Effective Use of Logbooks in Engineering Education: Enhancing Communication through Short Design Activities

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Effective Use of Logbooks in Engineering Education: Enhancing Communication through Short Design Activities

Summary
For engineering educators who employ active learning techniques such as design projects, logbooks are an ideal way to enhance students’ ability to communicate effectively. In industry, students are expected to write effective reports and produce design documentation (Canadian Engineering Accreditation Board, 2008). In order to fully develop these documentation skills, students must have regular practice. Logbooks are an excellent repository for design documentation and encourage regular use. However, merely requiring the use of logbooks without providing regular guidance or training is irrational.

Logbooks are primarily used in the engineering profession as a way to document an individual’s progress with a particular project. Activities such as precursory analysis, initial sketches, task lists, programmatic issues, reflections of past work, meeting agendas and meeting minutes are typical items recorded in a logbook. Logbooks are typically hardback, paper based products that are bound in such a way as to ensure that pages cannot be removed; consequently, logbooks are sometimes used as legal records in professional liability, intellectual property and project scope disputes (McAlpine, Hicks, Huet, & Culley, 2006).

Design projects present an ideal situation to employ logbooks to enhance communication skills (Yang, 2009). Many engineering educators require their students to use logbooks in active learning projects. However, after regular use, a renewed focus on logbooks is often necessary to reconsider what to record as pertinent information and when is an appropriate time to do so. For participants who are currently supervising design activities, a renewed look at logbooks will assist them in asserting the importance of logbook use in design activities. Furthermore, it will also enhance their own communication skills and the skills of the students they supervise.

This workshop is intended for instructors, professors, and graduate students to consider interactive methods to teach proper logbook use. Participants in the workshop will sample an interactive activity that is recommended to teach students the importance of logbooks. Instruction, brainstorming, and discussion will follow. Participants in the workshop will learn the importance of a logbook, define which activities should be recorded in a logbook and state the necessary elements to record in a logbook.

Keywords
engineering instruction, logbooks, design activities, incidental writing

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Effective Use of Logbooks in Engineering Education: Enhancing Communication through Short Design Activities
Libby Osgood, University of Prince Edward Island and Dalhousie University

SUMMARY
For engineering educators who employ active learning techniques such as design projects, logbooks are an ideal way to enhance students’ ability to communicate effectively. In industry, students are expected to write effective reports and produce design documentation (Canadian Engineering Accreditation Board, 2008). In order to fully develop these documentation skills, students must have regular practice. Logbooks are an excellent repository for design documentation and encourage regular use. However, merely requiring the use of logbooks without providing regular guidance or training is irrational.

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KEYWORDS: engineering instruction, logbooks, design activities, incidental writing

LEARNING OBJECTIVES
By the end of this workshop, participants will be able to:
- explain why logbooks are necessary for engineers;
- identify which design activities to record in a logbook;
- produce a sample logbook entry for a design exercise; and
- incorporate the necessary information on each page of a logbook.
REFERENCE SUMMARIES

McAlpine et. al note that Leonardo da Vinci’s notebooks, which contain detailed information and sketches, are the epitome of the engineering logbook. Using da Vinci’s notebooks as an example, this article describes the typical content of logbooks as follows: provides rationale for decision making; documents the results of analyses; states successes and failures; describes notes on the customer; records meeting minutes; and, maintains a legal record of events.

Additionally, McAlpine et al. conduct a study of fifty participants from academia and industry to determine the following: what their primary purpose is for keeping a logbook; what content is contained within their logbook; the frequency of logbook use; and, their preferred method for locating information. From a list of seven possible reasons, participants were asked to choose three answers. The two most frequently selected uses were: 1) as a personal work record; and 2) as a reminder of work in progress (>70%). 62% of respondents reported that they use their logbooks and stated that the main method of data location was browsing through the pages (61%). The article outlines 26 types of information typically recorded in logbooks, including: written notes; meeting notes; contact details; calculations; sketches; graphs; external documents; and, memorandums.

In a follow-up investigation of sixteen logbooks, over 30% of the logbooks consist of written notes and meeting notes. The remainder of the article discusses methods of computerizing logbooks for dissemination and retention of data since much of the data in a logbook does not appear in formal reports. Further, up to 80% of design is adaptive and not original. The lists included in this article regarding the typical content and use of logbooks shapes the lecture in part two of this workshop and the information on the handout that participants receive.


