

## Idea Notebooks for Engineering Students

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*The power of the unaided mind is highly overrated. Without external aids, memory, thought, and reasoning are all constrained. But human intelligence is highly flexible and adaptive, superb at inventing procedures and objects that overcome its own limits. . . . [One way humans have overcome the limits of the unaided mind is] through the development of tools of thought--cognitive artifacts--that complement the abilities and strengthen mental powers.*

--Donald Norman, *Things that Make Us Smart*<sup>1</sup>

Nearly everyone would agree that students come to the university to improve how they think and solve problems. Yet beyond insisting that students think, faculty often fail to teach students much about developing effective tools for thinking. Hence, our goals—as a business manager and a university professor—have included developing tools for reflection and analysis and introducing these tools to engineering students so they can use them throughout their education and career.

One of the best tools that humans can use to enhance thinking is a notebook. Since elementary school, students have probably kept some sort of notebook, using it to record what the teacher writes on the blackboard and to do assignments. Immediately, one can see that a notebook is great aid for overcoming the limits of human memory: rather than having to remember everything, we can write things down and look at them later.

Notebooks, however, can be more than just an external aid to memory; they can also be a space for creativity and analysis. We can use a notebook not just to record information but also as a place to try out new ideas. Frequently, the basic act of writing down an idea and illustrating it with a simple sketch permits us to sharpen our ideas and generate new ones. Many creative people, including Leonardo da Vinci, Michael Faraday, Thomas Edison, and Thomas Jefferson, used notebooks to develop their ideas, and in fact, keeping a notebook was probably one of the "secrets" of their success.<sup>2</sup>

For a notebook to function as a space for creativity, one does have to make an important emotional shift. An idea notebook has to be *personal*, not one that the student keeps to satisfy a

teacher (or anyone else). It is likely that any notebook in elementary or high school was kept in order to please the teacher and the student may have assumed that the teacher would evaluate him or her by looking at the notebook. In contrast, an idea notebook has to be personal, a place where one feels safe to try out any idea, no matter how outrageous or silly or trivial.

As useful as notebooks are as external aids to memory and a space for creativity, it is not obvious to students how to use a notebook for anything other than writing down notes from the blackboard. Consequently in this paper, we will describe a technique for using notebooks to generate ideas and how we adapted this system for use by first-year engineering students at the University of Virginia (UVa).

### **What is the Idea Marathon System?**

At UVa, first-year engineering students do not take their basic composition course in the English Department but rather in a special unit of the engineering school, the Division of Technology, Culture, and Communication (TCC). The Division emphasizes that students learn to write and speak in ways that enhance their abilities to be leaders and problem-solvers.<sup>3</sup> Consequently, in our sections of the first-year course (TCC 101), one of us (Carlson) requires the students to build a small cardboard clock kit and asks them to record their ideas for improving, manufacturing, and marketing the clock in a notebook.<sup>4</sup> Initially, I simply specified the kind of notebook and announced that I would periodically collect the notebooks. Much to my surprise, most students found it extremely difficult to come up with ideas to write down in their invention notebooks. Unlike Edison, they did not automatically see the notebook as a cognitive artifact, as a tool to help them to think and create.<sup>5</sup> What the students needed was some guidance--a system--that would help them to learn how to use a notebook in developing creative ideas.

Hence, I was delighted in 1997 to learn about a set of techniques for keeping a creative notebook developed by Takeo Higuchi, a technical manager at the Mitsui & Company in Japan. Higuchi began developing his notebook system in 1984 and has been modifying it continuously since then. While the notebook is at the center of his system, he has recently begun to experiment with using a Sony pocket voice recorder to help capture ideas. Higuchi calls it the Idea Marathon System (IMS) because he sees life as a marathon race in which we must be continuously learn and create new ideas.

At first glance, the principles of IMS may seem deceptively simple:

1. Keep a notebook for your creative ideas. Treat it as your special notebook and use it whenever you can;
2. Write down as many creative ideas as you can, but be sure to record at least *one new idea everyday*;
3. Give each idea a number, date, and title;

4. Describe the idea as *simply* as you can. Short sentences and phrases are fine as long as you can figure out later what you meant;
5. Wherever possible, add a little sketch to illustrate your idea; and
6. If you write down more than one idea on a particular day, keep track of the number of surplus ideas. (Balance Sheet Number).

