Stimulating Creativity in Engineering and Science

1. Personal Creativity

2. Creativity in Technical Education

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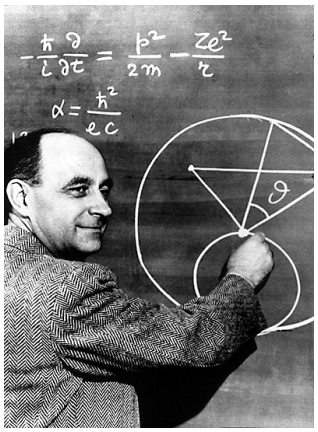
Personal Creativity

Take account of your personality and temperament

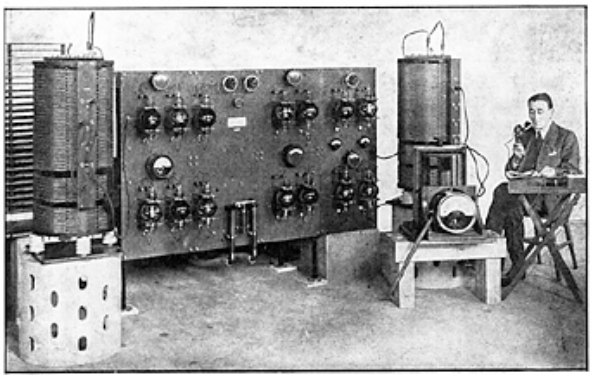
To get good ideas you must take account of your personality and temperament in choosing your technical field or science and your interests in that field. Be yourself.



Fermi

Copernicus, Newton, Galileo Kepler, Bacon

Hopper (compiler inventor)