Engineers must process information as they develop their design and should record anything that is relevant to the design problem in a notebook. This includes alternative design solutions, discussions, changes to the design solution, analyses, test plans, test results and reflective thoughts related to the design. This article presents a series of guidelines for the content that logbooks should contain, which include:

• a table of contents;
• the range of dates contained in the logbook;
• bound pages, so they cannot be removed;
• passages written in permanent ink;
• mistakes crossed out with a single line;
• legible writing, though not necessarily neat;
• the corners of external documents taped with signature and date on tape;
• a title, signature, page number, and date on every page; and
• entries recorded consecutively, without gaps.

These guidelines are included in the lecture and used to form the sample questions for the evaluation in part three.


This article provides an example of how to seamlessly incorporate logbooks into an engineering design activity. Students record calculations, sketches, fabrication plans, and provide a description of work throughout the design process. Based on a study of two design classes with a total participation rate of fifty-seven students, this study considers logbooks as an assessment technique and attempts to correlate the maturity of drawings to the corresponding design result. Although Yang does not find a statistically significant correlation, the article does determine that logbooks are usually maintained with varying degrees of detail based on the time requirement required by the project. This workshop uses Yang’s guidelines about the types of design activities that should be recorded as part of the lecture and accompanying handout.


This article provides an example of an active learning course in New Zealand that required the use of logbooks to achieve the communication learning outcome. Students were expected to write research papers based on records from their logbook in order to activate the meta-cognition of the design activity. By reflecting on the design activity on a regular basis, such as through logbooks, students are more aware at each stage in the design process. Using this article, I have included reflection as a component of the recommended content list for logbooks and included these findings into the lecture.


Incidental writing captures the thoughts that occur during the design process. As an informal method of writing, logbooks are one method to attain this knowledge. This also allows for reflective cognition, improves problem-solving skills, and forces students to write on a regular basis. Furthermore, this article suggests that logbooks can be limiting to the learning process when students only use their logbooks before major reports are due or when instructors criticize students’ skills rather than provide instruction or encouragement. The article also reports that students often feel intimidated by the act of writing, which reinforces the need to enhance their skills. Consequently, the article suggests that in order for students to be successful at incidental writing (through the specific use of logbooks), instructors should insist that students write short passages at regular intervals, provide written feedback with no associated grade, concentrate on the content rather than
the grammar and spelling, and encourage students to take risks with their writing style to improve the quality. This article is a helpful tool to boost knowledge of the writing process and reinforce the importance of meta-cognition and the reflective process.

CONTENT AND ORGANIZATION

<table>
<thead>
<tr>
<th>Duration [min]</th>
<th>Subject</th>
<th>Activity</th>
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<tbody>
<tr>
<td>30</td>
<td>Section 1: Short Design Activity</td>
<td>Open the workshop by asking participants to design a solution for a given problem and then exchange papers with another participant who then adds to the design. The papers are then exchanged with a third person that will evaluate the design. Inform participants that this activity is recommended in order to elucidate the need for effective logbooks. Encourage participants to replicate this activity in their own classrooms but to keep the intended purpose of the activity hidden from the students to ensure they produce the same amount of detail they would normally. This activity focuses on good logbook practice (which comes later) in order to promote the recognition that if the participants had taken more time to write the initial problem or include the necessary design constraints, the third person could do a much better job determining if the design adequately solves the problem.</td>
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<tr>
<td>[10]</td>
<td>Section 1A: Design</td>
<td>Explain to the participants:</td>
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<td>• They will be given a particular design problem labeled with the letter A, B, or C.</td>
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<td>• They should work in silence to design a solution to 'solve the problem'.</td>
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<td></td>
<td>Once you have explained the activity, distribute the problem statements and sheets of blank paper.</td>
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<td>Note: Consult Appendix A for a list of sample design problems to assign students.</td>
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<tr>
<td>[3]</td>
<td>Section 1B: Exchange Papers</td>
<td>Ask the participants to stop and:</td>
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<td></td>
<td></td>
<td>• Record their problem statement letter at the top of the paper.</td>
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<td></td>
<td></td>
<td>• Return the problem statements to the front of the room.</td>
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<tr>
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<td></td>
<td>• Return the papers documenting the design to the pile at the front. It is important that all the participants with problem statement A put the papers in pile 1. Problem statement B goes into a separate pile, etc.</td>
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</table>
|                |                              | • Ask participants to take one of the papers documenting...
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Content</th>
</tr>
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</table>
| 1C | Analysis and Test | Request that participants:  
- Read the work that has been documented on their sheet.  
- Define the analyses and tests that one could perform to ensure the success of the design.  
Although some pages will have the problem statement written down, most will not. Consequently, participants will need to use the information provided in the logbooks. |
| 1D | Exchange Papers Again | Ask the participants to stop and:  
- Return the papers documenting the design to the pile at the front in separate piles.  
- Take one of the papers documenting the design from a different problem statement pile.  
- If you were A, take from B.  
- If you were B, take from C.  
- If you were C, take from A. |
| 1E | Evaluate the Solution | Request that participants:  
- Read the work that has been documented on their sheet.  
- Define the problem statement and evaluate whether or not the design and analysis/tests will resolve the problem.  
Ideally, it should be possible to determine if the problem can be resolved using the proposed design solution. |
| 1F | Class Discussion | Ask participants to describe the problem statements. Then, have a discussion on the aspects of the documentation that made it easier to understand what the problem was and how it was solved. Sample questions include:  
- For the paper you are reviewing, is there a problem statement?  
- What are some techniques to explain the design?  
- Is there a sketch?  
- Are there annotations on the sketch?  
This part of the discussion solidifies the need for improved written communication in logbooks. |
| 2 | Discussion and Lecture | Following the completion of section one, section two focuses on what components should be included in good logbook instruction.  
Purpose: This section focuses on learning objective two, being able to identify... |
which design activities should be recorded in a logbook, and learning objective three, producing a sample logbook entry for a design exercise.