However, while these rules appear simple, they embody several important notions. The first is that of action and empowerment. By making the decision to write down new ideas everyday, an individual is acknowledging that he or she is a creative intelligence in the universe and capable of bringing about change.<sup>6</sup> Second, IMS is not overwhelming and can help overcome creative blocks because IMS lets one write down whatever ideas strike one as interesting and only requires that one enter the ideas as simply as possible. And third, the system is encouraging, because through the numbering system, one gets an immediate sense of accomplishment.

A key feature of using a notebook in IMS is that the notebook is personal--it is for one's own growth. As a result, one should feel free to write down all kinds of new ideas. They can include

- ideas for new products, software, or devices;
- ideas for new procedures for manufacturing and marketing;
- solutions to major problems confronting human society;
- predictions about the future, or how one would like society to be;
- plans for your education, career, family;
- insights to personal problems;
- activities you would like to try, such as new hobbies, sports, or places to visit;  
and
- themes or topics for assignments and essays.

In short, IMS provides a framework which can help individuals shape a notebook into a personal space for analysis.

### **How did we use idea notebooks in the engineering classroom?**

The Assignment. In the fall of 1997, one of us (Carlson) decided to adapt IMS for use by the undergraduate engineering classroom at UVa. In particular, I hoped that students would find that using IMS would introduce them to the idea of designing their own cognitive artifacts, their own tools for thinking.

For one of the first classes, the students read about cognitive artifacts in Norman's *Things That Make Us Smart*. After discussing cognitive artifacts in class, I proposed that the students create their own tool for thinking in the form of an idea notebook. From the bookstore, all of the students had purchased a DayTimer planner with extra blank pages. I explained they should follow IMS and write down at least one creative idea everyday. To get the creative ball rolling, I showed the students how to generate ideas by looking at items in their backpacks. I took several different items (a candy bar, matchbook, and diskette) and generated five different ideas from each in my own notebook. I emphasized how one should look at everyday objects and events and try to imagine as many different alternatives as one could. I also suggested that if they couldn't necessarily think up any solutions, they should at least write down the problem or opportunity they had encountered. I reminded them that the goal of IMS is to exercise the creative faculties and that no idea was too strange or goofy.

As sources of new ideas, I suggested students look at magazines and see what new products are being advertised. They could go to the library and look at engineering journals. They might talk to their engineering professors and visit his or her laboratory to see what kind of research they were doing. Students could ask their friends what they liked or needed or wished for. They might visit the university's art museum or drive out to nearby Monticello to look at Jefferson's gadgets. In general, I told students that they might find ideas anywhere, provided one is receptive and observant.

I also suggested to the students that they might find it useful occasionally to copy short passages from books and articles, passages that seem to capture a powerful concept or insight. As a student, Jefferson kept a notebook of passages he copied from the books he read, and scholars generally think that this effort helped him to develop his distinctive literary style and his political vision.

Periodically during the term, I asked students at the start of class to spend five minutes writing down ideas in their notebooks. However, students were generally expected to devote 10-15 minutes each day to using their idea notebook.

What did students do with their notebooks? I found that most students were able to make entries in their notebooks everyday. However, the entries were often too terse and could have been enhanced by little sketches. A few students only made entries when they knew that I was going to collect the notebooks.

Students generally came up with ideas related to their daily lives. They wrote down suggestions for storing things in their cramped dorm rooms, for improving service in the cafeteria, and for enhancing sports on TV. Some women came up with ideas for increasing security on campus. Most of the entries were for devices, although some students proposed changes for the campus organizations they had joined. I was surprised at how few entries related to improving the clock kit or were triggered by ideas the students had learned in other courses.

Evaluation. Since the notebook was to be seen as something personal, evaluating the notebooks was one of the trickiest parts of the exercise. At the outset of the semester, the students were told that this was an ungraded assignment, but that to pass the course they did need to have a notebook with at least one idea for each day of the semester. During the term, I randomly collected the notebooks, to check that the students were making daily entries and to provide encouragement. As I read entries, I made comments on small Post-it notes. In this way I offered feedback without interfering with the student's flow of ideas. In order to maintain a degree of privacy, students were permitted to remove any highly personal pages before handing in their notebooks.

At the end of the semester, I evaluated the notebooks. What counted was the degree of enthusiasm and good will that the students had brought to the task of shaping the notebook into a personal tool. For the students who took the assignment seriously and produced a steady stream of ideas, I rounded their final grade up by several points. For those students who made perfunctory daily entries, I made no change in their grades. And for those few students who failed to make regular entries, I rounded their grade down.

