

Hyper-Innovation through Simulation

CHARLES HARRELL



Outline

- ▶ Introduction
- ▶ Traditional Use of Simulation
- ▶ Introduction to Hyper Innovation
- ▶ Hyper Innovation Through Simulation

Introduction

Charles Harrell



- ▶ Founder ProModel Corporation
- ▶ Associate Professor of Engineering and Technology, BYU
- ▶ Education
 - BS Manufacturing Engineering
 - MS Industrial Engineering
 - PhD Manufacturing Engineering
- ▶ Experience
 - Mfg Engineer, Ford Motor Co.
 - Project Manager, Eaton-Kenway
 - CTO-President-Director, ProModel Corporation

ProModel Overview



- ▶ Founded in 1988
- ▶ A leading provider of simulation solution and services
- ▶ Over 150 Direct & Indirect employees
 - 110+ Direct employees in North America
 - Over 24 International Distributors
- ▶ Over 6000 users of our solutions world wide
- ▶ Microsoft Gold Certified Partner



ProModel's Predictive Modeling Tools

Strategic Planning

Phase 1

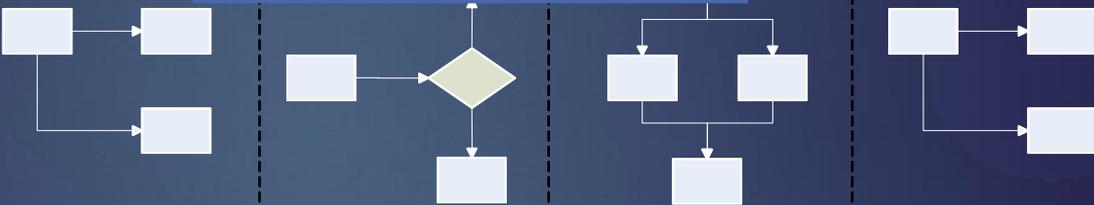
Phase 2

Phase 3

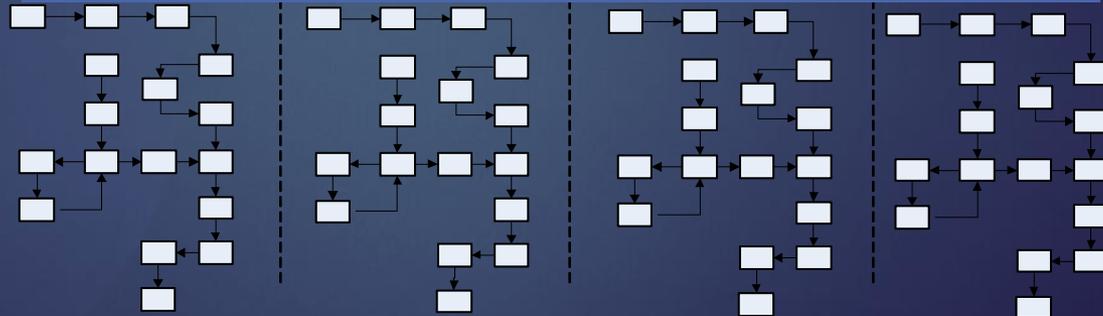
Phase 4

PORTFOLIO of Business Initiatives

Tactical Planning



Detailed Process Analysis/Improvement



E
N
T
E
R
P
R
I
S
E

Adapted Tools: Excel
or VBA based apps

Custom Tools: AST,
DST, NST

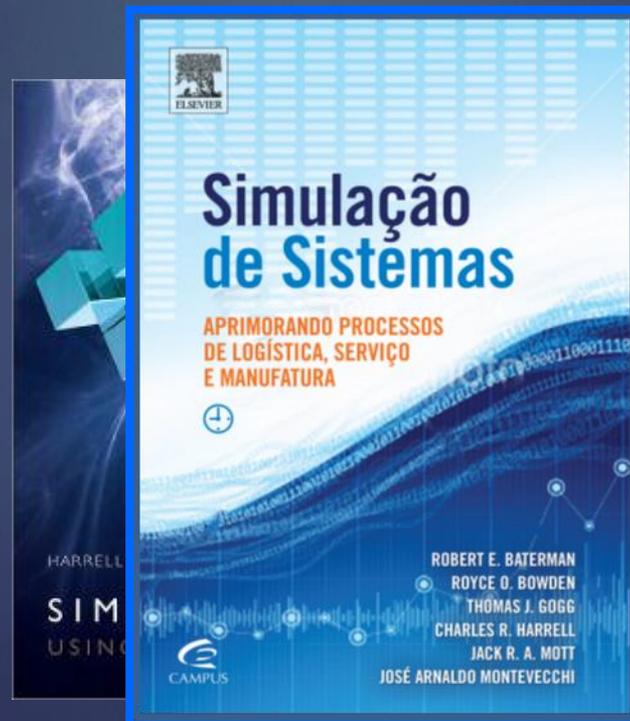
**Application Specific
Tools:** Enterprise Portfolio
Simulator, Patient Flow
Simulator, Clinical Trials
Simulator

**General Purpose
Tools:** ProModel,
MedModel, Service
Model, ProModel
Enterprise, Process
Simulator

**ProModel
Simulation
Platform**

Simulation Textbook

- ▶ Principal Author, Simulation Using ProModel (3rd ed.)
- ▶ Co-author, Simulação de Sistemas

