Systems Thinking: The Art of Seeing

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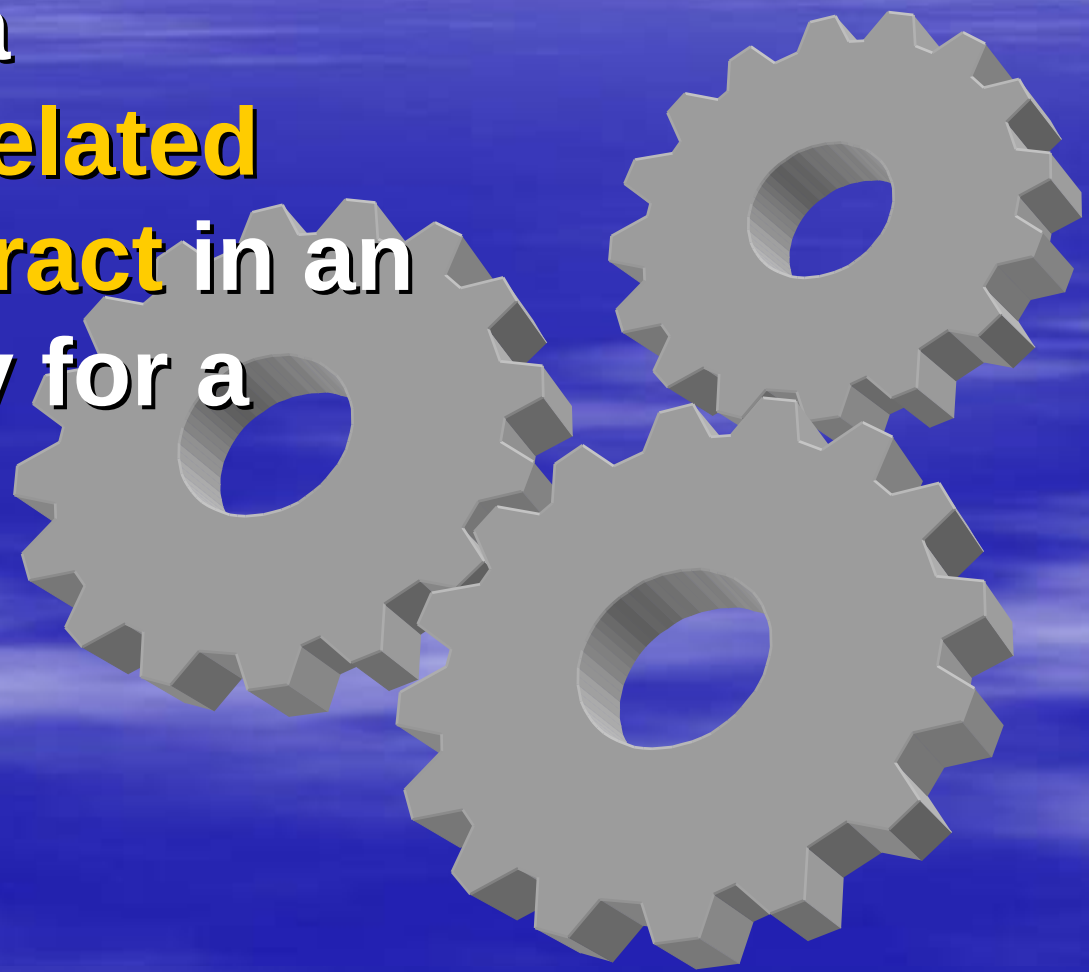
Summary

- Systems Engineering and Projects
- Results of Concrete / Abstract Thinking
- Seeing Systems
- Whole-Brain Thinking
- Beginning the Development of Whole Brain Reasoning

System = Whole

- A system is a collection of related parts that interact in an organized way for a purpose



What is a System?

(American Heritage Dictionary)

- A group of interacting, interrelated, or interdependent elements forming a complex whole.
- A functionally related group of elements, especially:
  - The human body regarded as a functional physiological unit.
  - An organism as a whole, especially with regard to its vital processes or functions.
  - A group of physiologically or anatomically complementary organs or parts: *the nervous system; the skeletal system.*
  - A group of interacting mechanical or electrical components.
  - A network of structures and channels, as for communication, travel, or distribution.
  - A network of related computer software, hardware, and data transmission devices.
- An organized set of interrelated ideas or principles.
- A social, economic, or political organizational form.
- A naturally occurring group of objects or phenomena: *the solar system.*
- A set of objects or phenomena grouped together for classification or analysis.
- A condition of harmonious, orderly interaction.
- An organized and coordinated method; a procedure.
- The prevailing social order; the establishment. Used with *the*: *You can't beat the system.*

Connectedness
(Sherwood, 2002)

- If you wish to understand a system, and so be in a position to predict its behavior, it is necessary to study the system as a whole. Cutting it up into bits for study is likely to destroy the system's connectedness, and hence the system itself
- If you wish to influence or control the behavior of a system, you must act on the system as a whole. Tweaking it in one place in the hope that nothing will happen in another is doomed to failure—that's what connectedness is all about

Systems Engineering

- Related to Problem Solving
  - Connecting of disparate ideas / concepts
  - Relating previously unconnected elements
- Like Project Management on steroids
  - Understand what you intend to do
  - Plan the work required
  - Execute the plan
  - Learn as you go forward

What are the success and failure modes of typical endeavors?