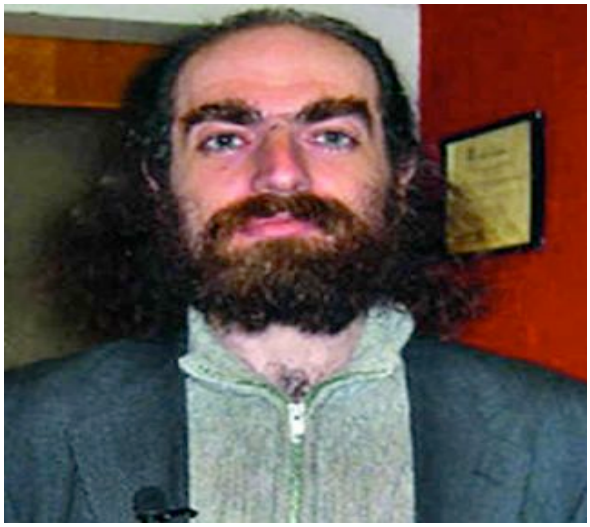


Marconi

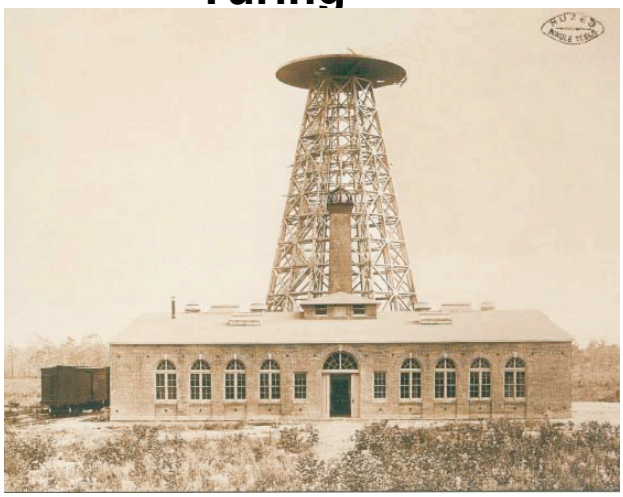
Personal Creativity

Curie

Turing



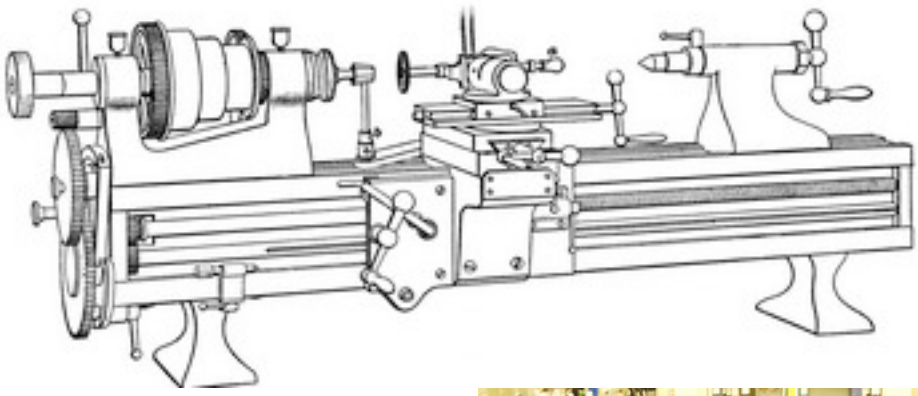
Perelman



Tesla's transmitting tower

Personal Creativity

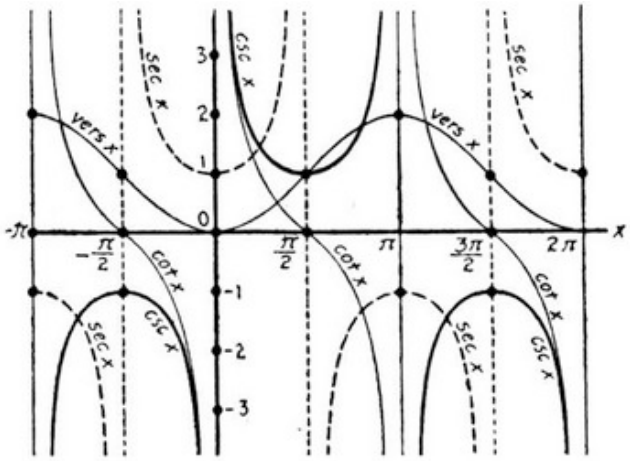
When choosing what you work on in engineering and science honestly evaluate the extent of your hands-on and laboratory skills.

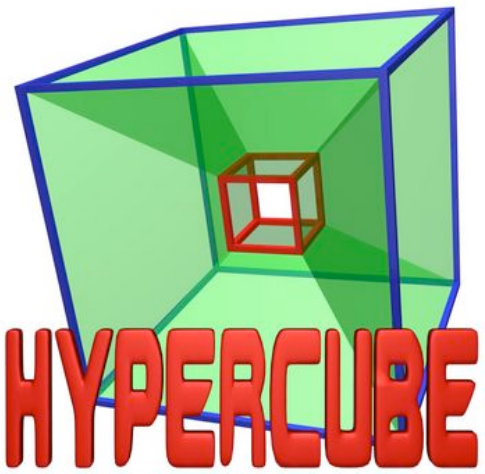


Personal Creativity

Mathematical ability is important

Don’t try to fit yourself into any particular image of what a scientist or an engineer should be. You don’t have to be a mathematical genius. There are lots of fields where mathematics is secondary. But you should be competent in mathematics.