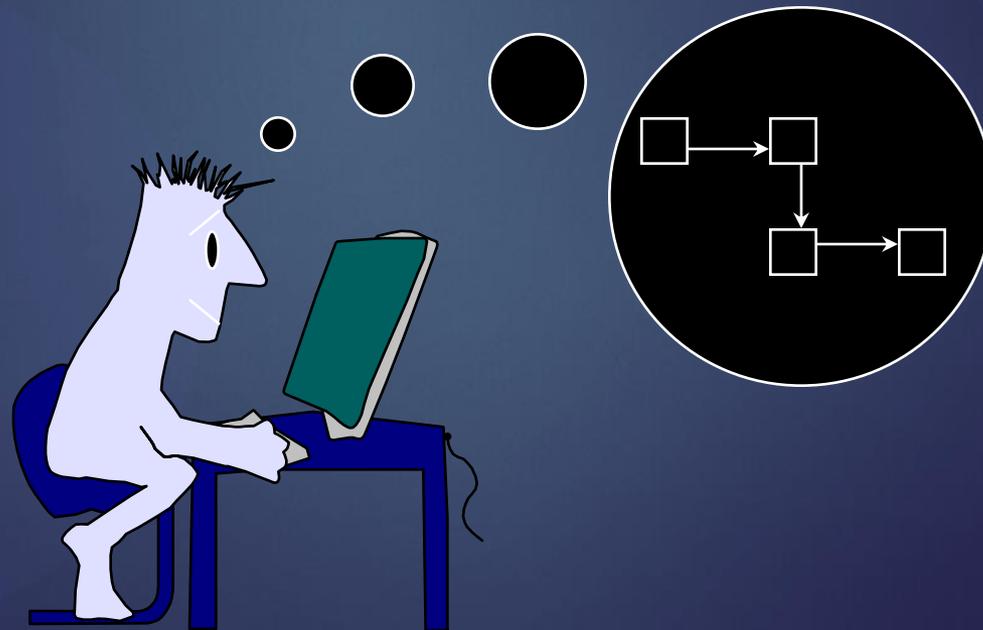


What is Simulation?

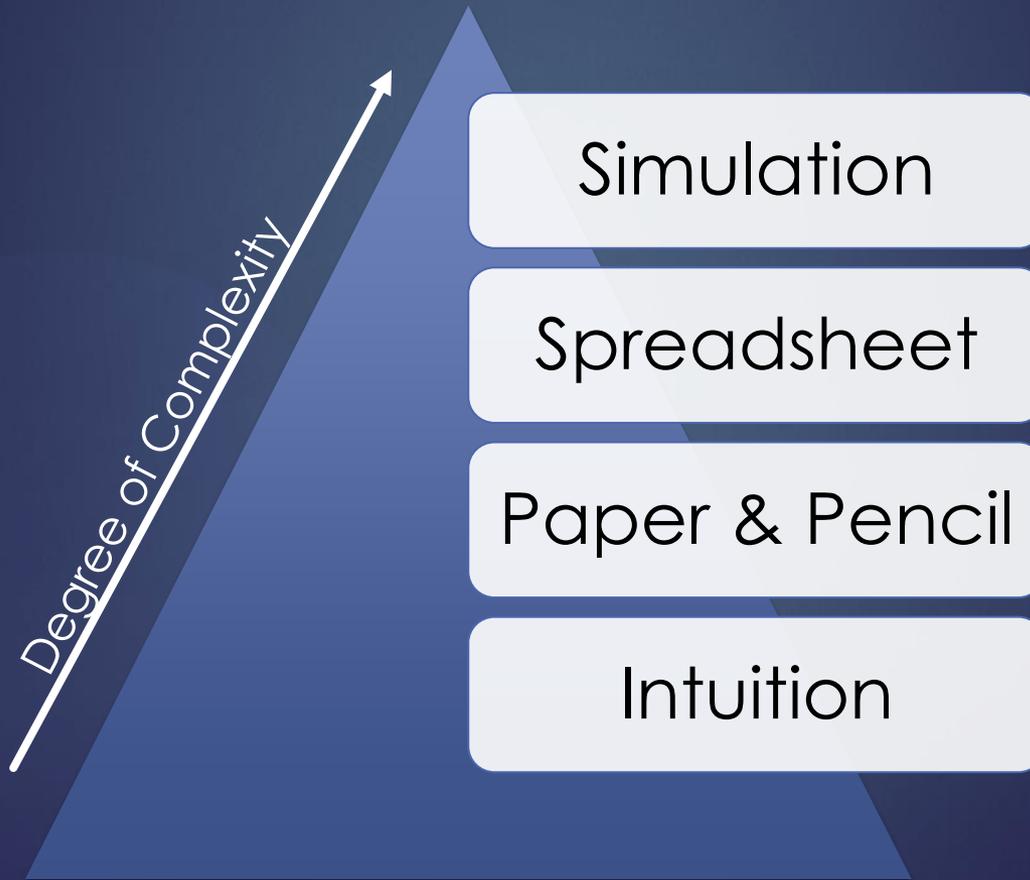
“The action or practice of simulating, with intent to deceive; false pretense, deceitful profession.” – Oxford English Dictionary