Key Elements

(Standish Group CHAOS results, 1996)

- Top Success Factors
  - user involvement
  - executive management support
  - clear requirements
  - proper planning
  - realistic expectations
  - smaller project milestones
  - competent staff
  - ownership
  - clear vision and objectives
  - hard working, focused staff
- Top Failure Factors
  - lack of user input
  - incomplete requirements
  - changing requirements
  - lack of executive support
  - technology incompetence
  - lack of resources
  - unrealistic expectations
  - unclear objectives
  - unrealistic timeframes
  - new technology

Critical Success / Failure Factors in Projects

(Belassi & Tukel, 1996)

- Top management support throughout
- Proper goal definition and setting
- Accurate estimates
- End-user involvement
- Project manager on site
- Appropriate team selected
- Testing and training

Patterns of Software Systems Failure and Success

(Jones 1996)

- Project Management Failure Factors
  - no historical software measurement data
  - failure to use automated estimation tools
  - failure to use automated planning tools
  - failure to monitor progress of milestones
  - failure to use effective architecture
  - failure to use effective development methods
  - failure to include formal risk management
  - failure to use formal configuration management
  - more than 30% creep in requirements

Principal reasons for DOD software project failures

Report of the Defense Science Board Task Force on Acquiring Defense Software Commercially (1994)

- Poor requirements definition
- Inadequate software process management
- Lack of integrated product teams
- Ineffective subcontract management
- Too little attention to software architecture
- Poorly defined, inadequately controlled interfaces
- Limited or no tailoring of military standards

Software Systems Failure Modes

(Website: http://suraj.lums.edu.pk)

- Hostile culture
  - Punishing bad news messengers
- Poor reporting structure
  - Sponsors are not involved
- The Success of Any Project is Linked to the People
  - Take care of the people to succeed
- Over-commitment
  - Unclear expectations and understanding of the scope
- Decision Making Escalation
  - Movement becomes more important than progress
- Political Pressures
  - Hidden Agendas
- Technology-focused developments
  - Ignoring the Human
- The lure of the leading edge
  - It can be costly and heartbreaking

Software Systems Failure Modes

(Website: http://suraj.lums.edu.pk)

- Complexity underestimated
  - Simplified by individuals who are not informed
- Inadequate consultations with major stake holders
  - User needs in the dark
- Design by committee
  - No major responsibility holder
- Technical fix for a management problem
  - Lack of whole picture thinking
- Staff turnover
  - Lack of engagement
- Competency
  - Decisions made by the wrong people
- Receding deadlines
  - Soft plans with malleable objectives and milestones
- Inadequate testing and training
  - Not having discipline in our development
- Communication problems and work group problems
  - As always…

Left Brain Style

- Responds to verbal instructions
- Problem solves logically and sequentially
- Looks at differences
- Is planned and structured
- Prefers established, expected information
- Prefers talking and writing
- Prefers multiple choice tests
- Controls feelings
- Prefers ranked authority structures
- Sees cause and effect
- Is a splitter, distinction is important
- Draws on previously accumulated, organized information

Right Brain Style

- Responds to demonstrated instructions
- Problem solves with hunches, looks for patterns
- Looks at similarities
- Is fluid and spontaneous
- Prefers elusive, uncertain information
- Prefers drawing and manipulating objects
- Prefers open ended questions
- Free with personal feelings
- Prefers collegial authority structures
- Is a lumper, connectedness important
- Is analogic, sees correspondences, resemblances
- Draws on unbounded patterns, clustered around images

Consolidating all these reports: Right and Left Brain Activities

Hostile culture	Lack of Right Brain
Poor reporting structure	Lack of Right Brain
The Success of Any Project is Linked to the People	Lack of Right Brain
Over-commitment	Lack of Right Brain
Decision Making Escalation	Left Brain Knee Jerk
Political Pressures	Lack of Right Brain
Technology-focused developments – Ignoring the Human	Lack of Right Brain
The lure of the leading edge	Lack of Right Brain
Complexity underestimated	Lack of Left Brain
Inadequate consultations with major stake holders	Lack of Right Brain
Design by committee	Lack of Right Brain
Technical fix for management problem	Lack of Right Brain
Staff turnover	Lack of Right Brain
Competency	Lack of Left Brain
Receding deadlines	Lack of Right Brain
Inadequate testing and training	Lack of Right Brain
Communication problems and work group problems	Lack of Right Brain

Success/Failure Conclusions

- Factors in systems project failures are largely a lack of connecting issues between right and left brain:
  - User involvement / Requirements management
  - Management support / Communication
  - Change / Adaptation

Is this a growing problem? Project completion statistics

(Marchewka, 2003)

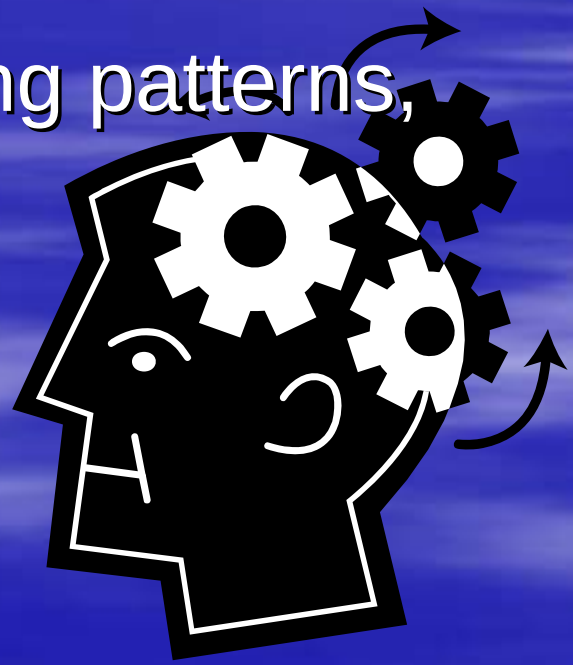
Project Size	Avg Budget	Avg Actual Cost	Avg Over Budget	Avg Over Sched	Original Scope Realized	Completed On-time On-budget	Completed Over-budget Late, not all Functions	Cancelled Before Completion
Small	$203K	$435K	214%	239%	74%	28%	51%	22%
Med	$740K	$1.36M	182%	202%	65%	16%	47%	37%
Large	$1.3M	$2.3M	177%	230%	42%	9%	62%	30%

What do we intend to do about it?