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<tr>
<th>Section</th>
<th>Activity</th>
<th>Description</th>
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<tr>
<td>[5]</td>
<td>Section 2A: Small Group Discussion</td>
<td>Ask the participants to brainstorm in small groups (3-5 people) the reasons that engineers need a logbook.</td>
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<tr>
<td>[10]</td>
<td>Section 2B: Class Discussion</td>
<td>Discuss the reasons an engineer requires a logbook as a large group. Record reasons on the board as participants share their responses. Lead a discussion identifying the types of activities each reason would need to be recorded: meeting minutes and agendas, design drawings, schedules, analyses, and reflections. (McAlpine et al., 2006).</td>
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<tr>
<td>[10]</td>
<td>Section 2C: Lecture</td>
<td>Provide participants with a handout (Appendix B) and present a short lecture outlining the following information: • necessary elements on every page in a logbook; • activities that require logbook documentation; • a list of what should be included for each of the activities; • sample logbook activities. This component explains why logbooks are necessary for engineers and identifies which design activities should be recorded in a logbook.</td>
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**Section 3: Effectively Documenting Designs**
Following from section 2, section 3 includes a second activity that encourages participants to employ good logbook practice. This section concludes with a section on how to effectively incorporate logbook instruction into the classroom.

**Purpose:** Section 3A focuses on learning objective number three, which is being able to produce a sample logbook entry for a design exercise. By producing a high-quality example of how to document a design, participants are more likely to employ high-quality logbook techniques in the future. Section 3B focuses on learning objective number four, which is incorporating the necessary information on each page of a logbook. By incorporating the necessary information on each page and then evaluating other’s work, participants will be able to further solidify the elements that should be included in logbooks.

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<tr>
<td>[5]</td>
<td>Section 3A: Documentation</td>
<td>Ask participants to choose one of the problem statements from part A and document a solution. They should include: • the design problem; • the design solution; • analyses and tests to verify the design addresses the problem; and • further work that should be performed to ensure the design is successful.</td>
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<td>[5]</td>
<td>Section 3B: Evaluate</td>
<td>Instruct the participants to exchange their logbook entries with the person next to them. Ask participants to evaluate...</td>
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the entries based on what they have learned (Kelley, 2011). Some considerations include:

• Is name, page number, date and title on every page?
• Is there a sketch of the design solution?
• Are there annotations on the sketches?
• Is it legible and in pen?
• Is there a reflection regarding the design?
• Is future work defined so the person can proceed at a later date?

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| [15] | Part 3C: Reflection | Ask participants to work in pairs or alone to identify ways they can incorporate logbook instruction into their courses. Sample questions include:
• Could these two activities be beneficial in logbook instruction?
• How would you adapt this for your class? |
| [5] | Part 3B: Conclusion | Invite any closing questions or remarks. Ask participants to share ideas that arose during the brainstorm. Reiterate the need to be diligent in helping students improve their communication skills. |

**Total Time:** 85 minutes

PRESENTATION STRATEGIES
This is an interactive workshop that uses a combination of different strategies such as lecture, small and large group discussion and independent reflection.

Appendix A and Appendix B are designed specifically in support of this workshop: appendix A provides a comprehensive list of problem statements while appendix B is a handout for students.

