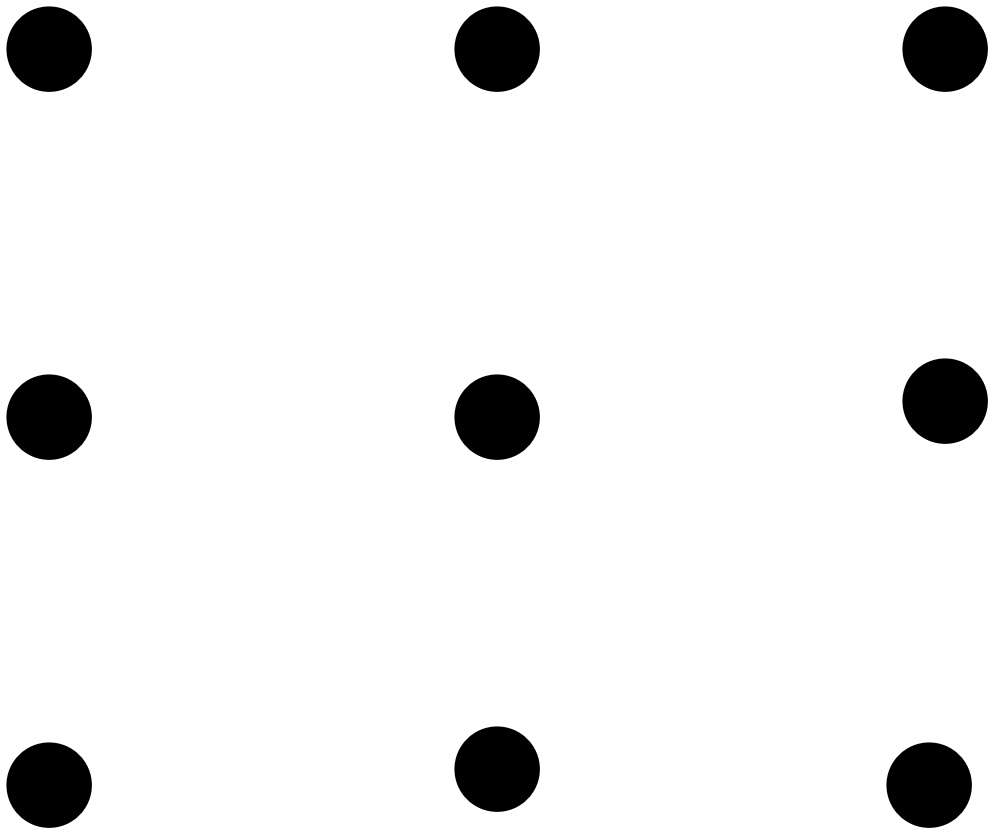
An Introduction to Electrical Engineering

Critical Thinking

Lectured by: Dr. A. Haghbin

Think Outside the Box



Critical Thinking

- Be CREATIVE
- Identifying and stating the problem
- Identifying and defining the variables in the problem
- Evaluating the problem for its research ability
- Reviewing the literature related to the problem

Be CREATIVE

- http://www.creativeeducationfoundation.org/
- http://new.odysseyofthemind.org
- http://www.academia.edu
- http://www.asee.org
- http:// www.polymathlectures.org (free creativity course)
- http://www.successfuleducation.us

Be CREATIVE

- http://education.engineering.uga.edu
- http:// www.ctechinnovation.com
- http://www.waseda.jp/eng/academics2/cse.html (School of Creative Science and Engineering)
- http://www.eeic.osu.edu (The **Engineering Education** Innovation Center)

Be CREATIVE

- North Carolina State University
- Cambridge University
- Northampton University (UK)

Creativity

- “Creativity as the production of something that is both new and truly valuable”--Rothenberg
- “It would seem to be our responsibility to produce some creative engineers or at least not to extinguish the creative spark in our students.”–Richard Felder

Be CREATIVE

- Creativity in Engineering, needs
  - Immerse yourself in a domain or problem
  - Be prolific—generate lots of ideas
  - Use tools for representations and thoughts
  - Play with ideas
  - Avoid premature closure

Be CREATIVE

- Don’t be afraid to be different
- Be open and receptive to new ideas
- Do it—practice your craft
- Maintain a product orientation
- Relax—indulge your diversions
- Reflect—review what you have done
- Have fun!

Be Creative

- Seltzer and Bentley (1999)
- Creativity is the application of knowledge and skills in new ways to achieve a valued goal.
  - The ability to identify new problems, rather than depending on others to define them
  - The ability to transfer knowledge gained in one context to another in order to solve a problem

Be Creative

- A belief in learning as an incremental process, in which repeated attempts will eventually lead to success
- The capacity to focus attention in the pursuit of a goal, or set of goals

Be Creative

- Creativity is a process of generating and manifesting a new idea
- Innovation is taking creative ideas into reality and implementation to produce a new product or system

Factors That Boost Creativity

- Record your creative ideas
- Take a walk!
- Travel!
- Practice 1: randomly select a word and then try to formulate ideas incorporating this word

Factors That Boost Creativity

- Practice 2: Define your problem, then ask six questions: What? Where? When? Why? Who? and How?
- Exercise your brain by talking to educated people, being a member in a scientific society, reading scientific papers and patents of interest

Factors That Boost Creativity

- Writing
- Be healthy
- Be happy
- Be confident
- Playing imagination games, have fun and play
- Brainstorming

Creative Thinking Techniques

- Applied Imagination
  - Put to other uses?
    - New ways to use as is? Other uses if modified?
  - Adapt?
    - What else is like this? What other idea does this suggest? Does the past offer parallel? What could I copy? Whom I could emulate?
  - Modify?
    - New twist? Change meaning, color, motion, sound, odor, form, and shape? Other shapes?