- Understand the right and left brain
- Understand how we truly solve problems, which is a combination of both sides
- Define those areas of right brain activity that will enhance our ability to develop systems successfully

The Human Brain

- A self organising, self patterning system
- A good pattern maker but a poor pattern breaker
- Creativity => the art of breaking patterns, habits and certainties
  - Left Brain versus Right Brain

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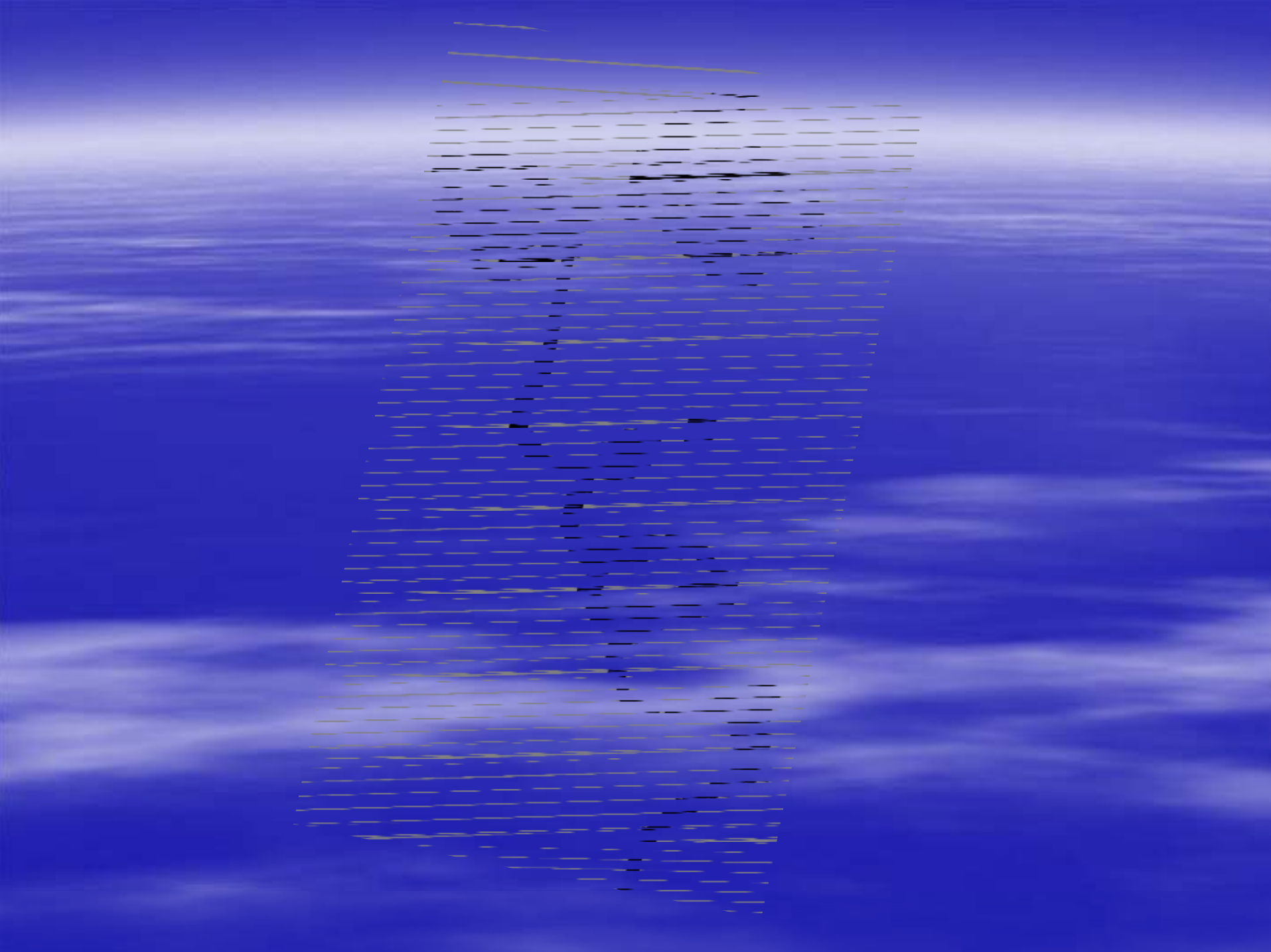


A brief History of Thought: Ancient, Mediaeval and Modern Periods

- Early Philosophers: 400 BC- Plato, Socrates, Aristotle
  - The Development of Logic and Vertical Thinking
- The Dark Ages and the Renaissance: Copernicus to Galileo
  - Suppression of analytical thinking
- The Industrial Revolution
  - The rapid expansion of knowledge applications
- The Information Revolution and the Knowledge Economy
  - The Future – What kind of thinking is required?

Lateral Thinking

(Edward de Bono, 1970)

- Lateral Thinking
- Follows least likely paths
- Frequently incorrect
- Non sequential
- Provocative
- Generative

- Vertical Thinking
- Follows most likely path
- Always correct
- Sequential
- Analytical
- Selective

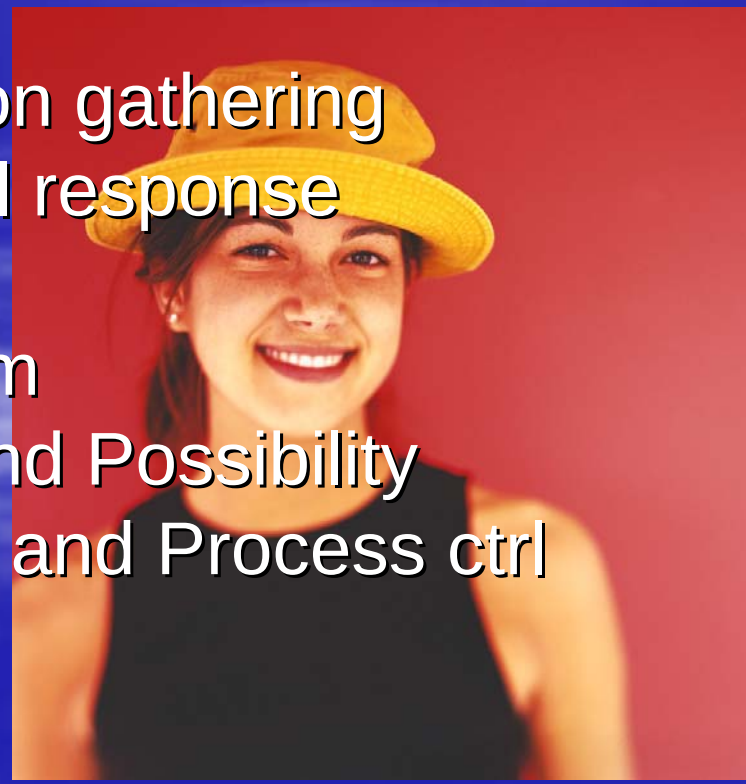
Lateral Thinking: The 4 Golden Rules

- Check your assumptions!
  Especially the more experienced / intelligent you are!
- Ask Searching questions
  To gain better insight
- Deliberately adopt a different point of view
  Change your perspective; “What If?”
- Borrow with Pride: Adopt, Adapt, Improve!