A More OR Appropriate Definition

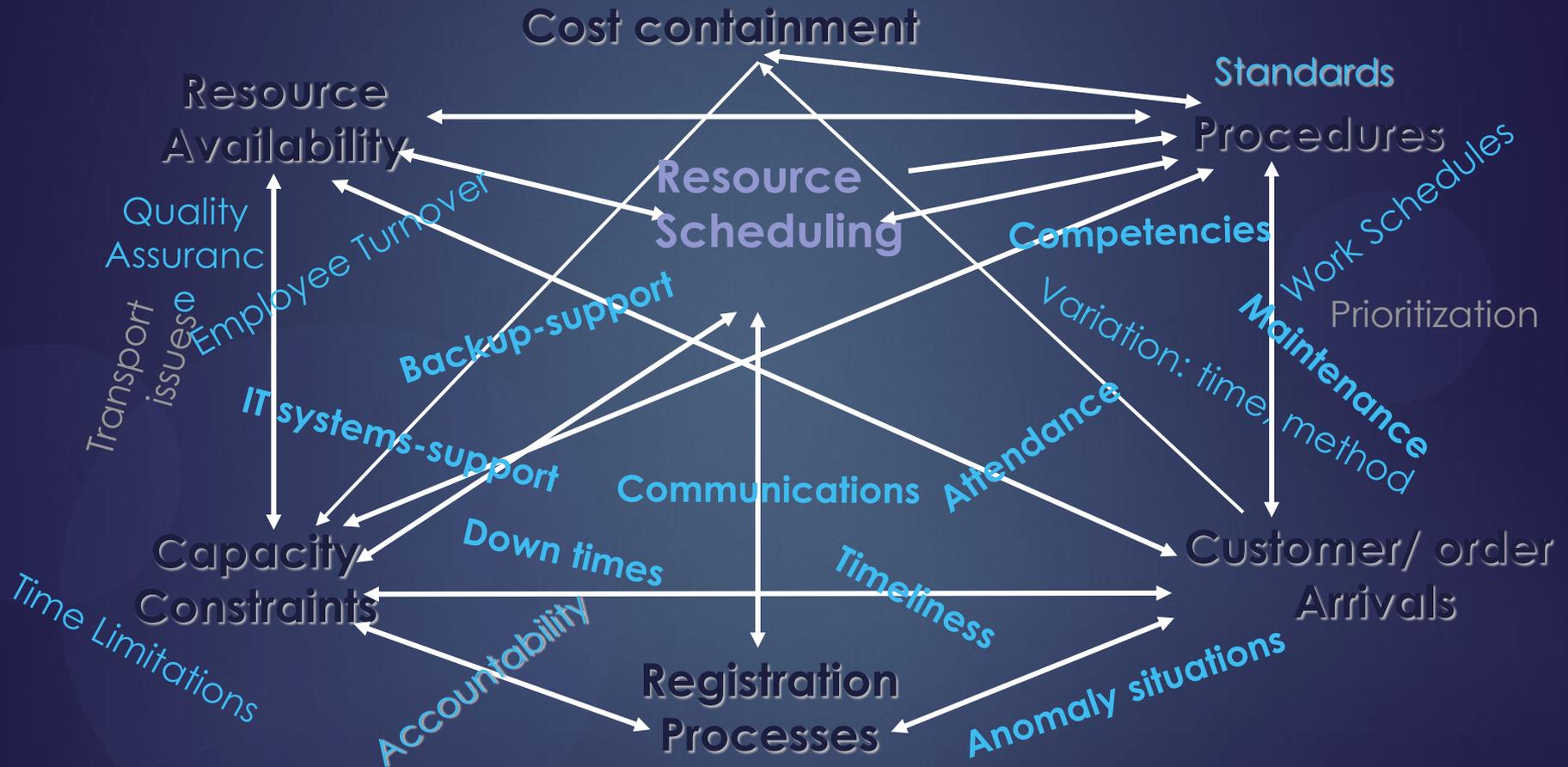
Simulation is the imitation of a dynamic system using a computer model in order to evaluate and improve system performance.



Complex Systems



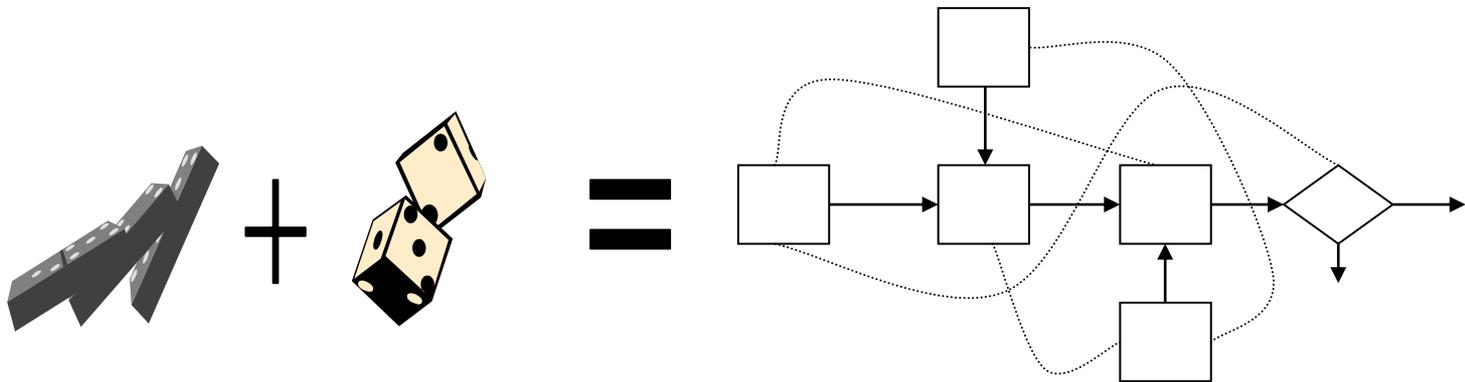
Challenge of Complex Systems



Hyper Complexity

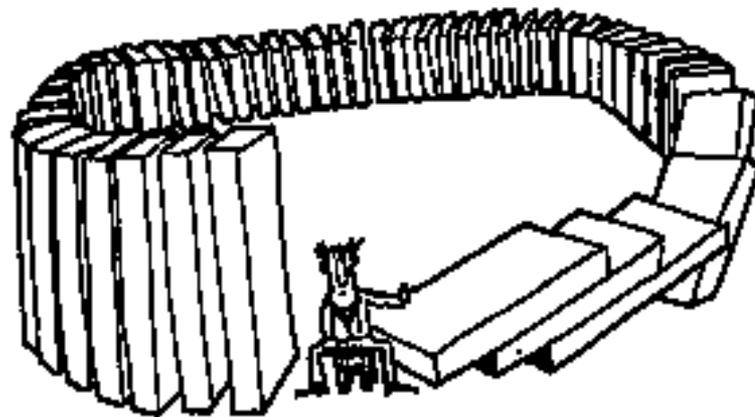
Sources of System Complexity

- ▶ **Interdependencies** (elements in the system are dependent on each other)
- ▶ **Variability** (element properties and behavior are variable)



Interdependency

A Non-systems Thinker
Creates More Space for Himself



Variability

How random is this?