### **What did we learn by having the students use idea notebooks?**

Our principal finding is that IMS did provide the students with a "lightly" structured space for creative thinking. We found that, if asked, students will keep an idea notebook and they will make entries. IMS did seem to give them the necessary guidance in terms of generating ideas and the numbering system did provide some positive reinforcement. However, we were disappointed that only a few students took notebooks to heart and learned the basic lesson of creating one's own cognitive artifacts.

We suspect that one of the problems with the idea notebooks is that first-year students have difficulty seeing the notebook as being their personal tool. In high school, they were often required to keep a class notebooks because teachers told them to do so, not because they wanted to. In a certain sense, those high-school notebooks "belonged" to the teachers. With the idea notebook, we were trying to reverse this perspective and argue for a learning tool belonging to the student. From a larger perspective, the issue of "ownership" of the idea notebook reflects a fundamental change that must take place during college education; students need to recognize that they are pursuing an education for themselves and not to please their teachers or parents.

Students also seemed to have problems imagining new ideas to write down in their notebooks. At first, this genuinely puzzled us, but then we realized that students were not accustomed to observing the world around them. They tended to take the world pretty much for granted and they did not wonder why things are the way they are—and hence how they could be different. Students did not automatically look for patterns in objects and processes and this made it hard for them to visualize alternative patterns or configurations. We realized that if one is not willing to *look* at objects and *imagine* different patterns, then it is nearly impossible to generate new ideas.

We found that students had *computer-philia* and *notebook-phobia*. In a questionnaire at the end of the course, we asked students if they would continue to keep an idea notebook. Many said they were willing to record ideas everyday, but they preferred to do so on the computer. They claimed that it would be easier to express their ideas on the computer and that they could look up old ideas more quickly. They scoffed at the idea of using an ordinary notebook and pencil, for that was too old-fashioned for them. The students failed to see the tremendous flexibility in using a paper notebook--that one can easily bring together words and pictures, that one doesn't need any special software, hardware, or electricity, and that with a minimum amount of care, one's notebook will last for years. (When was the last time you heard about someone's paper notebook crashing?) Yes, the pencil and paper may not be electronic, but humans have yet to come up with any technology that is as effective and conducive to thought and reflection.

### **What do we plan to do in the future with idea notebooks?**

These various problems do not discourage us from using idea notebooks in the engineering classroom. Rather, these challenges posed by the students reveal the ways in which we are planning to improve how we teach about using a notebook as a personal tool for learning.

One of the most important things that needs to be done is to help students develop their powers of observation. We need to create a sequence of exercises that will help students learn how to look carefully at the world around them, recognize existing patterns, and generate new patterns. As we see it, these exercises might begin with students writing down simple descriptions of an object, applying a variety of standard patterns to the object (form, structure, function, input/output), and sketching the object in several ways. To get ideas as to how these exercises might be structured, we have been consulting *Drawing on the Right Side of the Brain*.<sup>7</sup>

A second step we would like to take is to provide the students with sample notebook entries which they could look at and partly emulate as they develop their own note-keeping style. Hence, for the next iteration of the course, we are planning to give the students a resource packet of notebook pages from both students as well as prominent inventors such as Leonardo, Edison, and Alexander Graham Bell. (The Library of Congress has just announced that it will be putting the Bell notebooks on the Web, and we will ask students to use this site when it comes available).

A third innovation would be to have students buy an engineering thesaurus. Although not commonly used today, these splendid reference books provide illustrations of thousands of different devices and movements.<sup>8</sup> Students would be encouraged to consult their engineering thesaurus to come up with alternative arrangements for devices they have observed or imagined.

A fourth change would be to let the students compare the advantages and disadvantages of using the notebook and computers for generating ideas. Here we would let the students record their ideas in a notebook for several weeks and then switch over to the computer for one or two weeks. Afterwards, we would have the students report on how well each method worked. To undertake this experiment, we would need to identify suitable software or hardware that would

make it easy for the students to record both words and sketches. One of us (Higuchi) has been experimenting with the electronic Crosspad which directly transfers handwritten notes to files that can be stored on a PC, but it is not clear whether such technology would be affordable for students.<sup>9</sup>

A fifth idea which we are considering is to work with instructors teaching other first-year courses in order to set up cross-course assignments. For example, while students are taking TCC 101 they are also taking a course in engineering concepts, and it might be possible to have the students be required to use a notebook for generating ideas for solving problems or developing designs. In this way, the students would be encouraged to start thinking about how their idea notebooks function as a tool for working on technical problems.

In conclusion, we are committed to the need to not only teach students how to think but also to provide them with tools for thinking. Only by introducing students to the idea of fashioning and using cognitive artifacts can we be sure that they will be well-prepared for solving the human problems of the next century.

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