De Bono's 6 Thinking Hats

- Most group thinking and discussion is adversarial: wearing a metaphorical "hat" encourages parallel thinking…….

- The WHITE Hat: Information gathering
- The RED Hat: Emotional response
- The YELLOW Hat: Optimism
- The BLACK Hat: Pessimism
- The GREEN Hat: Growth and Possibility
- The BLUE Hat: Overview and Process ctrl



Gorilla Spotting!

(Wiseman, 2004)

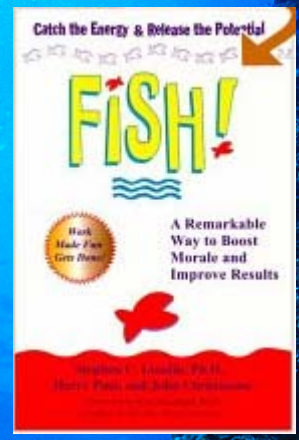
- We all have Blind Spots: sometimes we miss the obvious!

  Creativity is not about “wild and whacky” ideas……
- Be mindful of a problem; don’t focus or forget it – be aware and open to opportunities….. chance favors the open mind
- A Primed Brain + Time + Freedom = Eureka moments
- The seeds of great discovery are constantly floating around us, but they only take root in minds well prepared to receive them

  - Joseph Henry

The FISH Philosophy!

(Lundin, 2003)



- Choose your attitude
- Play
- Be Present
- Make their day

Each of these methods are proposing a different way (a more complete way) of thinking about your problem…

CREATIVITY

- Imagination is more important than knowledge

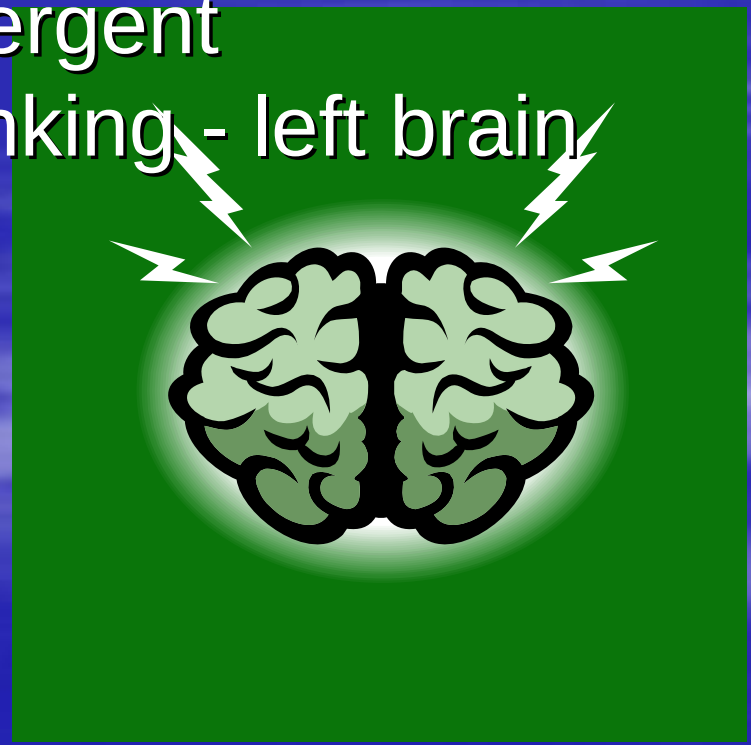
  - Albert Einstein

- Imagination is to create something which did not exist previously, but which can be realized through Design and Engineering

- Knowledge is memory of something which exists

CREATIVITY

- Imagination requires divergent, intuitive and creative thinking - right brain activity
- Knowledge require convergent deductive and logical thinking - left brain activity



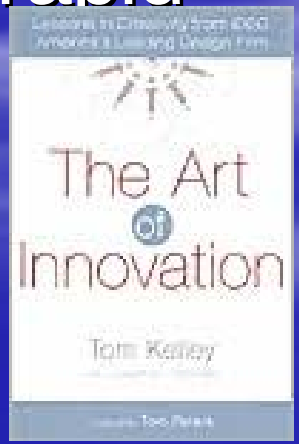
Related studies supporting the idea that Whole Brain Reasoning is key:

- The Art of Innovation
  - IDEO Corporation methods of success
- Deep Survival
  - Surviving is a Systems solution
- Arts and Music Education
  - Startling results demonstrating the benefit of combining right and left brain activities

The Art of Innovation

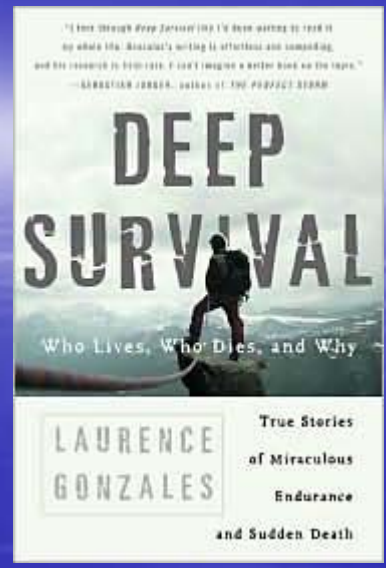
(Kelley, 2001)

- Understand the market, client, technology, constraints of the problem (left brain)
- Observe real people in real-life (right brain)
- Visualize new concepts and the customers who will use them (right brain)
- Evaluate and refine the prototypes in rapid iterations (left brain)
- Implement the new concept for commercialization (both sides)



Deep Survival

(Gonzales, 2005)



