechanism to track and monitor long-term student progression. Further future assessment of student performance in specific areas of the curriculum will have direct impact to curricular reform across the disciplines. This will no doubt remain an important assessment and evaluation tool.

With regards to technical writing, this report documents the first attempt on our campus to use a cross-disciplinary approach to assessment through the use of the campus writing rubric. Although this rubric originated in the Journal of Engineering Education, it was modified by the English faculty for general campus use. Having good utility for this purpose, it failed to adequately provide the engineering faculty a proper evaluation of the technical aspects of writing, and is being addressed through campus studies⁵.

Regarding the campus writing rubric itself, the faculty had several general comments:

- Although the rubric provides strong, acceptable, and weak categorizations, the faculty found it more useful to use a numbered scale with 4=strong and 0=weak. This allows for easier data analysis. This suggestion was adapted by the campus for use beginning fall of 2003.
- While ethics in writing is important, the faculty found it difficult to assess this category for the types of projects scored in GE 115. In most cases, this simply boiled down to a either a yes/no assessment of references.
- While the writing rubric is effective for evaluating writing, it is less so for evaluating technical content and general problem solving skills. This was solved by the development and institution of the GE 115 writing rubric which addressed these areas.

The ability to correctly setup, solve, and analyze engineering problems is crucial to all engineering programs. After this initial analysis, it was recognized that the process was incomplete not allowing the students to think through a problems, set it up, and solve it. The assignment was more of a repetitious, not creative, process. This weakness was overcome by developing and using new problems in the fall 2003 term that provided some degree of challenge for the students to solve. Data development on the spreadsheet became more of an issue than it had been and the students were required to think about what they needed to do as they entered and organized data prior to solving a specific problem.

Teaming remains an important curricular component of the course and teams consisting of 5 individuals are assigned during the 1st week of classes. All work during the lectures and labs are done as teams. Projects are performed as teams, and team meeting notes are kept in a journal maintained by the team. Indeed, a required posting to the E-portfolios is a copy of the Code of Cooperation (Table 2) which is a document developed by the team that outlines team rules of conduct. Assessment of these synergistic activities are evaluated in 2 ways: 1) faculty assessment of team function and productivity and 2) a team weighting form. A future addition to this process will undoubtedly consist of another rubric.

The program as it exists still has room for improvements. On the faculty side, all section instructors need to ensure they are utilizing the curriculum as it has been prepared and that they are provided the necessary information of the students regarding the E-portfolio posts, Digital Archive posts, etc. As we continue to engage the students and instill in them a attitude of learning, it is paramount that the faculty do not assume that we do not need to do the same.

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Biography:

DR. LARRY STETLER: Associate Professor of Geological Engineering and 1st-year engineering program coordinator. He oversees all aspects of the program and performs assessment of the 1st-year engineering program with other key faculty. Dr. Stetler has authored 16 technical papers appearing in journals and archival publications. His research interests include landscape evolution, engineering geology, and mechanics of particle transport. He is a member of the Association of Engineering Geologists, Geological Society of America, and the American Society for Engineering Education

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Appendix

GE 115 Scoring Rubrics

- A1. Campus Writing Rubric
- A2. WebPage Rubric
- A3. Excel Performance Rubric
- A4. Project Report Rubric

Campus-Wide Writing Rubric

A1

S = Strong = 4 A = Acceptable = 2 W = Weak = 0

Student ID#:

OUTCOMES	EVALUATION		
	S	A	W
1. The CONTENT of the document is effective.			
2. The document is ORGANIZED and FORMATTED appropriately for its intended audience and purpose.			
3. STYLE and TONE are appropriate for the intended audience and purpose.			
4. The document shows knowledge of writing FUNDAMENTALS.			
5. The NON-TEXTUAL ELEMENTS (graphs, charts, equations) are appropriate for the intended audience and purpose.			
6. The writing demonstrates an understanding of the ETHICS governing writing.			
Overall Evaluation			

KEY TO EVALUATING OUTCOMES

1. CONTENT

- Clearly states the purpose, providing an explicit justification for the document.
- Supports the purpose thoroughly and concisely.
- Explicitly defines the scope for the reader.
- Is factually correct.
- Substantiates claims and, when appropriate, addresses alternative claims

2. ORGANIZATION/FORMATting

- Conforms to conventions or requirements of the document type.
- Structures the content to represent a logical progression of ideas from introduction, to body, to conclusion sections.
- Uses a title, paragraphing, headings, and subheadings as appropriate to make the organization apparent to the reader and to facilitate navigation through the document.
- Uses effective transitional language to connect the pieces of the argument or document.

