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Creative Thinking

**“You can’t depend upon your eyes
when your imagination is out of
focus.”**

–Mark Twain



Learning Objectives

At the end of this module, you will understand some alternative approaches to creative thinking:

- Problem Posing and Creativity
- The Creative Process
- Types of Creativity
- Brain Research and Creativity
- Techniques for Creativity

Warning: This presentation is quite speculative in nature.



Inventions

- What is the most important invention in the past 2000 years?
- Scientific method, civil rights, rudders on boats, western classical music, space travel, laser, transistor, hay, internet, steel, moveable type, antibiotics, atomic bomb, steam engine, the clock, television, idea of free will, unconscious mind, birth control, internal combustion engine, education . . .



Inventions

“The question is impossible to answer with one thing; one could for instance say with some justification “the germ theory of disease” but then that goes back to the microscope -- otherwise no one would ever have seen a germ -- and that to the lens, and eyeglasses may be as important as germs . . . and so on.”

-Philip W. Anderson

“There is no such thing as the single most important invention of the last two thousand years. The evolution of technology doesn't work like that. It's a web of ideas, not a zero-sum game.”

-Howard Rheingold



Some Bad News

- Research indicates that pre-school children are incredible engines of creativity.
- Consider, for example, what a child can do with a blanket, a table, and a cardboard tube – defend a fort or ride a unicorn – whole new worlds where anything is possible.
- Measured levels of creativity then decline throughout elementary and secondary school.
- Perhaps this decline has something to do with the expectation by adults that children adhere to certain structures, rules of conduct, and patterns of thinking (**Nurture?**)
- Or perhaps it has to do with the rapid and abundant production of neurons in children, and the tendency of the brain to prune unused neurons as we age (**Nature?**)
- Whatever the reason, by the time people get to university, many are about as creative as rocks.



Some Good News

- Recent research indicates that we are not simply born with certain levels of creativity (and intelligence).
- The brain is rather plastic in nature (i.e., changeable). Not only can we learn to become more creative with practice, but with the right training, it is also possible to increase measured levels of intelligence.
- Biology IS NOT destiny! (Hard work may be ;-)



Innovation and Engineering: Problem Posing

- Observe how existing industrial, commercial, or consumer products and systems work.
- Note when some device or system irritates you (e.g., coin rollers).
- Identify the purpose of existing products or systems with an eye to finding inefficiencies or problems.
 - ❖ Analyze the nature of the problem by considering whether solving the problem is *physically* possible.
 - ❖ Determine how best to improve the product or how to resolve or restate the problem.
 - ❖ Consider how to develop and market the product (is solving the problem *fiscally* or *socially* possible?).

See the following for an alternative seven stage model of creativity:

<http://www.mgtaylor.com/mgtaylor/glasbead/7stagcrp.htm>



Problem Posing

Baby Monitor



Heart Monitor



- Things you can improve:
 - Reduce cost, size, complexity
 - Increase reliability, lifetime, user interface



The Creative Process

1. **Saturation:** Once the problem or creative challenge has been defined, the next stage of creativity is a left hemisphere activity that paradoxically requires **absorbing one's self in what's already known**. Any creative breakthrough inevitably rests on the shoulders of all that came before it. For a painter, that might mean studying the masters. For me, it involves reading widely and deeply, and then sorting, evaluating, organizing, outlining, and prioritizing.
2. **Incubation:** The second stage of creativity begins when we walk away from a problem, typically because our left hemisphere can't seem to solve it. **Incubation involves mulling over information, often unconsciously**. Intense exercise can be a great way to shift into right hemisphere in order to access new ideas and solutions. After writing for 90 minutes, for example, the best thing I can do to jog my brain, is take a run.