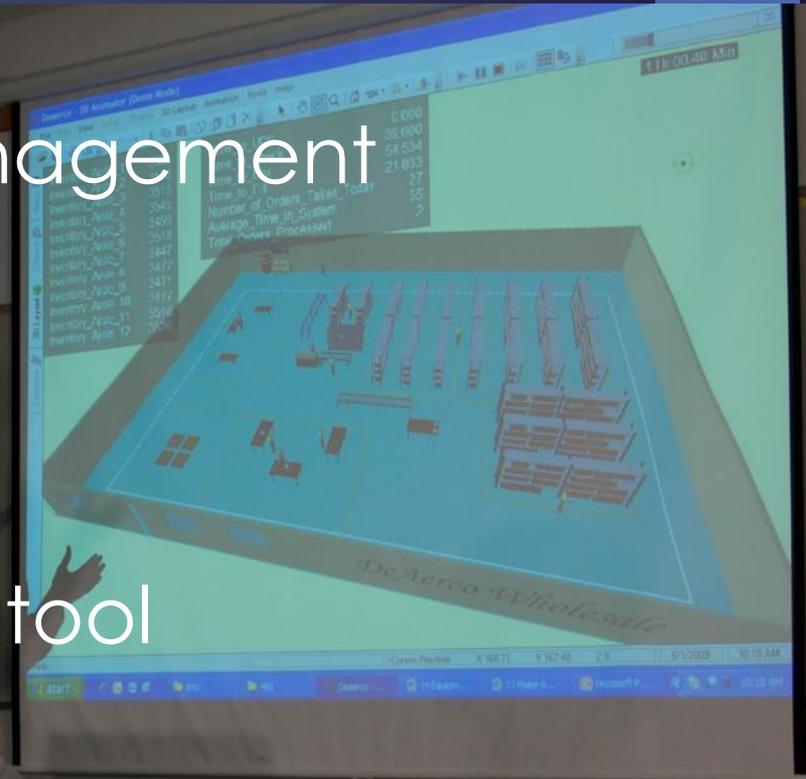
Benefits of Simulation

- ▶ Quick and easy to use.
- ▶ Versatile enough to model any system.
- ▶ Accounts for interdependencies and variability.
- ▶ Shows system behavior over time.
- ▶ Animation provides effective communication.
- ▶ Forces one to think through the operational details of a system.

Traditional Use of Simulation

Often defined in Management Science Terms

- Analysis tool
- Evaluation tool
- Decision-support tool
- Optimization tool



Role of Innovation in Modeling and Simulation



Symposium Theme

“Operational Research in the quest for efficiency in the public and private sectors”

Efficiency vs. Innovation

| | Efficiency | Innovation |
|-------------------------|---------------------------------|--------------------------|
| Goal | Eliminating waste in the system | Creating a better system |
| Approach | Analysis | Imagination |
| Type of Thinking | Linear (in-box) | Lateral (out-of-box) |



“Imagination is more important
than knowledge.”

- Albert Einstein , On Science

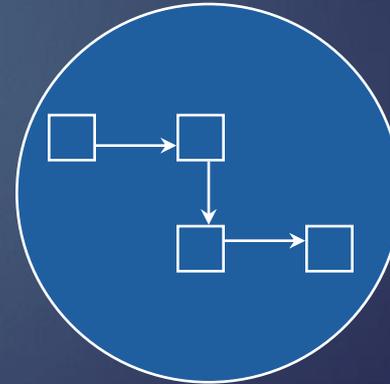


Simulation vs. Traditional OR Techniques

Simulation promotes a **qualitative approach** to problem solving, yet still with a **quantitative assessment**.

Answers or Insights?

- ▶ Simulation is a **thinking** tool, not just an analytical tool.
- ▶ A primary purpose of modeling and simulation is to help us **think**, not just analyze.
- ▶ Simulation is more like a **crystal ball** showing possibilities than a calculator crunching numbers.



Insight

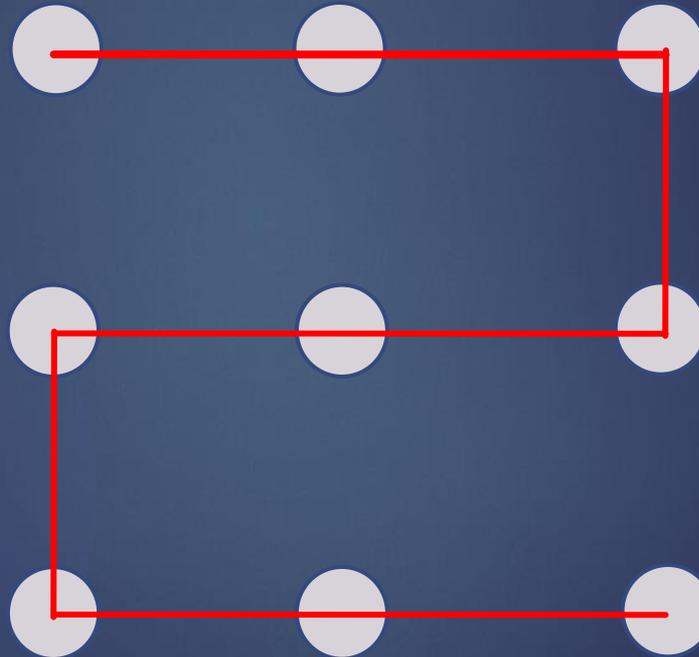


Hyper-Innovation?

- ▶ Extreme Innovation
- ▶ Super Innovation
- ▶ Outrageous Innovation

Creativity Challenge...