3. STYLE/TONE

- Holds the reader's interest.
- Includes a variety of sentence structures.
- Shows appropriate use of active and passive voice.
- Uses vocabulary that demonstrates an understanding of the content, concepts, and methods in the discipline.
- The tone (the writer's attitude toward the reader, the topic, and themselves):
- Takes the reader's knowledge into consideration.
- Matches the purpose in the level of formality.
- Presents a voice that is authentic and credible, so the reader knows that the writer understands the topic.

4. FUNDAMENTALS

- Uses correct punctuation, grammar, usage, and spelling.
- Uses proper citation form.

5. NON-TEXTUAL ELEMENTS

- Uses non-textual elements as necessary to enhance clarity and conciseness.
- Refers to, explains, and places non-textual elements appropriately in the text.
- Provides clear labels for tables, figures, and equations and sufficient space around these non-textual elements.

6. ETHICS

- Includes citations for any ideas, information, and/or non-textual material used from sources outside the writer.
- Does not use data selectively to manipulate reader.
- Acknowledges ideas or data that challenge the writer's conclusions.

Adapted from Carolyn Plumb and Cathie Scott, "Outcomes Assessment of Engineering Writing at the University of Washington," *Journal of Engineering Education*, 91, no. 3 (July 2002): 333-338.

Student ID#: _____

A2

Required Webpage Content:	Score
Construction of an accessible webpage	
Engineering discipline memo	
Resume	
Excel design problem--storage tank	
Excel analysis problem--Weibull distribution, population, or circuits	
Experimental report--coffee pot memo	
Technical report--trebuchet	
Final Webpage Content Rating:	

Score: 1 = item present on page; 0 = item absent (or not linked) from page

Webpage Design Criteria	3 Proficient	2 Apprentice	1 Novice	Score
Content/ Information	In addition to required postings, page contains information relevant to GE 115 projects as well as other class materials	Content information is restricted primarily to required GE 115 postings and supporting information links	Information is restricted only to required postings	
Layout	Content information is displayed in a logical manner so that specific information is easily located/retrieved	Content information is generally displayed in a logical manner but with little attention to content layout	Generally difficult to locate and/or retrieve information	
Format	Use of background, headers and alignment options present page content in professional and interesting manner	Limited use of background, headers or alignment options or page contains extraneous or distracting formats	Background, headers or alignment options are distracting or make location of information difficult	

Excel Performance Matrix

Criteria	3 Proficient	2 Apprentice	1 Novice	Score	
				Problem Solving	Data Analysis
Analysis	Applies correct mathematical concepts to formulate model; no conceptual or procedural errors affecting the solution	Applies correct concepts to formulate math model; solution contains minor procedural errors	Applies incorrect concepts to formulate a math model or procedural errors affect problem solution		
Layout (problem solving approach)	Correctly uses problem solving approach	Applies problem solving approach but omits 1 or 2 minor steps of the process	Solves problem without logical application of the problem solving method resulting in incorrect solution		
Format (merge cells, borders, alignment, shading, decimal places)	Correctly uses a variety of formatting options to communicate a logical problem methodology and solution	Limited use of formatting options but procedures used are applied correctly	Problem solution uses little or no formatting to highlight problem solution or methodology		

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Project Report Matrix

Criteria	3 Proficient	2 Apprentice	1 Novice	Score
Problem Solving	Correctly uses problem solving methodology with each step of the process fully documented	Correctly uses problem solving methodology with minor errors or with steps not fully documented	Incorrectly applies problem solving methodology or steps not delineated in project report	
Analysis & Solution	Applies correct concepts to formulate a math model; data supports working model	Applies correct concepts to formulate model; connection between working model and data analysis contains minor errors	Applies incorrect concepts for model formulation; data collection & analysis is either missing or fails to support model	
Organization	Organization follows problem solving methodology; good continuity of project development	Organization follows problem solving methodology; minor organizational errors lead to reduced continuity	Organization fails to follow problem solving methodology; project continuity difficult to follow	
Format	Uses appropriate headers and section titles; follows principles of technical writing; no grammatical or punctuation errors	Uses appropriate headers and section titles with few grammatical or technical writing errors	Limited use of headers and section titles or frequent errors in grammar or technical writing	

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