Engineering Design Process (EDP)

The Student Engineering Notebook — Teacher Guidelines

What is an Engineering Notebook?

Engineering notebooks are used by professional engineers to document progress and every detail of a project. The notebooks contain communications, ideas, designs, observations, and data from experiments, as well as reflections on considered improvements. The student engineering notebook plays a critical role in helping your students develop the best design and find efficient and elegant solutions to a problem. The student engineering notebook is a valuable part of your student's engineering project teams.

The engineering notebook is a complete record of a project *in chronological order*. The notebook not only shows what was being thought about or acted upon, it shows the precise time and order in which the actions occurred. There's no such thing as a *final copy* of an engineering notebook. A student's engineering notebook is the actual, complete-as-possible living diary and record of their project - all the misspellings, stains, failed experiments, team arguments, successes, and failures.

For professional engineers, engineering notebooks are useful to determine definitive ownership of intellectual property, designs, and techniques, and can even serve as legal documentation when filing for patents or defending disputes.

If done correctly, your student's engineering notebook shows their full process and demonstrates that they (and their teammates) truly understand the components and nature of the engineering design process.

Student Engineering Notebooks – Benefits for Teachers:

Student engineering notebooks provide valuable insight to project teams, but they are also a excellent tool for understanding how your students approach a project, work together, and reach conclusions.

Having students use engineering notebooks allows teachers insight into…

- …the thinking processes of each student (and each team) as they navigate through the EDP, allowing you to better adjust instructional components to maximize student engagement and achievement.

- …who is doing what on a team, and the amount of time they spend on each element of the project.
- …student achievement. Having students conduct peer reviews—including constructive suggestions for improvement—the level of achievement in all students should generally improve at a faster rate. (Be sure to have peer reviewers sign and date the engineering notebooks—it's a part of the process, as well!)
- …formative and summative assessments. The student engineering notebooks are an effective tool for assessment—and especially for assessment that supports the Next Generation Science Standards.

Tips for the Classroom

- At the beginning of the project cycle, it's critical to spend time reviewing the *Student Engineering Notebook Student Guidelines* with your students so that they have a complete understanding of the objectives and outcomes for the notebooks and what steps need to be taken to get started. This review will also be helpful in preparing your students for the backward-mapping involved with the creation of the notebook's table of contents.
- Consider including the *Student Engineering Notebook* as part of the Engineering Design Process (EDP) grade. Both the process of creating the engineering notebook along with the document itself can both be included in the grade. The rubric developed by the Georgia Institute of Technology can be used or modified to be properly aligned to your student's grade-level.
- Remind your students that their engineering notebook is a record of their *thinking* as well as their *doing* during their EDP project.
- Encourage your students to write reflections as often as possible to help them better explain *why* problems occur and *how* to address them in the course of their project. Extensive and repeated reflection should allow your students to better recognize problems and be better prepared and able to solve them in exciting ways.

Insight

The following quotes are from the extremely helpful paper, *The Engineering Design Log: A Digital Design Journal Facilitating Learning and Assessment (RTP),* from The Georgia Institute of Technology.

> Students who fully learn and practice the EDP, will be better able to address the Next Generation Science Standards which are focusing more on the process as compared to the content of science. The "systematic, iterative nature that characterizes the EDP as being an important part of engineering."[1]

> "Requiring a document in which students are tasked with recording their work as they move through the steps of the engineering design process has been offered as part of good practice in engineering instruction."[2]

> "This is consistent with industry practice, where engineers must undergo design reviews and protect their intellectual property."[3]

> The engineering notebook "provides evidence of a process, as opposed to simply outcomes or final products."[4]

> It "carries a high level of real-world relevance, and allows for an assessment that is both 'authentic' and 'performance' based."[5]

Next Generation Science Standards (NGSS)

Engineering Design Process projects using the student engineering notebook address the following **Next Generation Science Standards (NGSS)** for middle school (grades 6-8).

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

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[1] Roxanne Moore, Meltem Alemdar, Jeremy A. Lingle, Sunni Haag Newton, Jeffrey H Rosen, and Marion Usselman. "The Engineering Design Log: A Digital Design Journal Facilitating Learning and Assessment (RTP)". *2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana, 2016, June*. ASEE Conferences, 2016. https://peer.asee.org/26153 Internet. 25 Sep, 2017

[2] Ibid.

[3] Ibid.

[4] Ibid.

[5] Ibid.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

All eight practices of science and engineering can also be addressed.

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanation (for science) and designing solution (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Additional References

The Engineering Design Log: A Digital Design Journal Facilitating Learning and Assessment (RTP), from The Georgia Institute of Technology
https://ampitup.gatech.edu/sites/default/files/images/asee_hs_course_2015_final_submit.pdf

The FTC Engineering Notebook
http://www.ftc0001.org/files/PPTs/FTC Engineering Notebook 2010.pdf

The Engineering Notebook – One Team's Perspective and Practices
http://www.cafebot.net/documents/Engineering_Notebook_Presentation.pdf