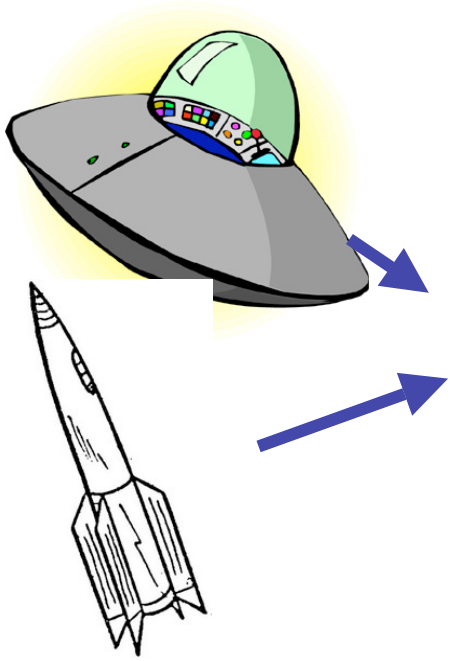




Personal Creativity

A powerful Imagination is crucial

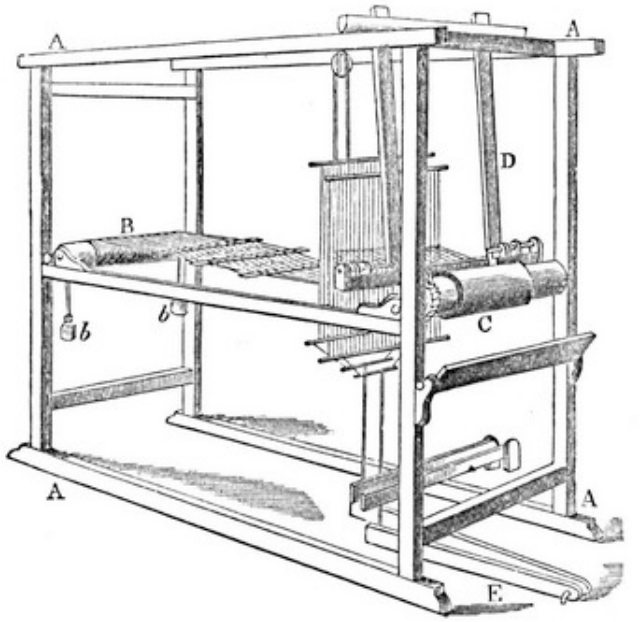
Imagination is a crucial ability required to be creative in engineering and science, imagination within the constraints of known physical laws, experimentation, feasibility and practicality. Begin with the far reaches of imagination at the science fiction level, then apply the constraints gradually.



Personal Creativity

Visualization ability is crucial

In engineering and scientific work it is crucial to be able to visualize how the work could be accomplished. The intended work might be the invention of a mechanical or electronic device, it might be the synthesis of a complicated molecule, it might be the design of an experiment to evaluate the efficacy of a new drug, it might be the modeling of how proteins fold and unfold.



Personal Creativity

Use patience and fortitude* in looking for good ideas.

For every good idea, expect to have five or ten bad or wrong or useless ideas

Astrology

Phlogiston model of combustion

Lamarckian evolution

Homeopathic medicine

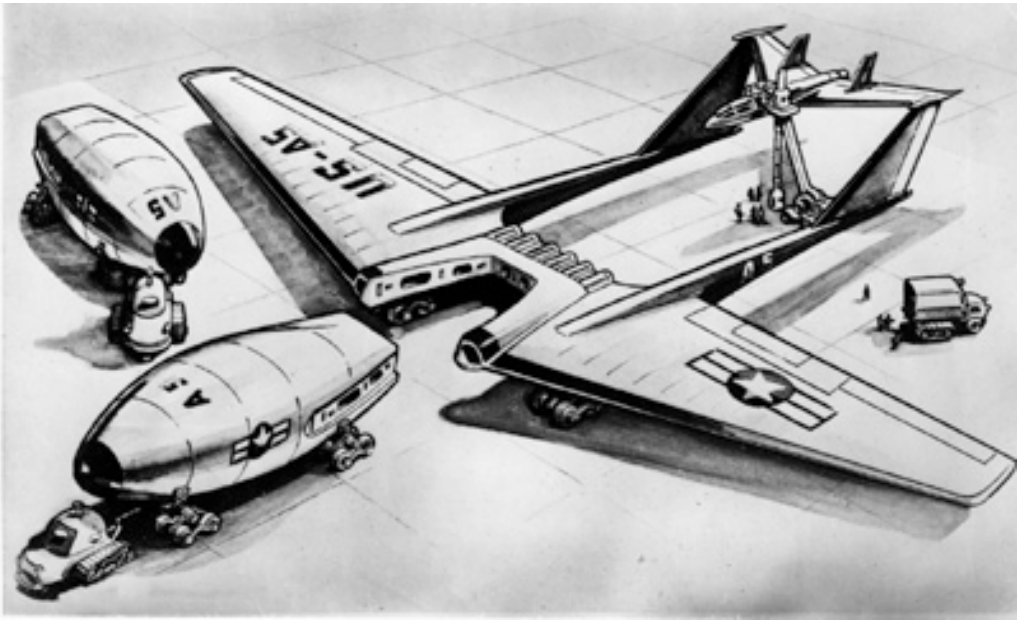
Electromagnetic ether

Cold fusion

*Motto of Fiorello LaGuardia New York Mayor in 1930's

Personal Creativity

A bad idea: the US R&D for a nuclear reactor powered airplane in the 1950's



The reactor was to be in the front and the crew in The rear.