1. Perceive

   Look, See, Believe. Be Observant and Cognizant

2. Stay Calm

   Use Humor, Use Fear to focus the mind

3. Think/Analyze/Plan

   Get organized, set small achievable objectives

4. Take Action

   Take bold and cautious actions

Deep Survival

5. Celebrate your successes

   Take joy in completing tasks

6. Count your blessings

   Be grateful, help others more than yourself

7. Play

   Sing, mind games, poetry, mathematics

8. See the beauty

   Treat it like a vision quest

Deep Survival

9. Believe you will succeed
   Develop a deep conviction of success
10. Surrender
   Let go your fear, put away the pain
11. Do whatever is necessary
   Be determined, have the will and the skill
12. Never give up
   Let nothing break your spirit, there is always one more thing you can do

Classifying by Abstract / Concrete

Left Brain Activities

- Think/Analyze/Plan
- Take Action
- Celebrate your successes
- Believe you will succeed
- Do whatever is necessary
- Never give up

Right Brain Activities

- Perceive
- Stay Calm
- Count your blessings
- Play
- See the beauty
- Surrender

Results of the mixture of art and science (various websites, 2007)

- Study of 37 student's IQ scores over 8mos
  - First group given no music lessons – 6% increase in spatial reasoning scores
  - Second group given music lessons – 46% increase in spatial reasoning scores
- Medical School acceptance
  - 66% of music majors accepted (highest %)
  - 44% of biochemistry majors accepted

More results

- Music and visual arts education given to first graders who underperformed in Kindergarten
  - After one year were 22% better at mathematical competency than their peers
- 1993-95 study on three groups of preschoolers
  - 1st group – no training – IQ ^ .5 pts
  - 2nd group – computer lessons – IQ ^ .35 pts
  - 3rd group – music lessons – IQ ^ 3.62 pts

More results…

- Students with musical performance experience
  - 53 points higher on SAT verbal portion
  - 39 points higher on SAT math portion
  - Than students without musical performance exp
- Students with coursework in music appreciation
  - 61 points higher on SAT verbal portion
  - 42 points higher on SAT math portion
  - Than students without music appreciation courses

Clearly there is something of significant value in Whole-Brain Reasoning…

The Art and Science of understanding a System

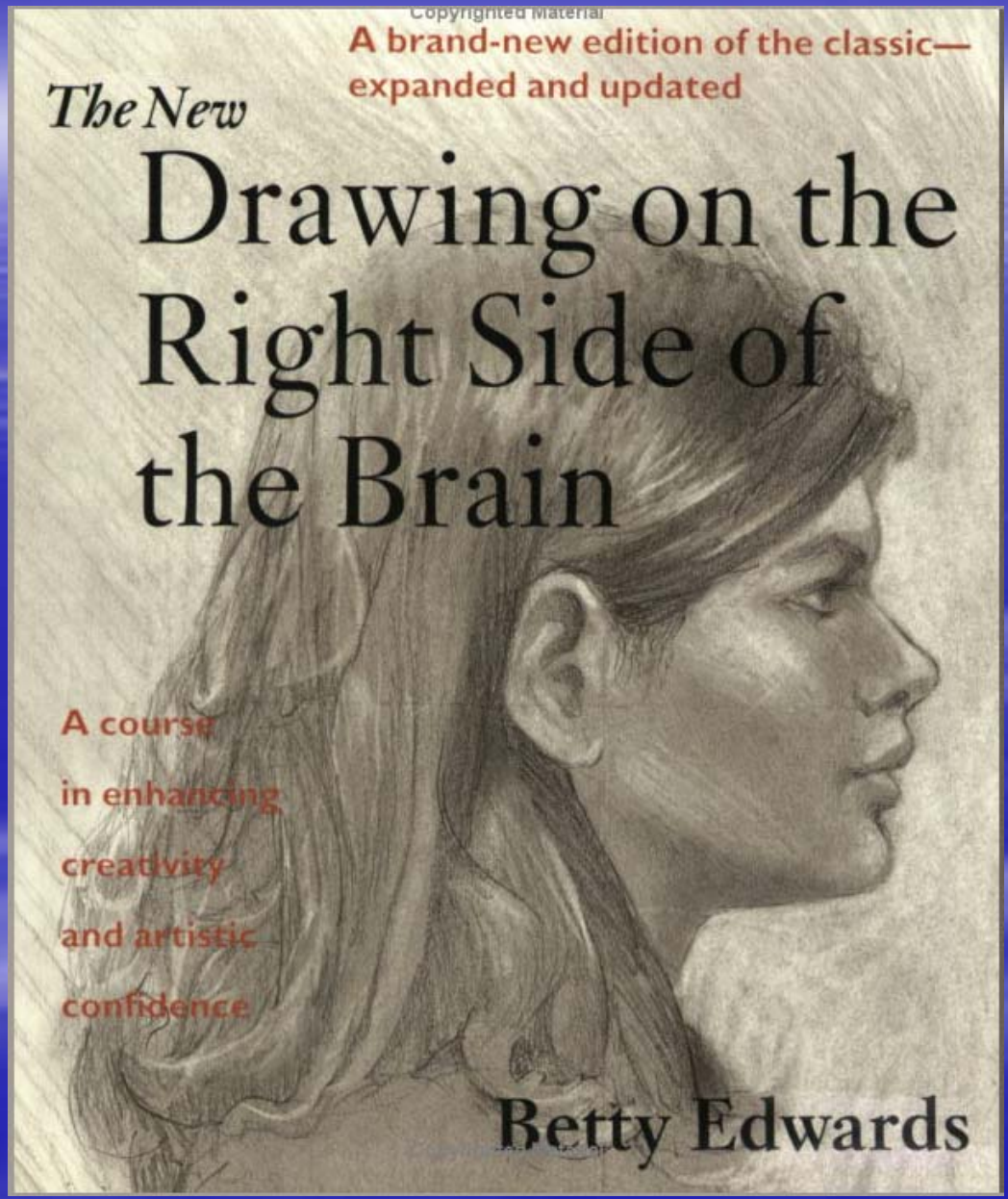
- Success in any endeavor is first and foremost a matter of accurate seeing
- Learning to really see what is in front of us allows us to better understand the world around us and the essence of our problem
- This is a departure from linear thought, and results in a crossing of both artistic and scientific reasoning