Creative Thinking Techniques

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- Magnify?
  - What to add? More time? Greater frequency? Stronger? Higher? Thicker? Extra value? Plus ingredient? Duplicate? Multiply? Exaggerate?
- Minify?
  - What to subtract? Smaller? Condensed? Miniature? Lower? Shorter? Lighter? Omit? Streamline? Split up? Understate?

Creative Thinking Techniques

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Creative Thinking Techniques

- Substitute?
  - Who else instead? What else instead? Other ingredients? Other material? Other process? Other power? Other place? Other approach? Other tone of voice?
- Rearrange?
  - Interchange components? Other pattern? Other layout? Other sequence? Transpose cause and effect? Change pace? Change schedule?

Creative Thinking Techniques

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Creative Thinking Techniques

- Reverse?
  - Transpose positive and negative? How about opposites? Turn it backward? Turn it upside down? Reverse rules? Change shoes? Turn tables? Turn other cheek?
- Combine?
  - How about a blend, an alloy, assortment, an ensemble? Combine units? Combine purposes? Combine appeals? Combine ideas?

Creative Thinking Techniques

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Creative Thinking Techniques

- Brainstorming
  - Generating ideas process in a group of people
- Brainstorming properties
  - Have a well-defined and clearly stated problem.
  - Have someone assigned to write down all the ideas as they occur.
  - Have the right number of people in the group.

Creative Thinking Techniques

- Have someone in charge to help enforce the following guidelines:
  - Suspend judgment
  - Every idea is recorded and accepted
  - Encourage people to build on ideas of others
  - Encourage way out and odd ideas

Creative Thinking Techniques

- Morphological Analysis
- Attribute Listing
  - Breaking down the problem into smaller bits
  - Looking for a replacement for every bit to produce a new product or system

Creative Thinking

- Divergent thinking vs. convergent thinking
- Random stimulation
  - Pick a word from dictionary or a paper from a database
  - Relate two unrelated concepts

Creative process

- First insight
- Saturation
- Incubation
- Illumination
- Validation

Creativity

- TRIZ (Theory of Inventive Problem Solving)
  - By Genrich Altshuller
  - http://www.iiits.org/index.asp
- Tree search for the best solution
- ARIZ
- USIT

Genrich Altshuller

TRIZ

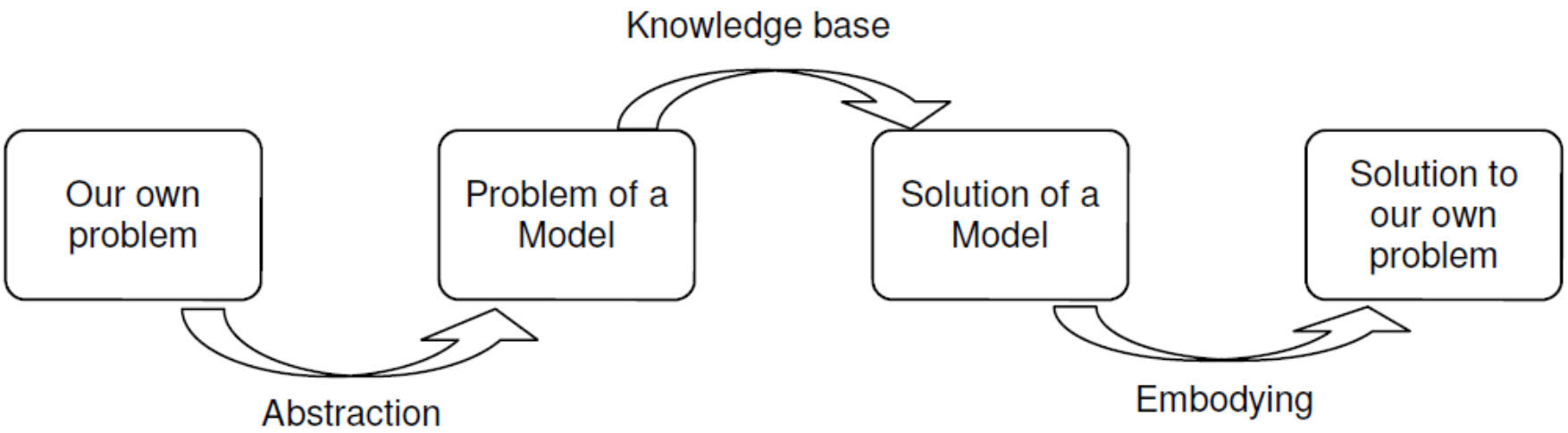
- Has extracted principles of invention
- Has revealed laws of evolution of technical systems
- Has established general procedures for problem solving
- Has succeeded in establishing a new system of methodology which has exceeded the level of "know-how to invent"

TRIZ Foundations

- The Resolution of Technical and Physical Contradictions
- The Evolution of Systems
- The Ideal System and Ideal Solution
- Degree of ideality = useful effects/harmful effects

TRIZ

- Basic model of problem solving in TRIZ



TRIZ Methodology for Problem Solving

Toru Nakagawa
Nov. 1997

"TRIZ Home Page in Japan
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Editor: T. Nakagaw

World of Information in Science & Technology

Science & Technology DB

Set ups → Effects

Patents DB

Problem → Solution

World Extracted by TRIZ

Inverse retrieval of technology

Trends of Systems

Target → Method, Method, ...

solving contradictions

Contra-diction → Principles of Invention

Principles & Examples of Invention

Support of Problem Definition

World of Your Own Problem

Description of Your Own Problem

Solution for Your Own Problem

TRIZ Example

- Airplane wing
- Quartz Watch
- Pizza box

Any Question?

THANKS FOR YOUR ATTENTION