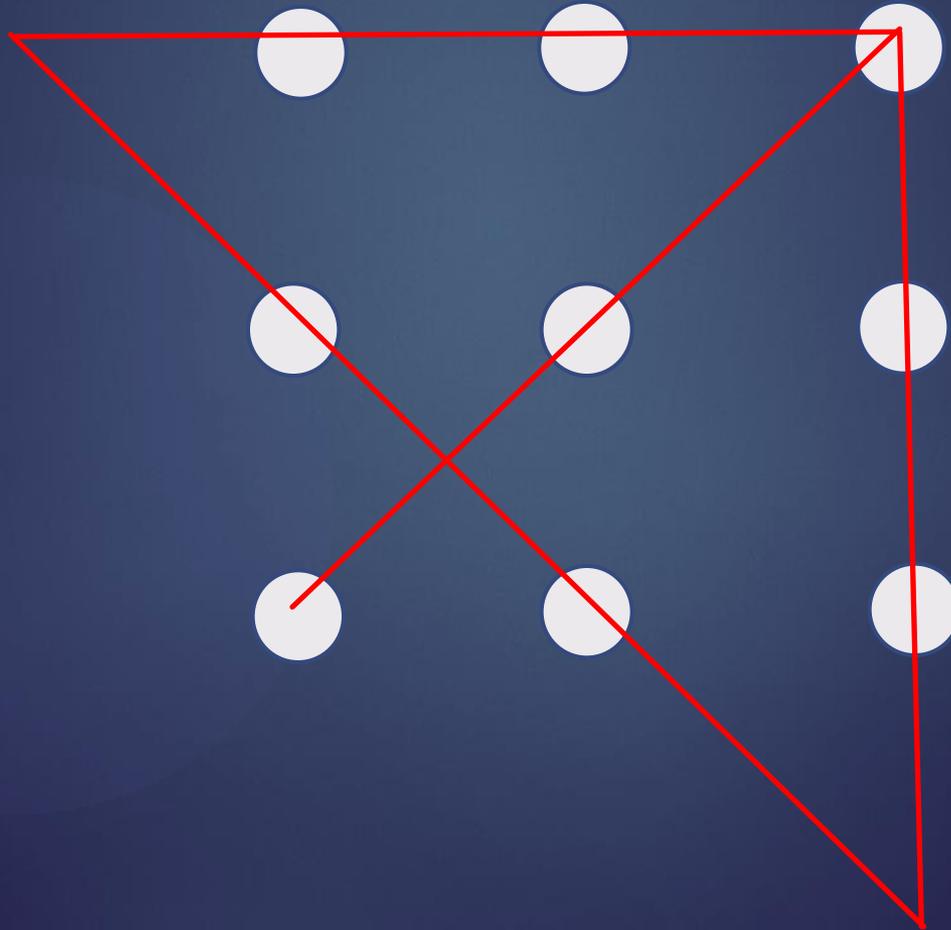
Connect the nine points below with as few straight lines as possible **without lifting** your pen or pencil from the paper.



5 lines

Creativity Challenge...

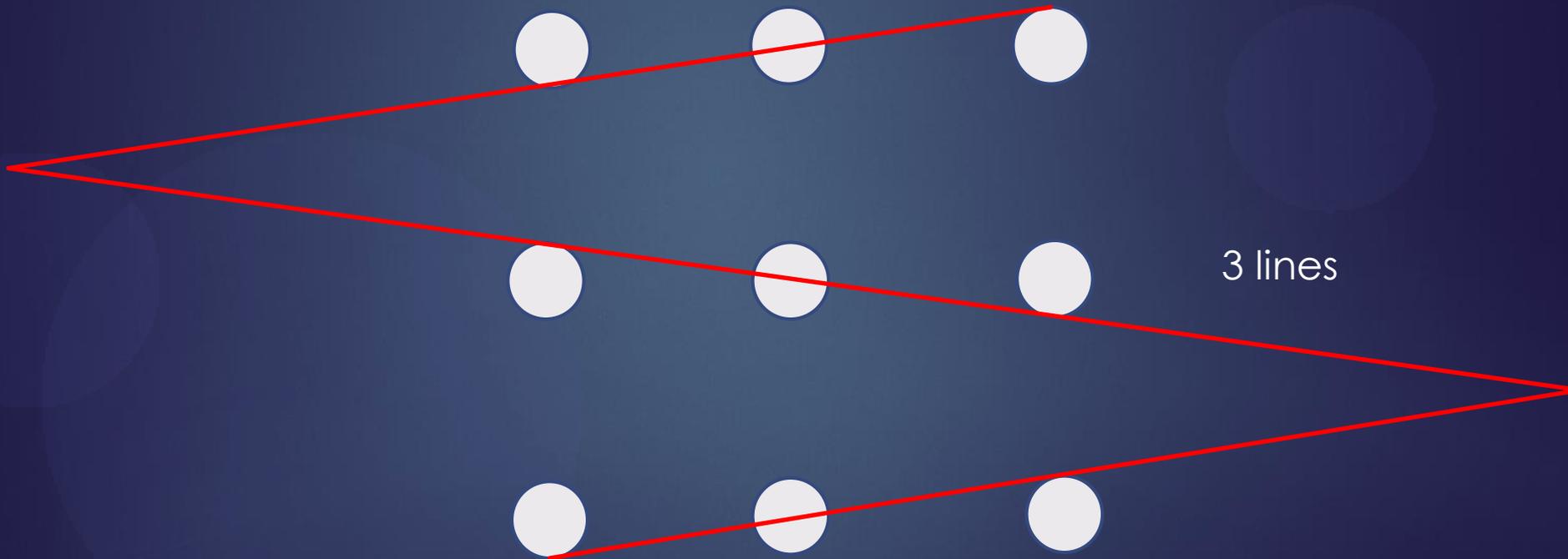
Connect the nine points below with as few straight lines as possible **without lifting** your pen or pencil from the paper.