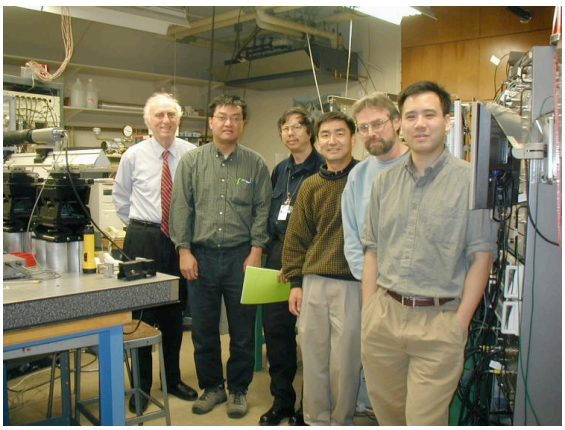
Personal Creativity

In the modern world the highly productive lone engineer or inventor or scientist is rare.

Personal Creativity

Find colleagues who are smarter than you and know more.

I always look for colleagues who are smarter than I am and who know more than I do. The obvious advantages are she or he may be able to solve the problem that has produced a dead end in my work. Most important, smart and knowledgeable colleagues can save me time.



Personal Creativity

Avoid colleagues who are fast and loud talkers. In fact, it is best to avoid such people in general.

Personal Creativity

There is no intellectual hierarchy in creativity in science and engineering.

clinical medicine

applied science

device design

academic medicine

invention

basic theory

engineering

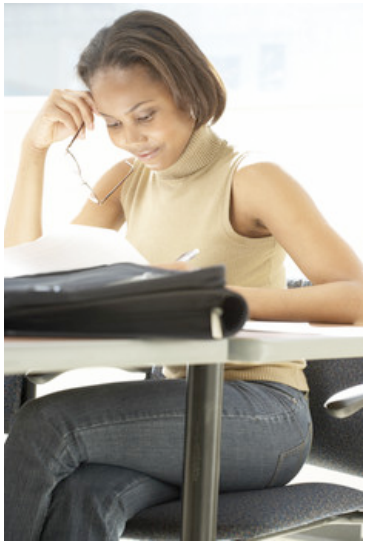
computer science

basic experimental science

Personal Creativity

Obsession is important when you have a good idea in computing, engineering or science

When you are developing an idea it is important to be obsessed with the idea. Think about the idea as much as possible, neglecting children, family, friends.



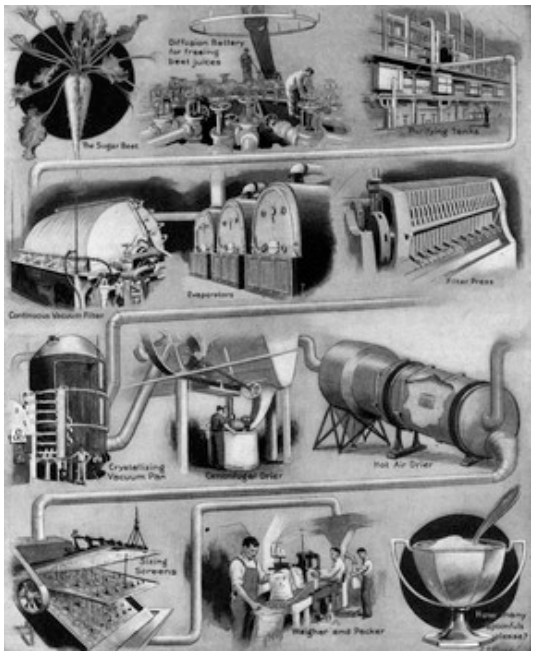
Personal Creativity

But if in the course of the work you find that someone has a better idea or that you have run out of money or that the idea is bad. Give up the obsession

and move on.