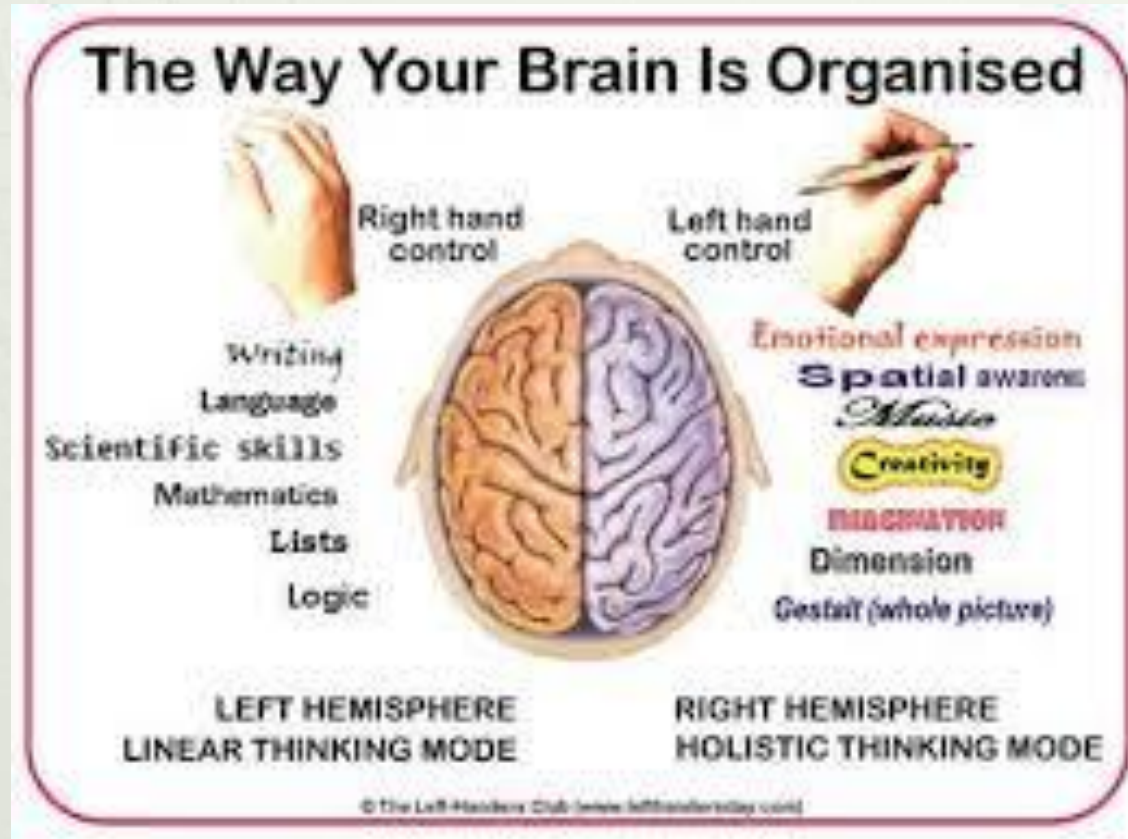


The Creative Process (cont'd)

- 3. Illumination:** Ah-ha moments -- spontaneous, intuitive, unbidden -- characterize the third stage of creativity. Where are you when you get your best ideas? I'm guessing it's not when you're sitting at your desk, or consciously trying to think creatively. Rather it's when you've given your left hemisphere a rest, and **you're doing something else**, whether it's exercising, taking a shower, driving or even sleeping.
- 4. Verification:** In the final stage of creativity, the left hemisphere reasserts its dominance. **This stage is about challenging and testing** the creative breakthrough you've had. Scientists do this in a laboratory. Painters do it on a canvas. Writers do it by translating a vision into words.

Source: <http://blogs.hbr.org/schwartz/2011/11/how-to-think-creatively.html>

Brain Lateralization is . . .



An over-used and over-stated over-simplification!



What is Consciousness?