4 lines

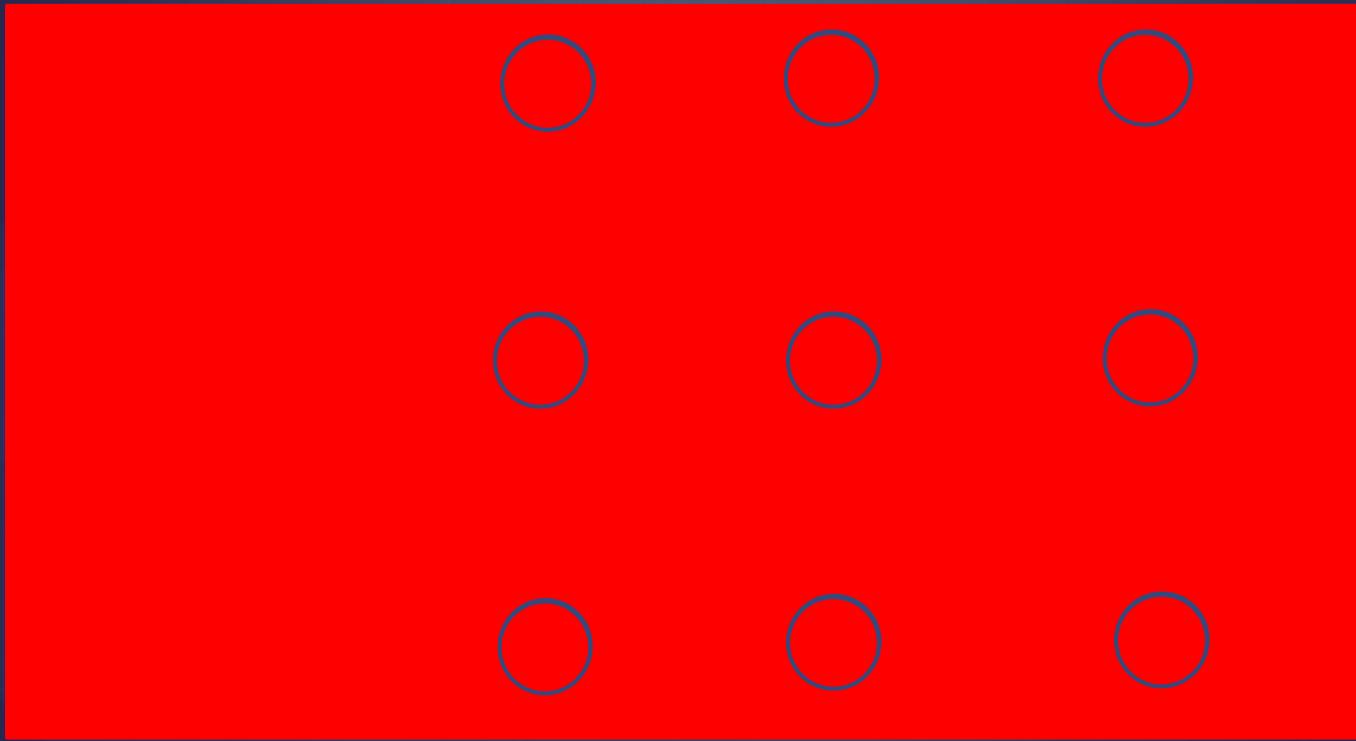
Creativity Challenge...

Connect the nine points below with as few straight lines as possible **without lifting** your pen or pencil from the paper.



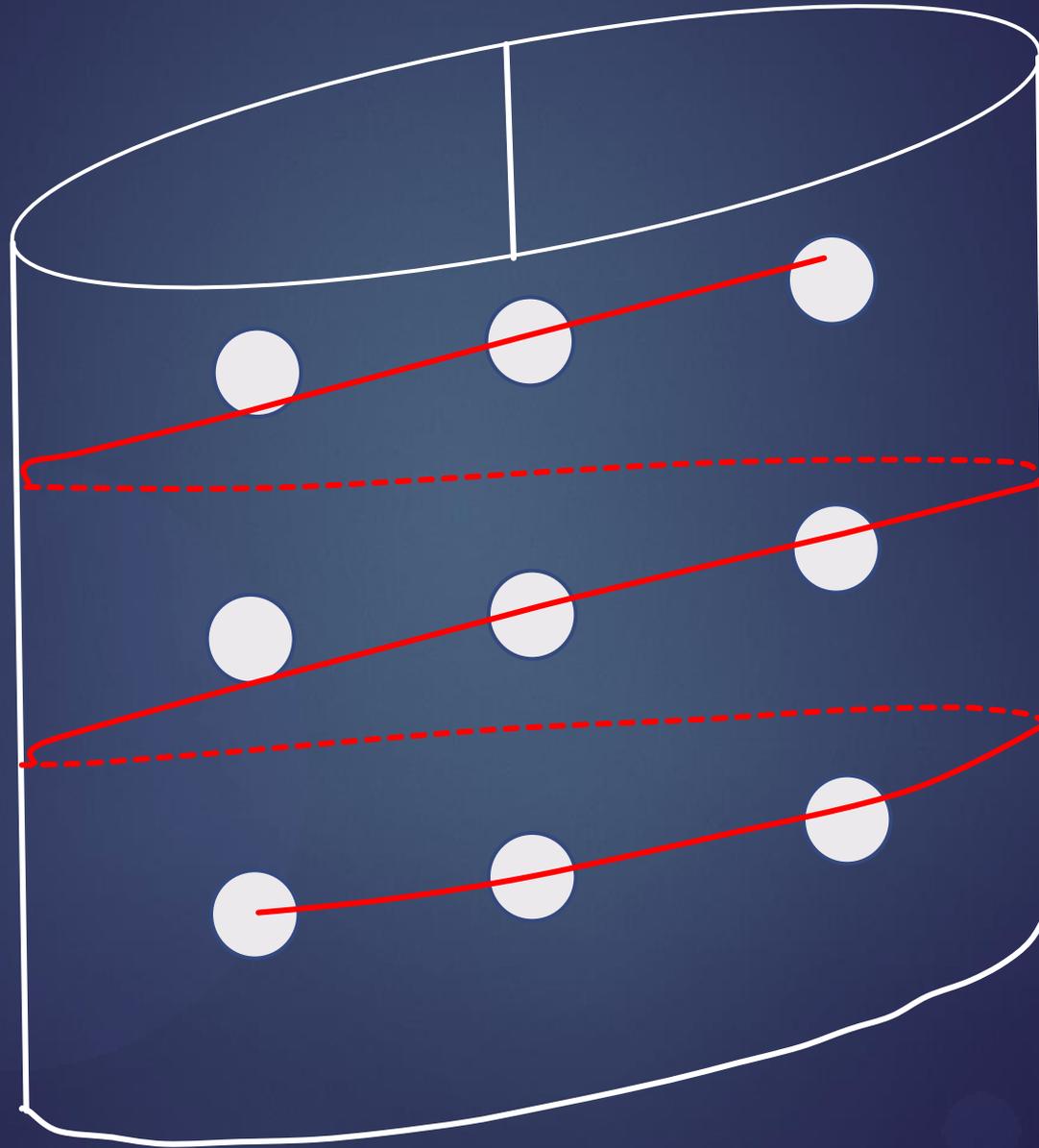
Creativity Challenge...

