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# Enhancing the Quality of Senior Projects*

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*Most engineering and engineering technology undergraduate programs include a project in their curricula. In the USA, it is commonly called the 'senior project' since it is offered in the senior year (the last year of the four-year BS program). The senior project involves comprehensive analysis of a problem and suggestions for its solution. The project work consists of a report and oral presentation, and its success is measured by the quality of the work and the report. This paper describes the guidelines for and the requirements of the project, including that of the write-up, as practiced at the author's university. We have found that giving students a detailed handout at the very beginning contributes significantly to the enhancement of project quality.*

## INTRODUCTION

ALMOST a hundred years ago, Henri Fayol (1841–1925) stated [1]:

> Our young engineers are for the most part, incapable of turning the technical knowledge received to good account because of their inability to set forth their ideas in clear, well-written reports, so compiled as to permit a clear grasp of the results of their research or the conclusions to which their observations have led them.

If Fayol were alive today, he might have been surprised to find that not much has changed since then. Most engineering and engineering technology graduates lack the writing skills necessary to express themselves clearly. This is obvious from the reports written on their 'senior projects'—a requirement in most undergraduate curricula. The senior project attempts to provide students with a 'real world' experience of investigating a problem and offering plausible solutions. The three major objectives are: (i) problem identification and definition, (ii) cost-effective solutions, and (iii) report and presentation.

One of the primary purposes of senior projects is to offer students an opportunity to hone the writing skills they have developed during their four years at college. At the University of Southern Mississippi, we have found that a handout, containing the guidelines for and the requirements of the senior project, given to students at the very beginning, enhances the quality of the senior project very effectively. In this paper, these guidelines and requirements are presented for the benefit of those faculty who supervise projects only informally. By delineating the tasks involved a handout is quite effective in conveying to the students well in advance as to what is expected in the course. The net result is a marked improvement in the quality of the project and in their learning. Although the description that follows pertains [2] to mechanical engineering technology, it is based on handouts for industrial engineering technology [3] and electronics engineering technology [4]. At the University of Southern Mississippi, the requirements for senior projects are about the same in all the six BS programs, though in other institutions [5] differences have been noticed in the rigor, the degree of originality, etc.

* Accepted 15 November, 1992.

## OBJECTIVE

The senior project is a 'capstone' course. Its objectives are twofold:

1. To provide students with an opportunity for and training in the comprehensive solution of a problem.
2. To offer students a 'taste' of the real world awaiting them on graduation.

## ABOUT THE PROJECT

To achieve these objectives students work on actual industrial problems that require application of academic 'tools' and techniques learned during the baccalaureate program. In some cases they can work on university-based research projects.

Students are expected to carry the project through from problem statement to implementation of solutions. Where implementation is not practical within the available timeframe or resources, a strong set of feasible recommendations is expected as the outcome of the senior project. In the case of university-based projects, an exhaustive literature search is expected. The project ends with a report and its open defense in front of the Industrial Programs faculty and others attending the presentation. Students are evaluated on the quality of work, insight in applying knowledge, ability to meet

reporting requirements and deadlines, effectiveness of presentation, and professionalism.

Students who enrol in the course for the first time and whose performance at the end of the semester is unsatisfactory are awarded an 'I' (incomplete) grade, which is removed only by completing the project successfully in the following semester. The entire work of both the semesters must be reported as a whole at the end of the follow-up semester.

## PROJECT SELECTION

Students work with their advisor, who is responsible for supervision and advice. The advisor also helps in selecting the individual project, which must be approved by the advisor. In the case of larger problems a group project may be allowed, but individual tasks for each team member will be delineated by the advisor. The group may select a project leader with the approval of the advisor.

Projects should be of sufficient scope and content to justify 3 h of credit on completion. In a lab course, three credits require 90 h (6 h/week over 15 weeks) of contact time over a semester. A senior project, which is more unstructured than a lab course, will demand approximately twice as much, i.e. 180 h of on-the-project effort. Thus, a senior project demands 12 h of effort per week, excluding commuting time, over the 15-week period. As a guideline these hours should be spent as follows:

| Tasks | Hours |
|---|---|
| Project selection | 10 |
| Library search | 15 |
| Meetings with the advisor | 10 |
| Mid-term report | 5 |
| Actual work | 120 |
| Report writing | 15 |
| Oral and presentation | 5 |
| Total | 180 |

Should a student desire to undertake a project of greater complexity and magnitude or should the project-in-hand (MET 400) arouse his/her interest during its progress to a point where its expansion is desired, the work may be continued with the consent of the advisor by enrolling in the follow-up course (MET 401).

