

Are Engineering Notebooks Dead?

Abstract

Engineering notebooks are not dead. They can be assessed. They can help freshman to document failure, find inspiration in frustration and collect enough detail for others to replicate their work. Engineering notebooks need to become the symbol of engineering happening in the real world, not just in movies like Iron Man or in TV shows like Numb3rs.

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Notebook Writing is not Dead

In the 1970's, at Harvey Mudd College, engineering notebooks could be found in sophomore level engineering course rooms. Old donated equipment was being worked on. Previous and current students left their notebooks in the classroom. The initial student motivation was to dig up information. Today students initially search the internet. Yet reading each other's notebooks taught a lot more than technical detail.

Before the summer of 2011, US patents began with writing in an engineering notebook. Now the US patent laws are in alignment with the rest of the world. Yet still today, some engineering companies require their engineers to write in notebooks. And still other engineers write in them voluntarily. Why?

Today most test equipment can generate a spreadsheet without engineers writing a single number in a notebook. Today it is better to draw with software than to sketch in notebooks. Yet give students a notebook and some will sketch because their creative energies flow in that direction. The notebook is not dead.

The First Robotics calls an electronic document a “notebook.” Electronic project documentation is important in today’s engineering competitions. They help document time and materials. They can turn any engineering into an expert witness or whistle blower. The mere presence of an engineering notebook at a meeting makes non engineers behave themselves. Signing in and out is still the only way to establish chronological integrity. Some standard organizations and certificate granting institutions only recognize engineering notebooks.

Engineering portfolios have no presence in the workplace, but are beginning to show up in education. Project Lead the Way encourages students to create portfolios in the EDD capstone class. Portfolio assessment is becoming a method of gaining college credit for introduction to engineering courses. All of this is happening because the vision of an engineering notebook is diminishing both on the job and in the classroom. One glance at a notebook can determine if someone has matured into a sophomore level engineer in the same way K-12 teachers can tell predict future success from a handwriting sample.

The goal of this paper is to challenge you, the engineer to begin writing in a notebook again ... or for the first time. Set a standard for your students to aspire to.

Personal Reasons

Most people with ADD can concentrate. They climb into a mental tunnel that tunes out the rest of the world. Then the world intrudes. Concentration is broken and everyone ends up irritated. A notebook helps rebuild the concentration. Reading the title, reviewing everything that was done will put one back into the tunnel rapidly and without effort. This alone can turn those with ADD into engineers.

Engineers with notebooks seem smart. Why? Engineer’s write what they learn. It is not because their brain gets larger or because they are gifted in some way. A notebook is sort of like a personal Goggle. But in addition to key word searching, the brains natural chronological and geographical context is leveraged. The notebook literally expands the brain.

Getting out a notebook is a commitment to work rather than play. Notebooks slow freshman down. They don’t throw away something thinking it is broken without proving that it is broken. They don’t take apart everything as fast. Notebooks break up the “I found it first, I did this first” extension of playing and refocuses this energy on design.

Notebooks are like Coffee. Notebooks must be signed out if work time is over. Notebooks are open while working. They are symbol of commitment. Not signing out violates chronological integrity. The ability to estimate time accurately is lost. Notebooks encourage forward, focused work.

Notebooks encourage detail, rather than reports to the teacher. The transition to capturing detail is the first sign of notebook appreciation. Looking back in a diary is a fun exercise that can end with “was that really me that wrote that?”. Engineering notebooks amplify this phenomena into “did I really see that?, think that? .. wow that’s complicated.” Notebooks inspire confidence in a profession that is dominated by frustration and failure documentation.

Without a notebook, one ends up doing the same thing over and over again while frustration begins to cloud productivity. With a notebook, repetition is obvious. Negative despair and fear of failure are exposed before they seduce. The efficiency of “doing it once” and “touching it once” creates a positive direction that normally would end in a fog of emotion, low self esteem and ultimately dropping out of engineering.

Some ugly, verbal, anal, compulsive, condescending behaviors are moderated. The seduction of brilliant thoughts is tempered by putting them in a notebook. The need to verbalize brilliant thoughts is reduced. The fear of forgetting brilliant thoughts is eliminated. Moments of calm can prevail. Brilliant thoughts can deflate into their own reality with a notebook.

Corporate Reasons

Engineers are constantly stepping off the cliff into the unknown. They are being paid to learn something first. Explorers of caves can unroll string, pile up rocks, or draw arrows on walls. Engineers explore too, but leave trails in notebooks. In the middle of frustration, fog, uncertainty, doubt, fear of failure and feelings of despair, they write. This raw material turns into the best tutorials.