- Many have naively argued that consciousness is something that resides in the brain.
- But recent (emergent), research suggests that consciousness doesn't reside in the brain – **consciousness IS the brain as expressed by the relationship between the various parts.**
- You are conscious because you are not a discrete right brain or left brain person. You are a whole person, who is much greater than the sum of your parts.
- And as I would argue, it is our consciousness that enables our creativity.



Types of Creativity (cont'd)

	Cognitive	Emotional
Deliberate	Thomas Edison	Aha! Therapeutic Moment
Spontaneous	Isaac Newton	Artists & Musicians (Writers?)

Source: Dietrich, A. (2004). The cognitive neuroscience of creativity. *Psychonomic Bulletin & Review*, 11, 1011-1026.



Types of Creativity (cont'd)

➤ Source is unknown (Boder?). **Where does Engineering fit????**

1. **Combine:**

- a. Field: Business
- b. Value: Synthesis
- c. Example: Steve Jobs

2. **Explore:**

- a. Field: Science
- b. Value: Curiosity
- c. Example: Charles Darwin

3. **Transform:**

- a. Field: Art (also politics/religion, psychology)
- b. Value: Change
- c. Example: Walt Whitman, Martin Luther King, the Dalai Lama, Carl Jung



Meta-Creativity?

- Perhaps Engineering is meta-creative in that it brings together
 - » Combining, Exploring, Transforming
 - » Synthesis, Curiosity, Change
 - » Innovation and Creation





Brain Research & Creativity (1)

- In its 100 billion neurons, a **toddler's brain has about double the average number of neuronal connections as the adult brain** (2,000 vs. 1,000 to 20,000 vs. 10,000 average synapses per neuron). Does this excess allow the brain to respond to novel and uncertain situations faster and more creatively?
- The brain **massively rewires itself between 3-6 years** (particularly in the frontal cortex, which controls organizing, planning, and focusing). Less creative and more predictable response to reality?
- Neuroplasticity is **the ability of the brain to change in terms of structure and function in response to the environment**. This may make the question, "Is it nature or nurture?", increasingly meaningless. Nature is nurture; nurture is nature?
- The **brain wires itself in response to stimuli. It can rewire itself following trauma**: some blind people appear to echolocate arising from the brain rewiring the visual and hearing centers.



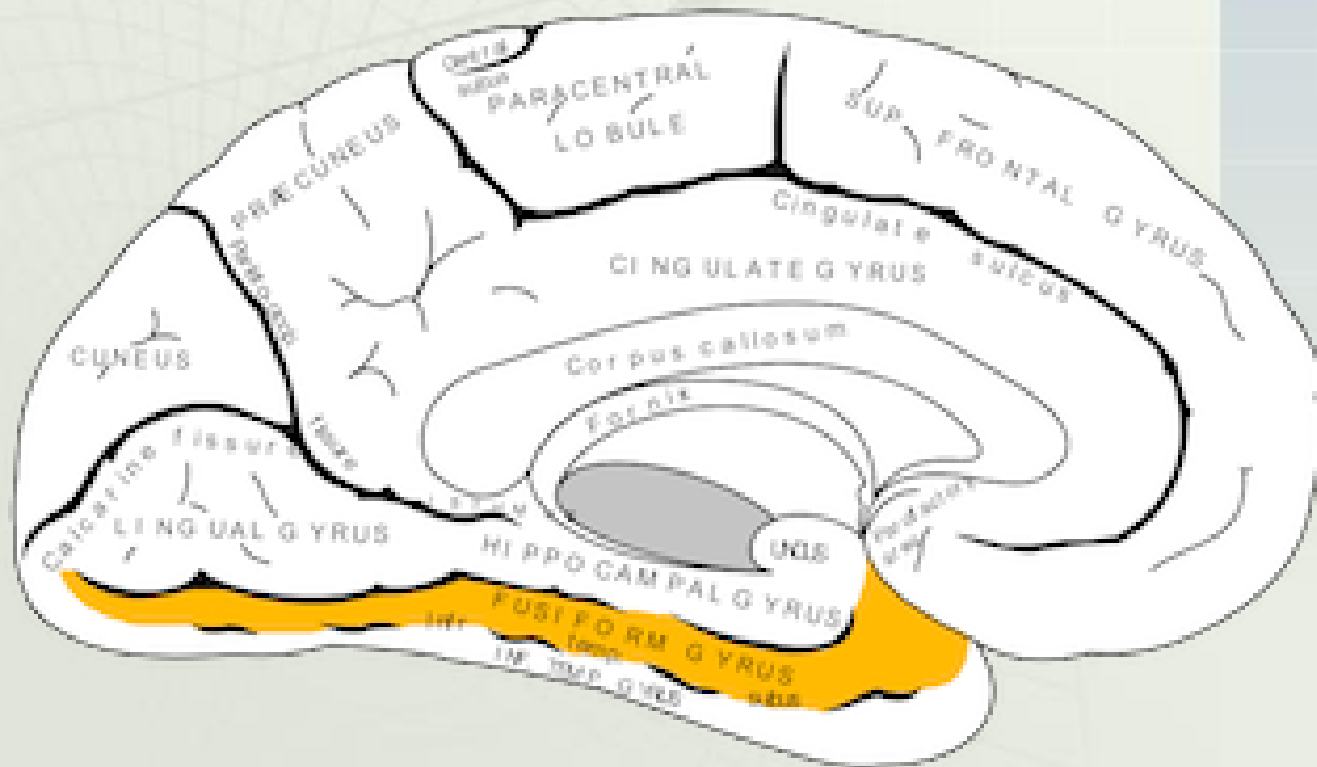
Brain Research & Creativity (2)