To solve a problem

- To solve a problem one has to
  - See exactly what the problem is
  - Imagine the system and the problem
  - Imagine the solution to the problem
  - With your eyes you see what isn't working, you make it work in your mind, and you simply have to identify the difference
- This is 'Whole-Brain' Reasoning

Whole Brain Reasoning

- Nuts and bolts observational analysis from the left side of the brain
- Free association image building from the right side of the brain
- This is a departure from traditional linear-thinking, sequential models
- A mixture of **art** and **science**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A brand-new edition of the classic—
expanded and updated
The New
Drawing on the
Right Side of
the Brain
A course
in enhancing
creativity
and artistic
confidence
Betty Edwards

Five basic skills of drawing

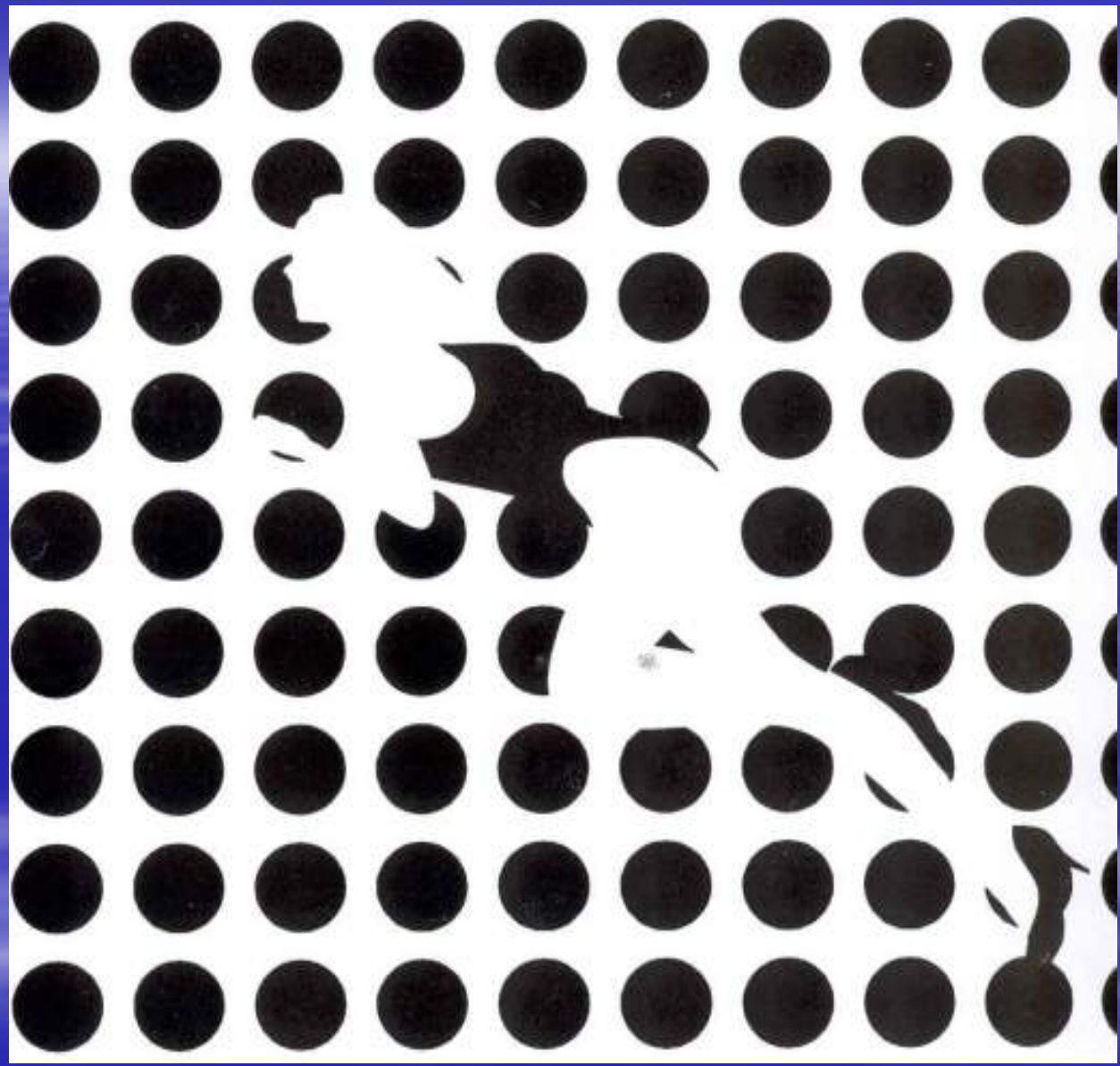
- The perception of edges
- The perception of spaces
- The perception of relationships
- The perception of lights and shadows
- The perception of the whole, or gestalt

Translating that into the five basic skills of Design

- The perception of interfaces
- The perception of context
- The perception of relationships
- The perception of light and dark, with regard to design intent
- The perception of the whole, or gestalt

This is what Systems Engineering is all about

- The combination of art and science to create:
  - Comprehensive
  - Cohesive
  - Creative
- The ability to combine the art and science is what differentiates the star performers from the average performers



We must understand when we see things that aren't really there

Image copyright Bev Doolittle

Whole-Brain Thinking

- Consider both the art and the science
- See what you are not seeing, due largely to
  - Incorrect mental models
  - Lack of focus
  - Lack of understanding
  - You simply have not posed the right questions
- Take a moment and simply reflect