ADDITIONAL REFERENCES


APPENDIX A: Problem Statements for Design Problems

Although any basic design problem is adequate, the design problem should be self-contained with enough information for the participant to work independently without asking questions.

**Problem A:** In my jewelry box, my necklaces are all constantly getting tangled and I spend too much time trying to get the little knots out of the chains. I want a device that is easy to travel with and can handle a varying number of necklaces, pendants, and types of chains.

**Problem B:** I never know what type of boxes and plastics go into compost, recycling bag 1 or 2, or the trash. I need an indoor sorting system to help me organize the different receptacles and also help me remember where to put that cereal box versus the shipping box or plastic milk jug versus the bag inside a cereal box.

**Problem C:** I enjoy cycling and hot yoga. However, it is hard to transport the yoga mat, a 5ft x 3ft towel, and a change of clothes on a bicycle. Design something to protect the yoga mat, carry the towel and clothes, and make it easy to transport on a bicycle.

The following are tips for the different steps, labeled by section and step.

**Section 1A**
- Distribute an equal number of problem statements. For example, if there are 30 participants, ten should receive problem statement A, ten should receive problem statement B, and ten should receive problem statement C. If there are an odd number or participants, one participant may have to use a paper with a problem statement they saw before.
- If participants are sitting at tables together, ensure there are different problem statements at the table to prevent the participants from working together.
- Stress that the participants work alone. This is to ensure that they do not discover what the other problem statements are.
- Be strict with the time limits. Participants should not have enough time to fully complete any portion.
- Do not answer any questions regarding problem statements. Stress that all the information provided is on the page. You do not want the participants with other problem statements to overhear any discussion.

**Section 1B and 1D**
- Ensure all of the problem statements are returned so participants cannot share information.
- Logbooks pages must be put in separate piles. It is easiest to call all of the participants with problem statement A to return their paper. When the participants with problem statement B return their papers, they should bring back a paper with problem statement A. Repeat for C. Then ask A to retrieve a paper with problem statement C.
Section 1C and Section 1E

• Do not answer any questions regarding content or problem statements. If participants complain that there is not enough information, assert that they must use only the information they were originally provided with.

Section 1F and Section 2

• During class discussions, let the participants lead the discussion and come to their own conclusions. If they are not able to move forward in the discussion, pose one of the suggested questions.
• Bring up aspects of the design that should have been considered. For example, in problem statement C, a hot yoga towel might require ventilation after a class. Similarly, necklaces in problem statement A might have very large pendants that require a certain encasement. This will reinforce the importance of documenting details of the design.

Section 3

• Allow participants to talk during the documentation process. The goal is to help the participants produce a high-quality logbook entry.
• Answer any questions they may have regarding high-quality logbook techniques.
APPENDIX B: Handout for “Logbook 101”

General Guidelines

- Record the date on each page & start each day on a new page.
- Label each entry and record this in a table of contents (reserve 3-4 pages at start).
- **Record:** Name of speaker, what they said, implications for your project, further work to look into
- Use ink. Do not erase. Delete an entry by neatly drawing a single line through it.
- Do not remove pages, and do not skip pages.
- Remember to include *everything that you contribute to: good, bad, and ugly!*

| A Meeting | • What were the main outcomes of the meeting?  
|           | • Was the meeting productive, and why?  
|           | • What are your personal action items before the next meeting?  
|           | • Is the team heading in the right direction?  
| Brainstorming | • Which ideas seem most feasible, and why?  
|              | • Are there enough good ideas?  
|              | • How could better ideas be developed based on this session?  
| Engineering Analysis | • What were the governing equations?  
|                      | • What were the most important findings?  
|                      | • What do the results mean and how should they be applied?  
| Drawings | • What are the major features/discoveries and why are these significant?  
|          | • What was learned about the problem or solution possibilities?  
|          | • What problems were resolved and what still needs to be addressed?  
|          | • How does this piece integrate with the whole?  
| Internet Search | • What key information did I find? How does it help achieve the objectives?  
|                | • Are there other sources/questions that should be pursued?  

Examples of what to include in your logbook

- Sketches/doodling
- Customer needs or requirements
- Class notes
- Project objectives
- Meeting notes
- Action Items
- Half-baked Ideas
- Math calculations
- Work-in-progress
- Design alternatives
- Vendor notes
- Research findings
- Sources of ideas
- Evaluation of data/results
- Design reviews
- Decision criteria
- Design process
- Rationale for decisions
- Project reflections
- Prof development