- Distinction sometimes made between **fluid intelligence** (the capacity to think logically and solve problems in novel situations) and **crystallized intelligence** (the ability to use skills, knowledge, and experience).
- **Mathematical/logical problems** are the main domain of fluid intelligence; **language/rhetorical problems** are the main domain of crystallized intelligence.
- Younger brains (0-26 yrs) solve **novel problems faster** than older brains; but older brains (24-120 yrs) solve **known problems with greater precision and novelty**.
- Recent (emerging) research indicates that through the use of computer-assisted learning-technologies, **the older brain can increase its fluid intelligence**. Use it or lose it.
- Are limits on the **ability/willingness to change** a barrier to creativity?
“Nothing endures but change” – Heraclitus (c.535-475 BC)



Brain Research & Creativity (3)

- What is the source of creativity in the brain? We don't yet know precisely, but some have put forward the Fusiform Gyrus as a candidate that points to a possible answer:





Brain Research & Creativity (4)

- “What do artists, poets, and novelists have in common? The propensity to link seemingly unrelated things. **It’s called metaphor.** So what I’m arguing is, if the same gene [linked to *Synaesthesia*], instead of being expressed only in the fusiform gyrus, is **expressed diffusely through the brain**, you’ve got a greater propensity to link seemingly unrelated brain areas in concepts and ideas. So it’s a very phrenological view of creativity.” (V.S. Ramachandran, cited in http://www.noahbrier.com/archives/2009/05/neuroscience_and_the_creativity_of_connections)
- *For more info see:*
http://www.ted.com/talks/vilayanur_ramachandran_on_your_mind.html and
http://www.psy.cuhk.edu.hk/~mael/papers/RamachandranHubbard_Synaesthesia.pdf



Techniques for Creativity

Mature creativity is not innate nor does it arise from mystical inspiration. It comes from observation of the world around us with a “what-if” attitude – a willingness to suspend our dependence upon rules – a view that anything is possible.

- Observing nature
- Focused meditation
- Role playing
- Free writing
- Journal writing
- Problem-Solving Heuristics



Observing Nature

Whitcomb Judson, inventor of the zipper in 1893

Did it arise from observing how feathers are held together?

George de Mestrel, inventor of velcro in 1948

Observed how the burrs of certain plants adhere to clothing and animal fur.