Connect the nine points below with as few straight lines as possible **without lifting** your pen or pencil from the paper.



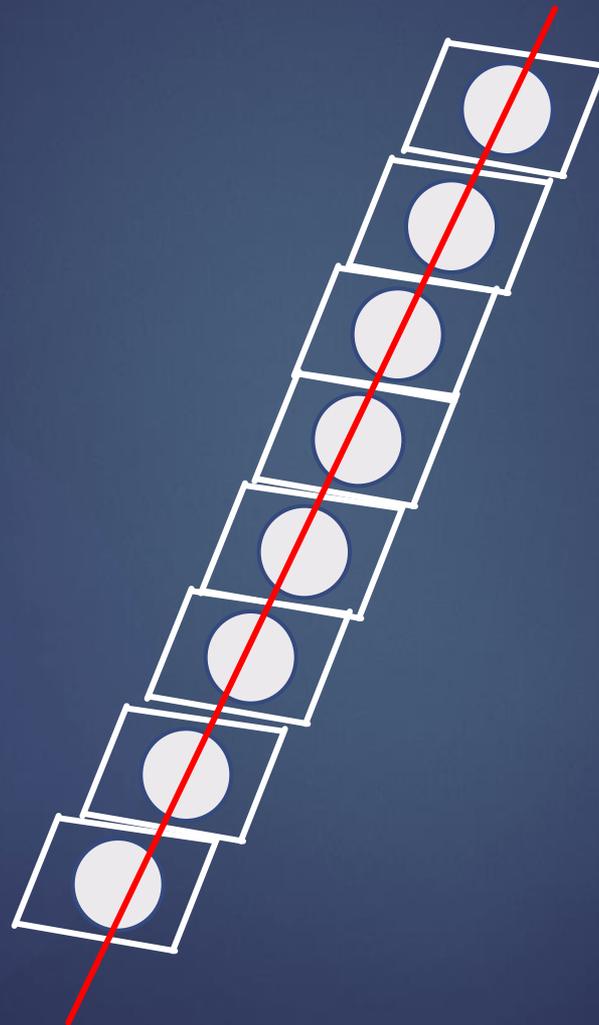
1 (thick) line

Creativity Challenge...



1 (spiral) line

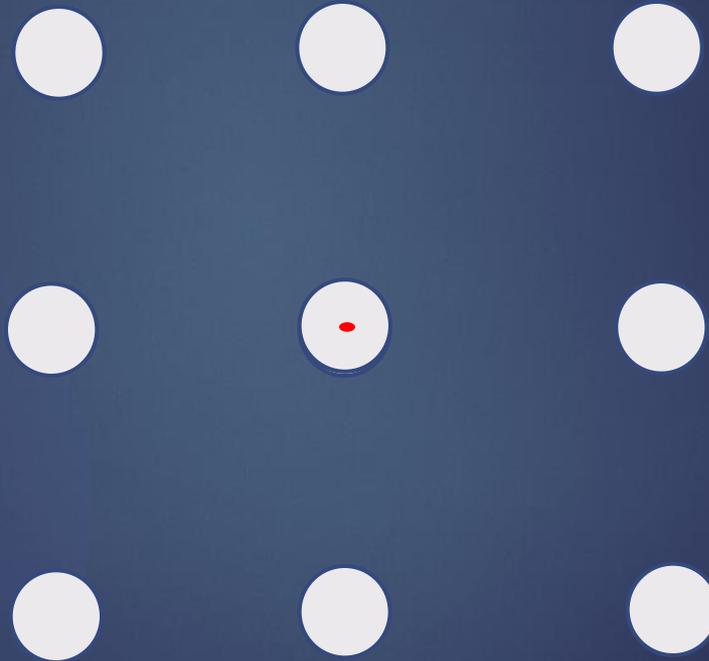
Creativity Challenge...



1 line through
rearranged dots

Upping the Challenge...

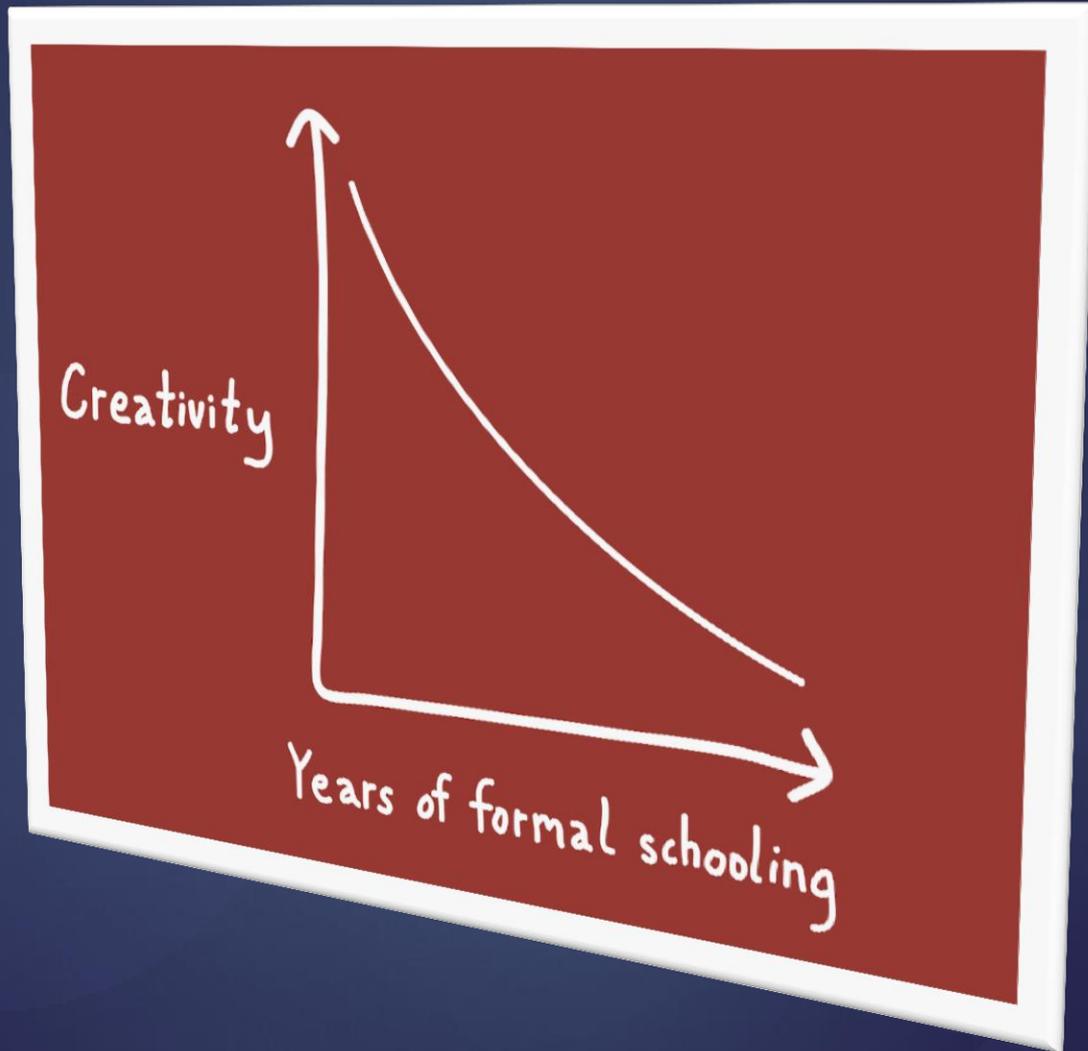
Now, can you think of a way to connect the nine dots with a single POINT?



