Design as a Foundation for Life-Long Learning

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Motivation

ABET
nj-nîr

**Engineer**

**NOUN:**  
1. One who is trained or professionally engaged in a branch of engineering.  
2. One who operates an engine.  
3. One who skillfully or shrewdly manages an enterprise.

**TRANSITIVE VERB:**

Inflected forms: *en·gi·neered*, *en·gi·neer·ing*, *en·gi·neers*

1. To plan, construct, or manage as an engineer.  
2. To plan, manage, and put through by skillful acts or contrivance; maneuver.

**ETYMOLOGY:**  
Middle English *enginour*, from Old French *engignieor*, from Medieval Latin *ingenitor*, contriver, from *ingenire*, to contrive, from Latin *ingenium*, ability. See *engine*.  

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**LAMAR UNIVERSITY**  
**ELECTRICAL ENGINEERING**

3
Engineer

Builder of engines.

Engine? Machine!

...engineers design machines.
Scientists discover, engineers design--this is the fundamental difference between the two.

You will never hear an engineer say "eureka". Designs are not discovered.
Design is creative

Design is the foundation of engineering and where we produce new things.

Design is not a linear process, but is cyclic and often requires many iterations.

Engineers design engines (machines).
Design

- To **conceive** or fashion in the mind; **invent**.
- To **formulate a plan for**; **devise**.
- To **plan out** in systematic, usually graphic form.
- To **create** or **contrive** for a particular purpose or effect.
- To create or **execute in highly skilled manner**.
A machine (engine) is something that has the ability to move through a state-space.

State: the state of a machine at any time \( t_0 \) is the amount of information at time \( t_0 \) that, together with all inputs for \( t \geq t_0 \), uniquely determines the behavior of the machine.
EE Machines

- electronic systems
- control systems
- power systems
- computer systems
- communication systems

...you have learned how these are designed.
innovation
noun
the action or process of innovating.
- a new method, idea, product, etc. : technological innovations designed to save energy.

DERIVATIVES
innovational adj

ORIGIN late Middle English : from Latin innovatio(n-), from the verb innovare (see innovate ).

innovate verb
verb [intrans.]
make changes in something established, esp. by introducing new methods, ideas, or products : the company's failure to diversify and innovate competitively.
- [trans.] introduce (something new, esp. a product) : innovating new products, developing existing ones.

DERIVATIVES
innovator n
innovatory adj

ORIGIN mid 16th cent.: from Latin innovat- 'renewed, altered,' from the verb innovare, from in- 'into'+ novare 'make new' (from novus 'new').
Stages of an Engineer’s Education

1. Arts & Sciences -- R³, history, comm
2. Engineering Science -- physics, math
3. EE Principles -- logic, circuits, electronics
4. Area Focus -- power, computer, controls, telecomm, etc..
5. Career Building -- tech writing, presentations, creative development (design).
**Table 1: Industrial Perceptions of Weaknesses in Engineering Graduates**

- Technical arrogance
- No understanding of manufacturing processes
- A desire for complicated and "high-tech" solutions
- Lack of design capability or creativity
- Lack of appreciation for considering alternatives
- No knowledge of value engineering
- Lack of appreciation for variation
- All wanting to be analysts
- Poor perception of the overall project engineering process
- Narrow view of engineering and related disciplines
- Not wanting to get their hands dirty
- Considering manufacturing work as boring
- No understanding of the quality process
- Weak communication skills
- Little skill or experience working in teams
- Being taught to work as individuals
Table 2: The New Industrial Paradigms

- Competitive world markets require a fundamental change in the way industry does business.
- Industry can no longer afford to design in a serial fashion: it costs too much time and money to "throw designs over the wall."
- Greater emphasis needs to be placed on developing better processes; these processes need to be consistently applied to get things done.
- World-class design requires integration of all aspects of the company.
- Disciplinary boundaries often provide unnecessary limitations to problem solving. Participative management and teamwork need to be enhanced and practiced.
- "Real" engineering requires a blend of analysis and synthesis.
What should have happened?

- Job trend assessment -- 10 year period
- Use of electives to produce job skill-building
- Examine junior year → senior year
- Senior seminar/design
  -- life-long learner activities
  -- job-driven skill-building
  -- career building activities

Is all lost if it didn't happen?
Intangible Skills

- Life Long Learning
- Creative thinking
- Problem Solving
- Teamwork
The Ideal Problem-Solver

• Make implicit assumptions explicit through searching for inconsistencies, worst case scenarios, making predictions and seeking criticism.

• Fractionation involves breaking ideas into component parts, thereby breaking down ‘programmed’ assumptions.