## REPORTING AND DOCUMENTATION

*(A) Project plan*

Within the second week of the semester, a project statement in a standard form (available from the advisor) must be presented to the advisor who approves it, if satisfactory. By the third week a project plan showing the various 'milestones' is submitted to the advisor. The plan should contain at least the following:

1. *Statement of the problem*. As unambiguous and concise as possible.
2. *Project objective(s)*. These should be stated clearly so that their accomplishments can easily be assessed later on project completion.
3. *Implementation plan*. This should include the steps to be taken to meet the objective, the required resources, and affirmation of their availability.
4. *Time schedule*. This should show the milestones for implementing the plan, preferably using a Gantt chart or PERT. The schedule should also include the dates for mid-term progress report as well as for the final report and presentation.

*(B) Weekly report*

An oral progress report must be made to the advisor every week. Use the advisor's office hours or mutually convenient time for regular meetings.

*(C) Mid-term progress report*

During the seventh week of the semester, a typewritten progress report should be submitted to the advisor. This should include at least the following:

1. The status of the work (identify the activities completed to date, those in progress, and those yet to be undertaken.)
2. A brief summary of the findings to date.
3. A revised project plan, if necessary (relate 1 to this)

*(D) Project log*

A detailed project log (diary) should be kept to record the activities on daily basis. Entries should include the date, the task(s) carried out, names of individuals met or contacted, etc. The project log must be submitted along with the final report.

*(E) Final report*

Three copies of the final report are due on the last Monday of regularly scheduled classes for the semester. The final report should be prepared in a professional manner (Appendix I) and typewritten (Appendix II). It should include the following:

1. Title page.
2. Abstract page.
3. Introduction.
4. Statement of the problem.
5. Objective(s).
6. Methodology or procedure (should include data collection, analysis, results/findings, etc.).
7. Recommendations.
8. Implementation, if any, and its effectiveness.
9. Further scope of work.
10. Conclusion(s).
11. References.
12. Appendices, if any.

Any drawings, sketches, computer programs, tables or other relevant documentation generated

during the project work should be included in the final report.

*(F) Oral presentation*

On the last day of regularly scheduled classes all senior projects are orally presented. Students schedule a time for their presentation with the instructor of record or coordinator. They attend and participate in all presentations as these count toward their grade. Each project is allocated 30 min for presentation, which should be done in a professional style; 15 min are for presentation and 15 min for discussion. The use of presentation tools such as transparencies, slides, video film of the process/problem investigated, photographs, prototypes, or computer animation is recommended. These enhance the quality of presentation (as well as of the report), which is evaluated by the entire Industrial Programs faculty.

## GRADING

The grading takes into account factors such as:

1. Level of effort.
2. Originality.
3. Quality of work, report and presentation.
4. 'Depth' of library research.
5. Effectiveness of implementation or soundness of recommendations.
6. Diligence and attitude.
7. Feedback from company of internship.
8. Overall professionalism.

The faculty evaluates every project as follows:

| Items | Points by | |
|---|---|---|
| | Advisor | Other faculty |
| Quality and content of report | 100 | 100 |
| Quality and content of presentation | 100 | 100 |
| Quality and content of overall work | 200 | 200 |
| Participation* points | 100 | |
| Total | 900 points | |

The points earned are converted to letter grades according to:

$$A \geqslant 810 > B \geqslant 720 > C \geqslant 630 > D \geqslant 540 > F$$

## CONCLUDING REMARKS

The handout clearly shows what is expected in the senior project course. It renders some structuring to the otherwise unstructured nature of a senior project course. With such a document, both the instructor and the student are aware of each other's expectations. The guidelines and requirements presented above may need to be modified to suit the needs and objectives of other programs.

* Participation involves attending other presentations, being attentive during presentations, raising sensible questions during discussions, and helping in all possible ways to make the senior project a memorable part of undergraduate study. The participation points are awarded by the records-instructor.

## REFERENCES

1. D. L. Babcock, *Managing Engineering and Technology*. Prentice Hall, Englewood Cliffs, NJ, p. 32 (1991).
2. S. Kant Vajpayee, Senior project handout for mechanical engineering technology major. University of Southern Mississippi (1992).
3. J. Jordan, Senior project handout for industrial engineering technology major. University of Southern Mississippi (1990).
4. C. A. Harrison, Senior project handout for electonics engineering technology major. University of Southern Mississippi (1988).
5. M. A. Dyrud, Senior projects: an outsider's point of view. *1922 ASEE Annual Conference Proceedings*, pp. 864–867.