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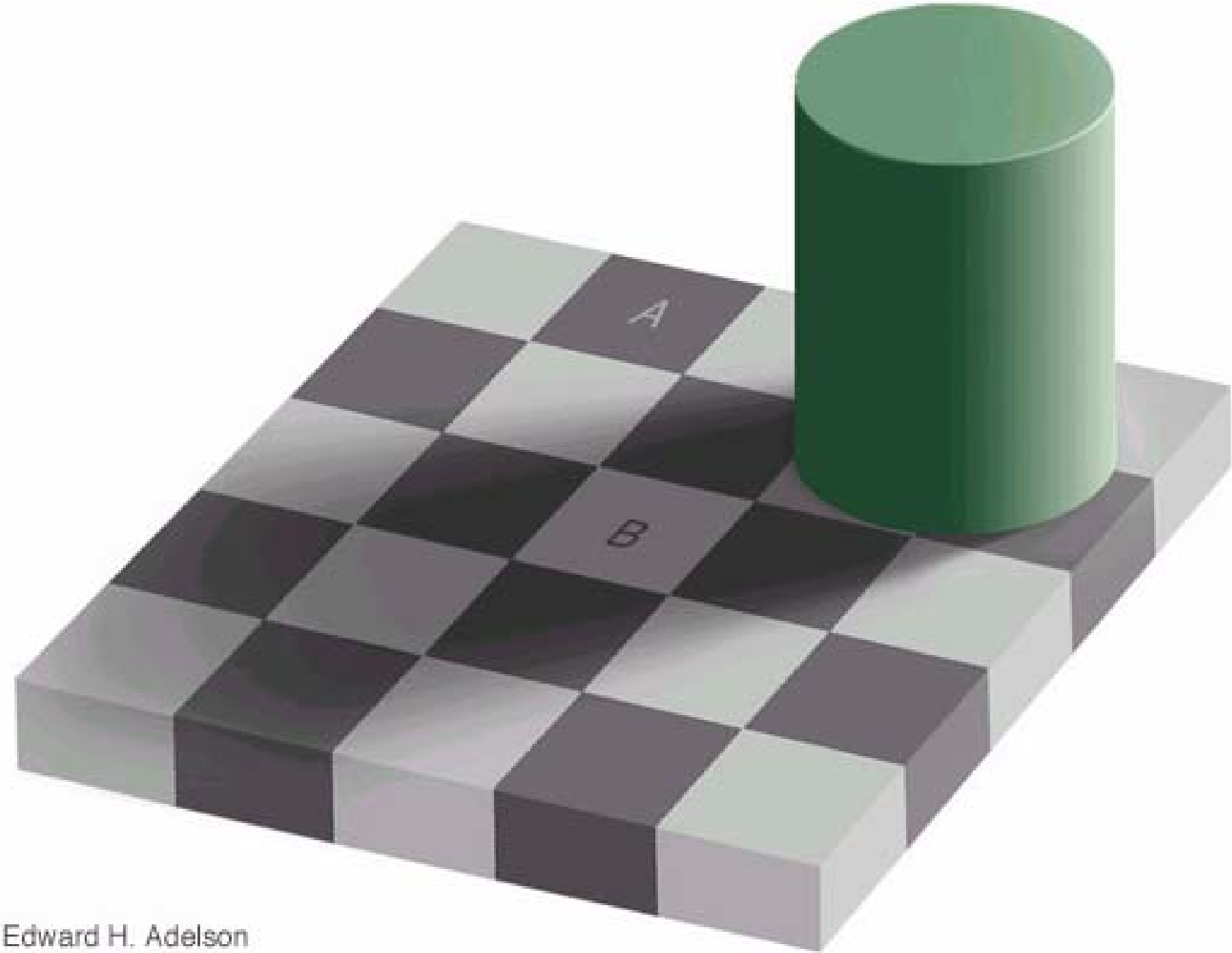
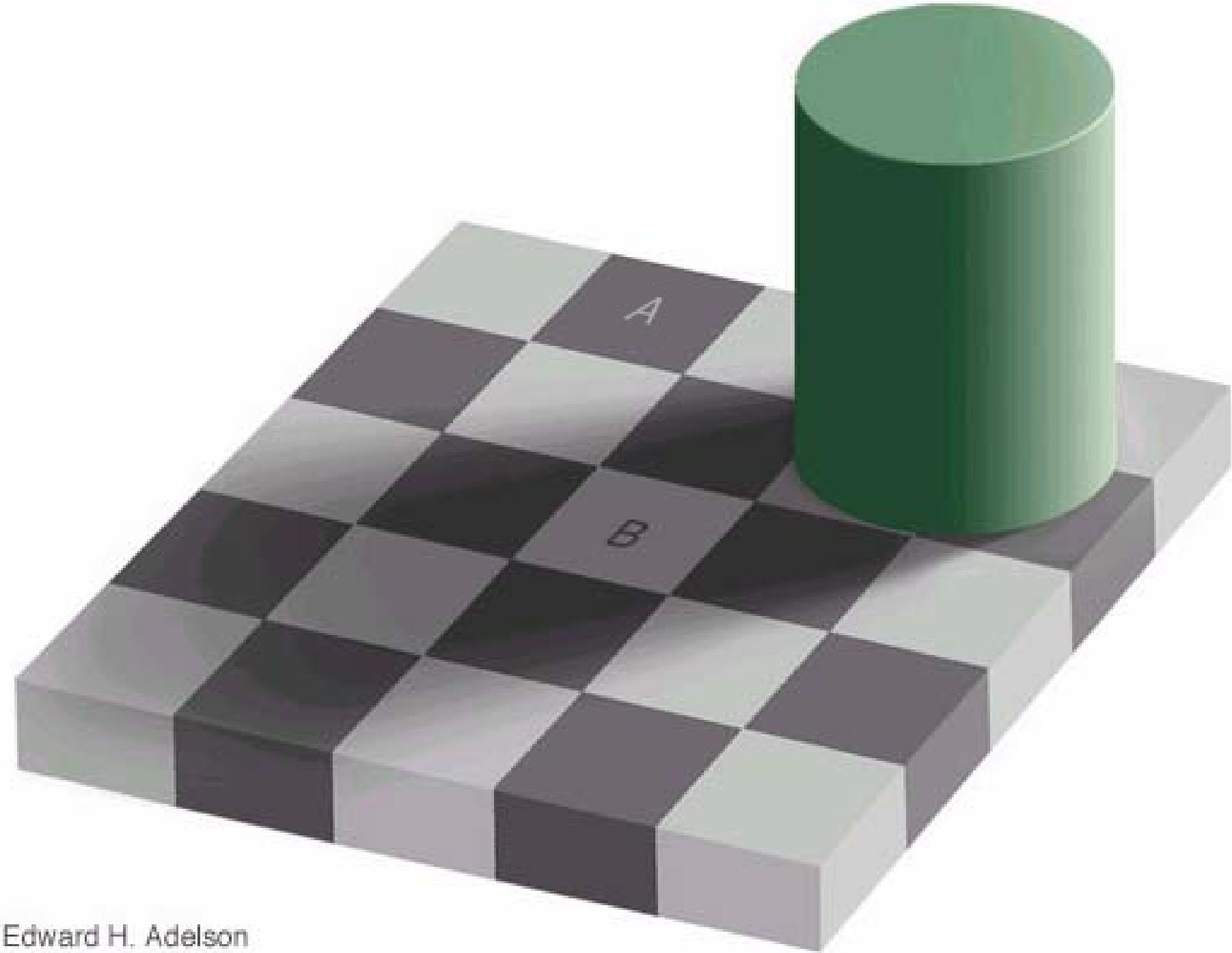