• The use of analogies.

• Brainstorming incorporates the first three activities into a group setting in order to facilitate the quantity of new ideas.

• Incubation requires breaks in a determined search for a solution and helps to alleviate mental fatigue.

• Communication of new ideas to others, for it is in the process of putting ideas into words that new ideas come to mind.

Elements of life-long learning

- Formal education and training.
- Self-directed learning/open learning.
- Informal learning.
Self-Directed/Open Learning

Characterized by:

an individual consciously setting out to learn about something outside, or in addition to, formal study.

This type of learning can:

often be vocational,

improve the skills needed at work,

enhance perspective on life, or

fulfill a need to discover and to understand.
Life-Long Learning Design

- Contrive to be a life-long-learner.
- Have a plan for life-long-learning.
- Create an engine for life-long-learning.
Tools for Life-Long Learning

- communication skills
- software skills
- creative development (design skills)
- optimized information acquisition skills
- critical (outside the box) thinking skills
Sparks of Genius: Portraits of Electrical Engineering Excellence by Frederik Nebeker
SPARKS OF GENIUS The Root-Bernsteins present a clever, detailed, and demanding fitness program for the creative mind. It is not exactly late-breaking news, and the authors don't play it as such, that the American educational system has a tendency to fragment knowledge, to disassociate ideas and laws from their practical applications, to quash the intuitive and sympathetic in favor of the empirical. But the Root-Bernsteins cogently attribute creative thinking to the work of the subconscious, those pre-logical glimmerings sensed amid the noise of formal thinking that intuitively synthesize an insight before it is translated into words, dance, music, math, pictures, whatever. This engagement of a whole cook's garden of subconscious ways of seeing, the Root-Bernsteins urge, is what we need to exercise. Here they demonstrate the transdisciplinary aspects of the creative process and give both examples of how they work in unusual minds, from Einstein (as he empathizes with a photon) to Helen Keller (as she thinks in wordless sensations), and ways readers can go about bringing them up to speed in their own lives. Their 13 tools include exercises in polysensual imaging, analogizing (is an electron like a vibrating string?), recognizing patterns as elegant as those of tectonic plate theory, moving from the abstract to the essence, and unleashing ferocious creativity through play. They conclude with some pedagogical tips to teach intuitive and imaginative skills, give arts and sciences equal billing, embrace transdisciplinary education that follow from their arguments but belabor the obvious, a failing that often haunts their text: “Pollock's work cannot be fully experienced just by looking it is necessary to feel as well.” Though readers' results will depend on their level of commitment, you don't need to be a genius to realize that pursuing even one of the Root-Bernsteins' pre-intellectual programs ought to improve creative thinking. (Photos) --

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...the American educational system has a tendency to fragment knowledge, to disassociate ideas and laws from their practical applications, to quash the intuitive and sympathetic in favor of the empirical.

Transdisciplinary aspects of the creative process, with examples of how they work in unusual minds, include Einstein (as he empathizes with a photon) and Helen Keller (as she thinks in wordless sensations).
Creativity

The 13 thinking tools of the world's most creative people:
abstracting
analogizing
body thinking
dimensional thinking
empathizing
forming patterns
imaging (visualizing)
modeling
observing
playing
recognizing patterns
synthesizing
transforming
Three types of engineers:

Those who make things happen.

Those who watch things happen.

Those who wonder what happened.
The significant problems we face cannot be solved at the same level of thinking we were at when we created them.

Imagination is more important than knowledge.

Albert Einstein
To conclude...

Consider life-long learning as a creative design process.
Engineering & Technical Invitational

Dashiell
Enterprise Products Company
National Instruments
Technip USA
Valero Energy
INEOS
S&S Professional Services
Huntsman
Chevron Phillips
DuPont
WhiteHat Security
TOTAL Port Arthur Refinery
CITGO Petroleum Corporation

Flowserve Corporation World Headquarters
United States Officer Program
Emerson Process Management Valve
Automation
Scallon Controls, Inc.
LyondellBasell Industries
ExxonMobil
Flowserve FSD
INVISTA
Jacobs Engineering
Sasol North America
Gerdau
Flint Hills Resources
Titanium Engineers
MWV - MeadWestvaco

Thursday, September 20, 2012
University Reception Center
Timeline

- **November**: Team Presentations Begin
- **December**: Technical Papers Due
- **October**: Project Board Review

**you are here**

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**Lamar University**
**School of Electrical Engineering**
Near-Term Timeline & Issues

• Today – Design & Life Long Learning
• Wednesday – no meeting
• Thursday – Project Declaration
• Tuesday – Project Management Start