## APPENDIX I: WRITING STYLE

*(A) Outline*

Working from an outline promotes an orderly and logical flow of information, helps prevent omission of vital information, and discourages inclusion of extraneous and unrelated information.

*(B) Conciseness and consistency*

1. Eliminate obvious details.
2. Use diagrams and tables whenever they aid in a clearer presentation.
3. Use specific terms and nomenclature which are standard within the field.
4. Use consistent terminology and nomenclature within the report.
5. When abbreviations are to be used, include their meaning in the first usage within the report. For example, '. . . computer-aided design (CAD) . . .'.

6. Use correct spelling and punctuation to prevent confusion and misinterpretation.
7. Avoid ambiguous or confusing sentence constructions.
8. Arrange sentences in a logical order.
9. Include in each paragraph only that information which is pertinent to the purpose of that paragraph.
10. Relate each paragraph to the preceding and following paragraphs.

*(C) Person and tense*

1. Use impersonal style throughout; avoid personal pronouns.
2. Use present tense to describe a diagram, table or piece of equipment.
3. Use past tense to describe a procedure or an experimental result.

*(D) Diagrams, graphs and tables*

1. Prepare all diagrams and graphs in black ink using drafting instruments and drafting techniques as taught in IET 148 or a suitable computer-aided drafting (CAD) program. *Sketches and other free-hand renditions are not acceptable.*
2. Type all tables in proper columnar form.
3. Diagrams and graphs are both considered to be 'figures'.
4. Refer to each figure or table at least once within the text of the report.
5. Number figures and tables in the order in which they are referred to in the text, but in separate sequences (Figure 1, Figure 2, etc.; Table 1, Table 2, etc.).
6. Provide a distinct, clear and self-explanatory title for each figure and table. Only the first word of the title should be capitalized (except for proper nouns). For example:

   Figure 3. Vibration vs RPM for hand drill (low speed).
   Table 2. Summary of velocity measurements.

7. Place table titles above the table.
8. Place figure titles below the figure.

*(E) References and footnotes*

Use ASME (American Society of Mechanical Engineers) format for references and footnotes. Consult any ASME journal, transactions or proceedings for example.

1. Use references to cite sources of published information.
2. Use footnotes for brief explanatory notes which are not a logical part of the text. More lengthy explanatory material should be placed in an appendix.
3. Number references in the order in which they are cited in the text; place the number in brackets in a logical position within the text. Multiple references may be used in one citation. For example:

   'In the latter context, high-temperature operation is desirable [7].'
   'As reviewed by Papadakis [11], the carbon is . . .'
   'Barna and Johnson [3], [4] demonstrates . . .'
   'Primary applications are in welding [12]–[15].'

4. List the sources cited in the Reference section of the report, and identify them by number in the same sequence as the text citations. For example:

   [7] Arguelles, M., Vajpayee, S., and Lipscomb, J., 'Spreadsheet Analysis of Waterjet Machining Parameters' *Journal of Engineering Technology*, Vol. 6, No. 1, pp. 18–20, Spring 1989.
   [8] Asimov, I. *I, Robot*. New York: Doubleday Inc., 1950, pp. 10–12.

   Note: ref. [7] is an example for a periodical; ref. [8] is an example for a book.

*(F) Equations and calculations*

1. Treat equations as mathematical sentences, and punctuate accordingly.
2. Number only those equations which are referred to in the text. The numbers should be enclosed in parentheses and placed near the right margin.
3. Place each equation or calculation on a separate line. For example:

$$F = mf,$$

where $f$ is the acceleration, and $m$ is the mass. Since

$$F = 100 \text{ N}$$

and

$$m = 2.5 \text{ kg},$$

then

$$f = 40\ m/s^2.$$

4. Refer to equations by number within the text. For example:

   'According to (6), the velocity is . . .'
   'Use (9) to calculate . . .'

*(G) Units and Symbols*

1. Use SI units and symbols. Refer to ANSI/IEEE Std 260-1978 (USM Library Reserve) for correct usage. Practical considerations may sometimes require use of other than SI units.
2. Do not place a period after SI symbols.
3. If the quantity is used as a noun, place a space between value and symbol; if the quantity is used as a modifier, place a hyphen between value and symbol. For example

   'The pin is 9 cm in length.'
   'This is a 9-cm pin.'
   'This engine is rated at 4 HP.'
   'This is a 4-HP engine.'