The reason most tutorials on the internet are bad is because writing begins after success has been experienced. Recalling the pain of frustration, the fog, the uncertain, the doubt after the fact is impossible. Only writing “in the moment” captures all the details that can blaze a path. “After the fact” writing is merely a report of what is possible. It can set expectations, but can also deceive. Writing without a notebook creates poor tutorials, poor documentation and poor replication success.

Both science and engineering have goals of repeatability. The goal of science is to repeat experiments from reading papers. This is why notebooks exist. Without notebooks, people don’t record their frustrations and failures in the moment while learning something. Only with notebooks can the repeatable objective be accomplished.

Notebooks become the root context of all associated electronic information: pictures, video, data. In the past, certifying organizations have insisted on paper trails that begin with notebooks. Some have begun accepting scanned images of notebook pages. Most engineering companies claim ownership of the notebooks and create a paper trail of failed brilliant ideas that may someday result in profit. In some companies this is all done on paper because of how easily electronic documents are stolen.

Notebook Assessment

There is no universal form for writing in notebooks. Engineers sign in and out of them in different ways. What students need is “a way.” They need to learn the discipline of following “a

way.” This starts with respecting page numbers and not ripping pages from notebooks. Then it progresses to using both side margins and the top margin. Students like to rebel by using white space in random ways. So win the fight over form issues and trust that future battles will disappear.

Most students will expect volume to be graded and thus wordy, lengthy reports will appear. Notebook writing will not be appreciated until students begin recording their learning curves. This begins with writing in the moment. Insist that they bring their notebooks to every class. Kick them out if they don't have it. Don't answer questions unless it is clear their notebook is open and they have written down what they are going to do. Emphasize writing in the moment, and give all reports little value. This frees students from English class expectations.

The words “hypothesis, procedure, and analysis” of science doesn't translate well to freshman engineering. Freshmen walk into an introductory engineering class with these words having many loaded, contradictory, chilling, side effects that cripple learning what engineering is. Make it simple. Grade form, not content. Grade “GoingToDo, Doing, Rant triplets.” Make sure they are not recording what they already know how to do. Make sure that they are Ranting appropriately. Rant means “Reflect, Analyze, Next.” Count the triplets. More triplets, better writing, higher score.

The goal of introduction to engineering is to teach students what an engineering project is. The creative, fun part of this class is to move students from playing, to doing things first, to design and finally to problem solving. The notebook the forum in which this narrative can be seen. The GoingToDo, Doing, Rant triplets map to the emergence of design in all of it's art, science and business aspects. Counting triples creates a student incentive to record more detail that leads to more drawing, simulation and testing.

The hard part is the last part of the engineering narrative: “Solving Problems.” Engineers have to learn all the different, swap, isolate, temporary fix, customer chaos management of technicians. Most students have been rewarded for solving problems, not lingering in the tension they create so that dreams of alternative solutions begin filling notebooks. Engineers doing things for the first time can't swap. Do not reward problem, solution pairs in engineering notebooks.

Reward Problems that are followed by a brainstorming activity called “possible solutions.” Don't focus on huge project organization, business management, efficiency issues when teaching beginning engineering students how to write in a notebook. CDIO (conceive, design, implement and operate) needs to be focused on many tiny small problems during the semester, not one large problem. Yes there will be huge project management issues, system issues and dependencies in the engineering future. But the goal is not to try to teach students the lessons from past engineering experiences. The goal is to free students to discover for themselves these issues while learning to write in the notebook.

The book *Zen and the Art of Motorcycle Maintenance*, describes an English teacher frustrated with a creative writing class. No one is being creative. In frustration, he asks them to write about the back of his thumb, or a brick on the wall. Eliminate the context. This frees students.

Students will try to manufacture problems. They will try to turn their fog, frustration, anxiety, despair, and ignorance into a problem. Don't let them. Tell them that problems are outside of themselves. Problems are in the world and they can help the world by solving them. If a student can't figure something out rapidly, the problem is the world not having an excellent tutorial. Improve the tutorial.

This line of thinking has grown into a "problem rubric" in the notebook. It consists of a triplet just like the design triplet "GoingToDo, Doing, Rant." It consists of "Problem, Possible Solutions, Testing." The key is "possible solutions." "One of the possible solutions can't be "give up". The goal is to sit in the tension of the problem long enough that one dreams about solutions. The goal is to learn to enjoy this aspect of engineering without despair or fear of failure. Reward students the list more than one possible solution.

Testing is not as important as "possible solutions". Yes there are test protocols that students are going to have to learn in the future. But often the testing results in a problem statement refinement. Focus on small individual problems written about in individual notebooks. Insist that engineers brainstorm solutions about the smallest things. Count the problem triplets. Give them twice as many points as the design triplets. Reward students that do engineering in their notebooks.