Andrew & Steve, inventors of SSTF (Slug Slime Thin Film)

After characterizing the electrical, optical, and mechanical properties of slug slime, they found that only slugs have a use for it. *(More recent research indicates that slug slime may well have a variety of biomedical applications. Oops, we missed that opportunity -- sigh).*



Focused Meditation

- Put on relaxing music.
- Find a comfortable chair or lie on the floor.
- Close eyes, and breathe slowly and deeply.
- Relax muscles in body, starting with face and moving through the torso down to the legs.
- Visualize ideas in your mind as clouds slowly passing by on a sunny day.
- Switch focus to the particular problem or idea you want to consider.
- Look at it from various perspectives as if it were a cloud floating by.
- Later record any insights or ideas that occur.



Role Playing

- Imagination is limited by our experiences.
- Overcome this by seeking out new experiences.
- Example: Learn how to best design products for the blind by wearing a blindfold at home for a few hours. Or spend a day in a wheelchair up at SFU to appreciate the difficulties faced by the physically disabled.
- Talk with your intended user group



Free Writing & Brainstorming

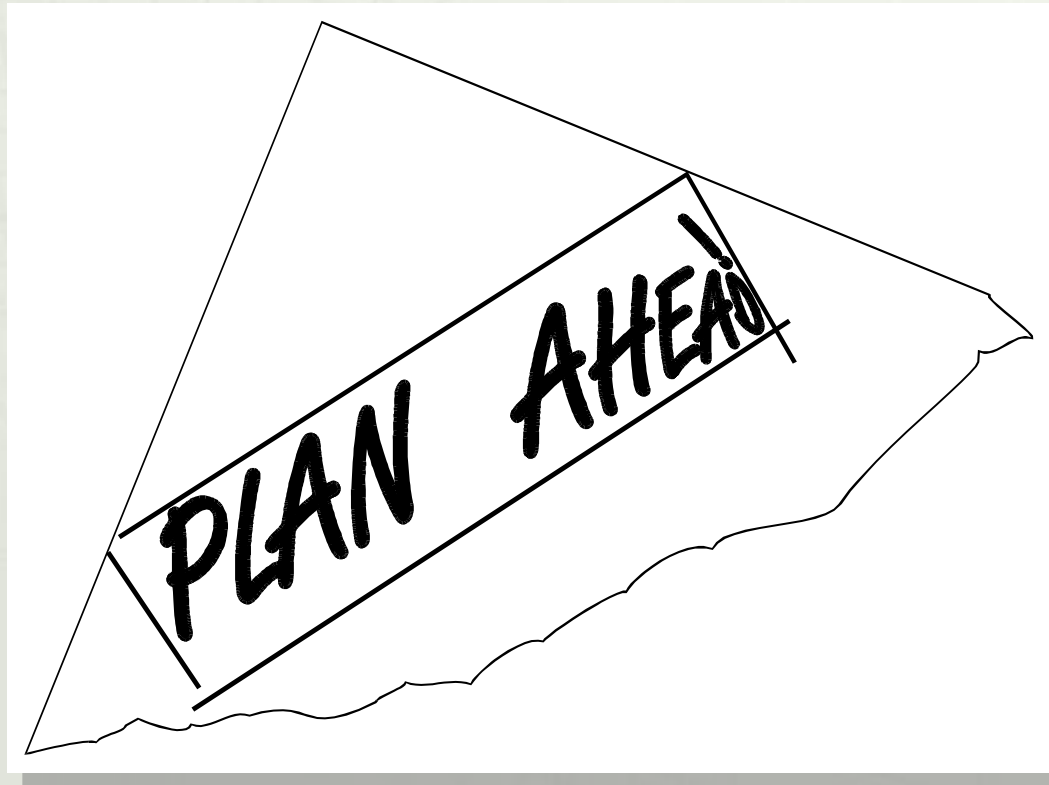
OK So I need to write about brainstorming. Usually its done in a group but not always sometimes individual. Works best in a group though people feed off each others creativity especially if they have different backgrounds - social professional - etc. So how does it work as a group