*(H) Special capitalization rules*

1. Use an initial capital letter only when referring to a specific section, paragraph, figure or table. For example:

   'The last box may be seen in Figure 12.'
   'Several configurations are presented in the figures below.'
   'Refer to Table 8.'
   'The data sheet may be found in Appendix 3.'
   'See the preceding paragraph.'
   'General procedures may be found in the Introduction.'

2. Capitalize the first word of each element in a list.
3. Show special instructions, and identify controls and indicators exactly as they will appear. For example:

   'Mark the container FRAGILE—THIS SIDE UP.'
   'The STOP indicator will illuminate when the OFF control is depressed.'

## APPENDIX II: TYPING INSTRUCTIONS

*(A) Materials*

1. Use a good-quality typewriter with clean typeface or a laser, daisy-wheel or near-letter-quality (NLQ) dot-matrix printer.
2. Use plain (not italic, cursive, etc.) typeface. Elite type is recommended, but pica is acceptable.
3. Use black carbon-film ribbon, or a nearly new medium-inked fabric ribbon.
4. Use 8.5″ × 11″ white bond paper. Tinted or specialty paper is not acceptable.

*(B) Spacing*

1. Double space between lines of text.
2. Allow 1″ for top, bottom, and right margins; allow 1.5″ for the left margin.

*(C) Special considerations*

1. Title page

(2″ from top)
PROJECT TITLE
(2″)
A Report Presented to the
Faculty of the Industrial Programs
The University of Southern Mississippi
(2″)
In Partial Fulfillment of the Requirements for
MET 400
(2″)
by
YOUR NAME
DATE

2. Abstract. Center the abstract vertically on a page by itself. Center the word ABSTRACT horizontally, three spaces above the text of the abstract.
3. Report text format.

I. INTRODUCTION
(3 spaces)
(Text)
(New Page)
II. Suitable Title
(3 spaces)

A. *Title of First Major Paragraph*. Major paragraph titles should be underscored; the initial letter of each word (excluding prepositions, articles and conjunctions) should be capitalized.
   1. Subparagraph (Level 1). Subparagraphs may or may not have titles; titles are not underscored. There must be at least *two* subparagraphs at any level; otherwise do not subdivide the text at that level.
      a. Subparagraph (Level 2)...
         (1) Subparagraph (Level 3)...
         (2) Subparagraph (Level 3)...
      b. Subparagraph (Level 2)...
   2. Subparagraph (Level 1)... (etc.)

4. Figures and tables.
   (a) Place figures and tables in the text as near as possible to the text that refers to the figure or table.
   (b) Separate figures and tables by at least $\frac{1}{2}$" vertically from the text above and below the figure.
   (c) Full-page figures or tables may be placed sideways on a page, if necessary, with the top of the figure or table to the *left*.
5. Equations and calculations.
   (a) Separate lines containing equations or calculations by three vertical spaces from the text above and below.
   (b) Separate '=' sign by one space from both the left and right members of an equation or calculation.
   (c) Align '=' signs vertically within a given group of equations or calculations.
6. Reference list. Center the reference list vertically on a page by itself. Center the title REFERENCES horizontally, three spaces above the list.
7. Appendices. Begin each appendix on a new page. Center the title horizontally at the top of the first page of each appendix, three spaces above the text of the appendix. For example:

(New page)
APPENDIX C
(3 spaces)
(Text)

8. Page numbers. Number pages, beginning with the first page of report text, using Arabic numbers, centered horizontally approximately $\frac{1}{2}$" from the bottom of the page. If an appendix is more than one page in length, number the pages of the appendix with the appendix identifier and an Arabic numeral (e.g. for Appendix C, use page numbers C-1, C-2, etc.). Do not number the title, abstract and reference pages.

**Dr. S. Kant Vajpayee** is professor of engineering technology and coordinator of Industrial Programs at the University of Southern Mississippi. He has been associated with university teaching and research in the USA, Canada, England and India for over 25 years. His industrial experience is as noise and vibration engineer in a British company. Dr Vajpayee has published over 80 articles and three books; the most recent book is due in 1995 on computer-integrated manufacturing. He has held grants totaling almost half a million dollars. He was a Commonwealth Scholar of the UK government. Dr Vajpayee is associated with SME, CASA/SME, ASME, Mississippi Academy of Sciences, and Institution of Engineers (India). He led and directed the forming of the Southern Mississippi Chapter of SME (#F270) and was its founder chairman. His interests lie in modern manufacturing technologies, especially CIM and its education, and noise/vibration.