Personal Creativity

You must be interested in, even enchanted by some of the technology or software or mathematics you use. Then the bad days are not so bad



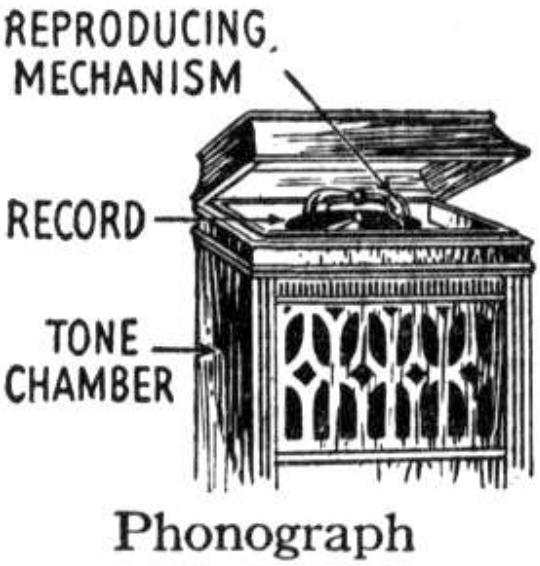
Personal Creativity

Another advantage of being enchanted by the technology is that you will be more likely to think of improvements and variations.

Edison

Personal Creativity

You should be fond of the technology that you use, but not too much in love with it. There may be a better way.



Phonograph

Personal Creativity

Above all, you must enjoy your engineering or science and like the people in that world.*

*At least like most of them

Creativity in Technical Education

Problems faced by technical students and technical professionals:

- Engineering and science keep changing
- More and more to learn
- Competing with established technical centers
- Responsibilities to local and world needs

Creativity in Technical Education

I have 9 proposals to help solve these problems. These proposals are somewhat contrary to present practice in undergraduate and graduate engineering and science

Creativity in Technical Education

Proposal: Reduce requirements for degrees.

Thus for a Physics Ph. D. :

A. Require **advanced** courses in classical mechanics, quantum mechanics through Feynman diagrams, electromagnetism, methods of mathematical physics with emphasis on computer usage.

B. Require **intermediate** courses in electronics, solid state physics, atomic physics, sub-atomic physics, statistical mechanics

Creativity in Technical Education

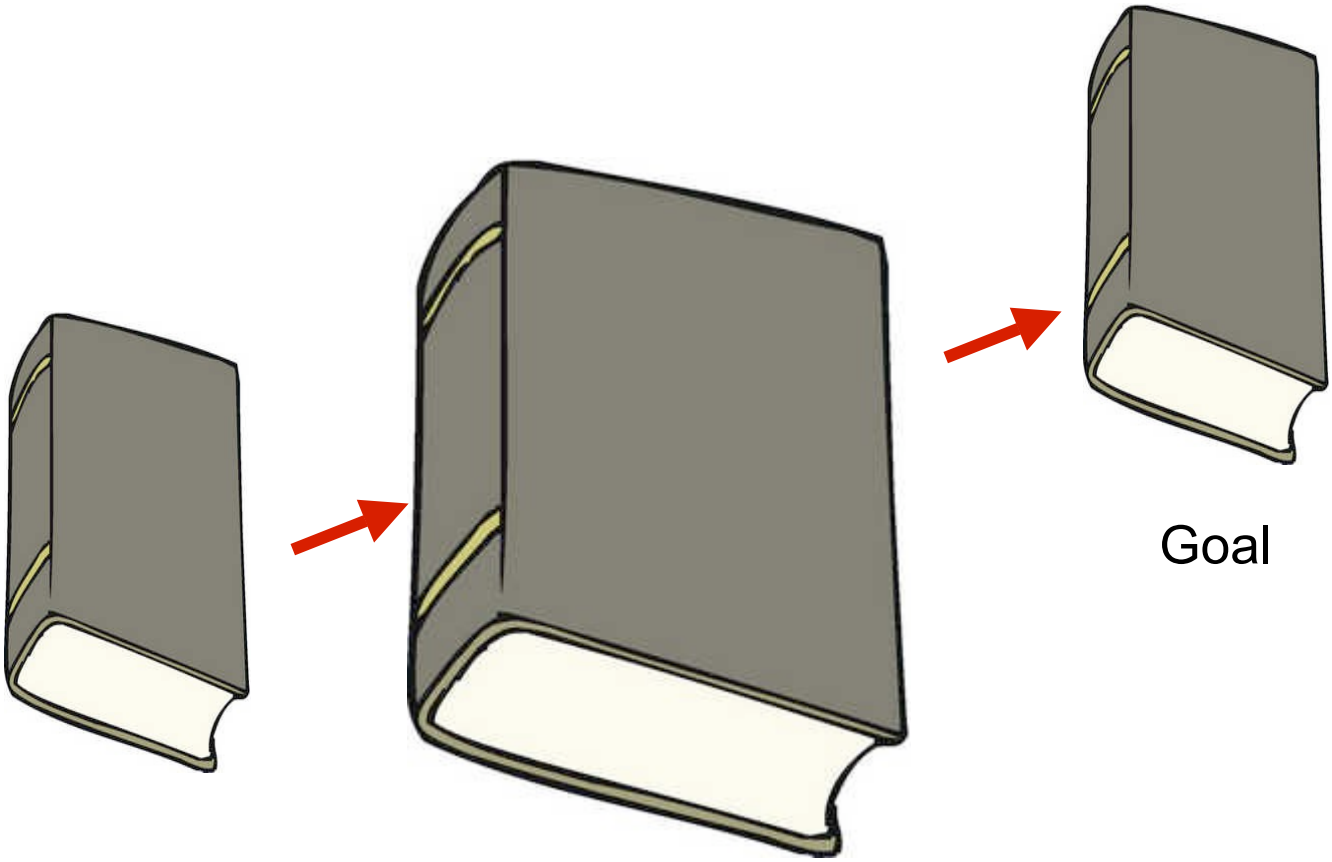
Proposal: Reduce stress on students and reduce competitiveness between students.