- get people together for a time period ½ to 1 hour*
- anything goes. no criticism - insane crazy ideas are ok*
- need to ensure nobody gets censored though so need a group leader to facilitate stuff. should also record*
- Also good to later sort out ideas by being critical and further exploring them*

But the biggest point is to make sure there is no criticism & that people can come up with all sorts of ideas. Should also be fun laughing - sort of like a creative party with stuff written on the blackboard



Informal Journals





Formal Engineering Journals

Nov 24, 1995

Sonar Data
 Sonar Setup
 off carrier 4000
 sample delay 1000 assumed
 clock freq. 1250000
~~Sub~~ Samples per sweep 600.
 .
 .
 _____ screen

NV101.dat
 Tuned transducer until I got a fairly
 low return across the bottom.
 Gain 26dB
 subsample factor 5.
 ↑note change
 no screen on bottom

NV102.dat
 Gain 21dB
 subsample factor 5
 Screen on bottom. *angle 30°
 (33° is better
 April 11, 1996)*

~~ES~~ Ping Pong ball 10 & 2 in voltage.
 Gain 35 dB + 26dB 30v transmitter
 range. .5ms/ div and 3.8 div
 1.4 117m range 4.4 vpp/ return



Problem-Solving Heuristics

Problem-solving heuristics are structured methods that allow one to discover new information or unexpected solutions to problems:

- Create analogies
- Generate contraries
- Synthesize ideas
- Research the Literature



Create Analogies

X is like Y – a very powerful technique

- **Static (or particle) perspective**
(i.e., How do jet engines work?)
- **Dynamic (or wave) perspective**
(i.e., What are the historical changes in jet engine design?)
- **Relative (or field) perspective**
(i.e., How are jet engines like rocket engines?: Vectored thrust)

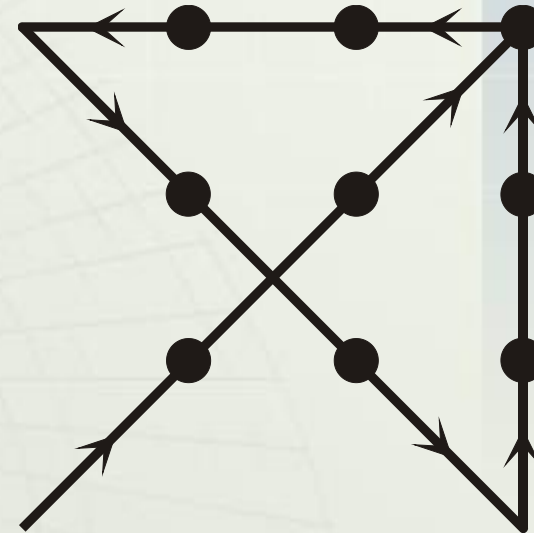


Generate Contraries

Thinking Inside the Box
(Thesis)



Thinking Outside the Box
(Antithesis)



Praise success and punish failure
Praise success **and** praise failure



Synthesize Ideas

The First Post-It-Note (Art Fry)



AKA: Serendipity

“Chance favours the prepared mind.”
–*Louis Pasteur*



Research the Literature

- See what other people have to say about the problem. Friends and colleagues? The web? Popular press? Libraries? Databases?
- www.lib.sfu.ca
- IEEE
- INSPEC
- SPIE
- scholar.google.com



Phrases that Kill Creativity

- We tried that before.
- It costs too much.
- It's too radical a change.
- Let's get back to reality.
- You're right, but
- Not that again.
- We did all right without it.
- Let's form a committee.
- It can't be done.
- Quit dreaming.
- **NO!**

Et cetera



Conclusion

“Computers are useless. They can only give you answers.”

–Pablo Picasso

“To invent, you need a good imagination and a pile of junk.”

–Thomas Edison