Edward H. Adelson



Edward H. Adelson

Creativity and Innovation

The ability to look at the same thing, and to see something completely differently

A mystery…

Dr.Haledjian was in Inspector Winters' office waiting for the next case to solve when Inspector Winters came in with Jacques Strap. "He's charged with murdering Frank Buzz," snapped the Inspector.

"It's a mistake," cried Jacques.

"So then what were you doing in an alley with a gun and a dead man?" asked the Inspector.

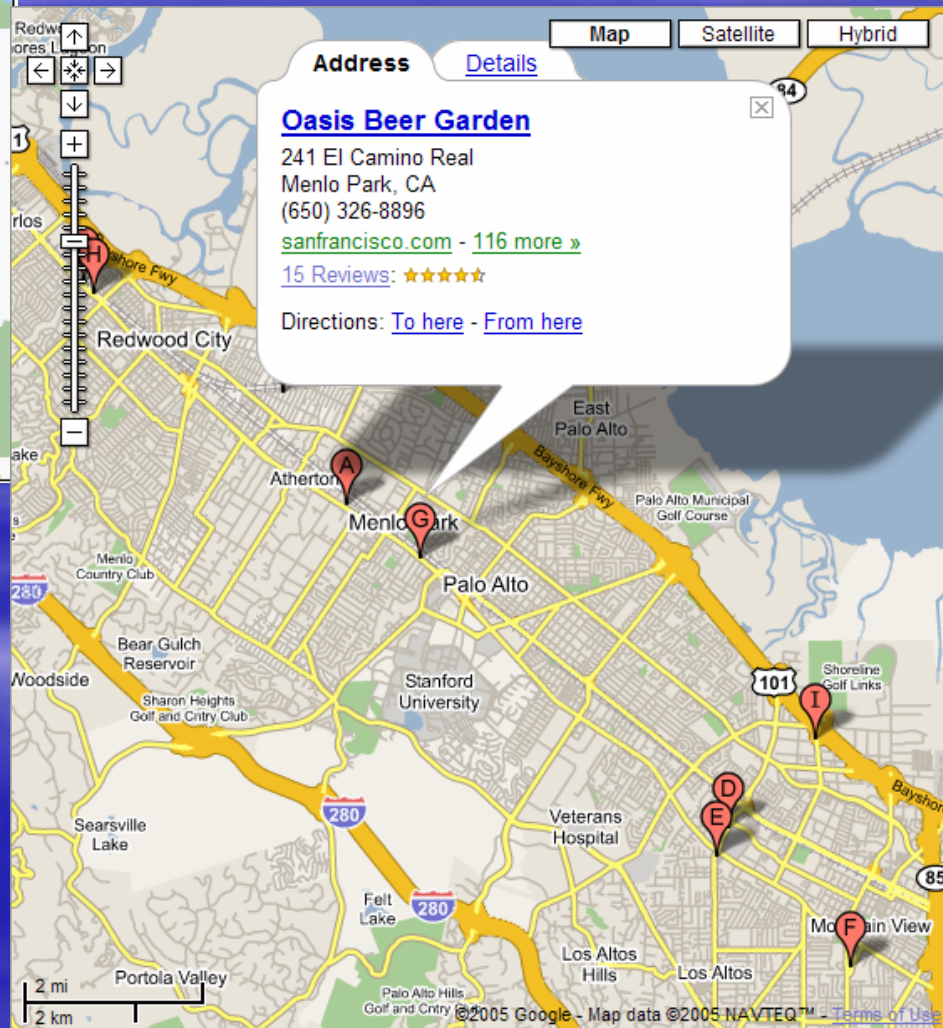
"It wasn't my gun , and I'll tell you the truth. I was walking past the theater when I saw two men run past me. The second man was carrying a gun. So I followed them. They turned into an alley and the second man fired six shots at the other. The first man dropped dead to the ground. The murderer was about to walk away when he caught a glimpse of me. Knowing there was no escape, he threw his Colt .45 at me and ran to the fire exit door of the theater. There he pushed open the door and went inside. I was still holding the gun when a cop came running up the alley," finished Jacques.

"I tell you I'm innocent."

"Give me a break", said Dr.Haledjian. "This story is impossible."

Example: Apple Visual Design

Example: Google Maps



Example: JSF

Example: Chrysler PT Cruiser

Retro: Patterns Learned

- 1939 Ford Coupe
- 2001 Chrysler PT Cruiser

Lawnmower Purchase

- You are asked
  - 18” deck or 22” deck?
  - Mulching blade required?
  - Do you want variable rate populsion?
  - Side or rear exhaust?
  - Electric or gas?
  - 2 or 4 cycle?

Lawnmower purchase

- You should ask
  - Why do you want a lawnmower?
  - What is your yard like? Lots of trees? Hills?
  - Do you like to mow, or is it a chore?
  - How long do you need to own a mower?
  - Who will do the mowing of your lawn?
  - Where is the nearest power outlet?

This is Systems Engineering

- The perception of interfaces
- The perception of context
- The perception of relationships
- The perception of light and dark, requirements, verification, validation
- The perception of the whole, or gestalt

Systems Engineering

- Has an existing methodology
- But requires us to see things differently
- And requires us to combine elements and perceive the system in ways not normally familiar to us
- We can borrow from the artistic world to better understand Systems from a whole-brain perspective

Summary

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In Closing

He who works with his hands is a laborer

He who works with his hands and head is a craftsman

He who works with his hands, head and heart is an artist.

- St. Francis of Assisi

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