Creativity in Technical Education

Proposal: Remove the pressure to study 24/7. Students should have time to relax and play and dream.

Creativity in Technical Education

Proposal: Reduce length of courses and size of textbooks.



Goal

Older textbooks or early editions

Present encyclopediac textbooks

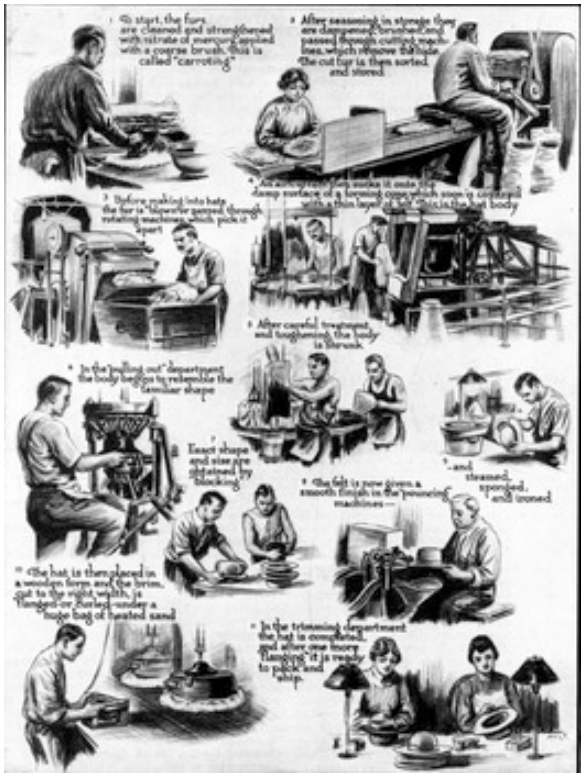
Creativity in Technical Education

Proposal: Teach students to learn as they go in their work or in new work.

You don’t have to do extensive study to move into new technical areas. You can learn a subject or a technology as you need it.
You can learn quickly from colleagues or books or journals and WEB sites. Learn by doing.

Creativity in Technical Education

Proposal: Rework laboratories so that there is an emphasis on process and problem solving rather than finishing prescribed experiments.



Creativity in Technical Education

- **Proposal: There is an over emphasis on ‘original research’ as a requirement for a Ph. D. The work is usually part of a larger, ongoing research program. It is primarily training in R&D. This time should be limited to three years or less.**

Creativity in Technical Education

Proposal: Teach students to look for new directions in science and engineering, particularly directions that will fill local needs.

Creativity in Technical Education

Proposal: Guide students to enjoy their engineering or science and to enjoy those worlds.