Don't get boxed in!

It's human nature to get stuck in traditional paradigms and same ways of viewing things.





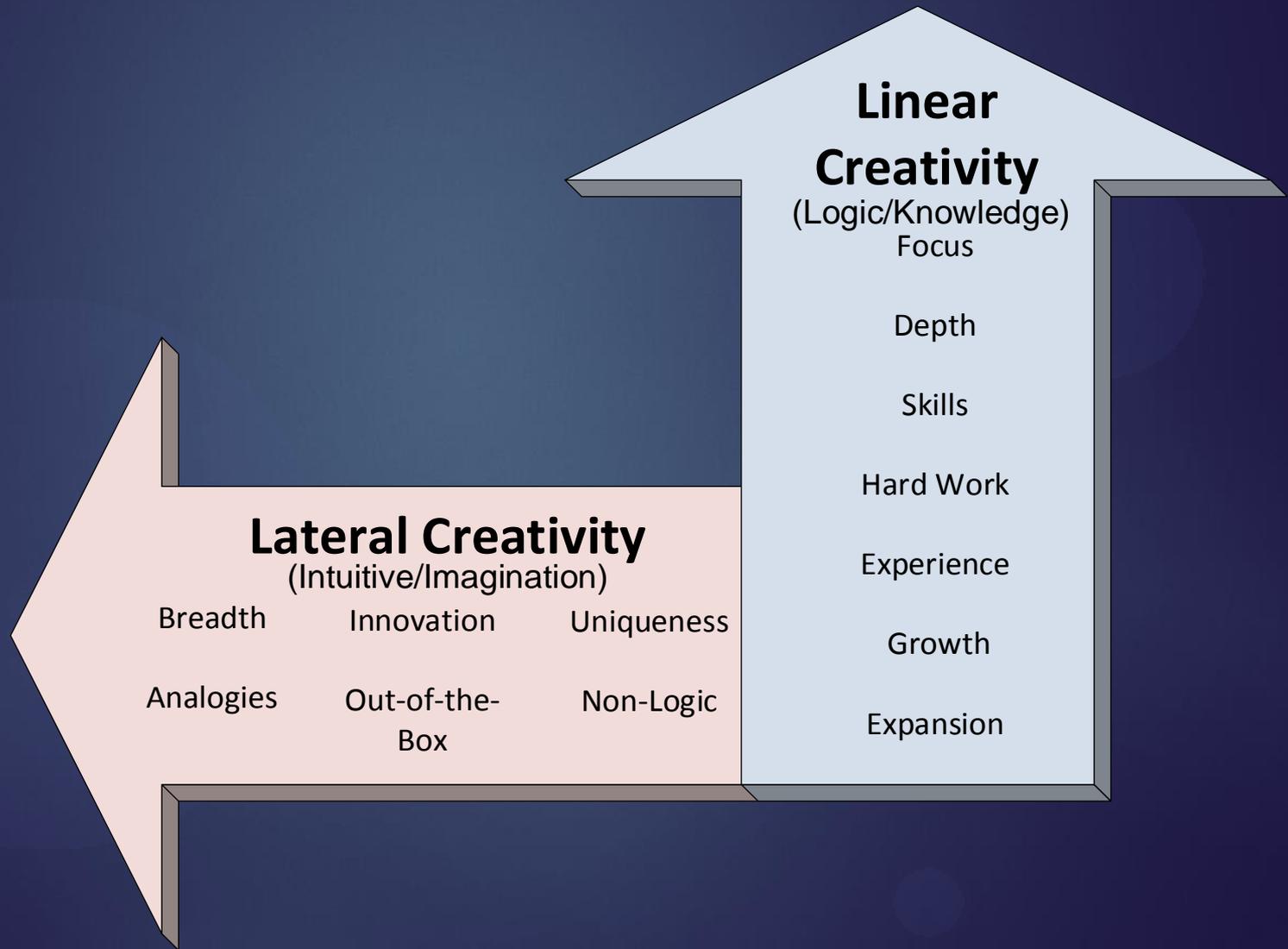
Left-brain, Right-brain...is a Myth!



Neuroscientists at the University of Utah did extensive brain scans of >1,000 participants doing creative and non-creative activities.

All participants used their **entire brain equally** in both quantitative and qualitative thinking.

Linear vs. Lateral Thinking



Linear vs. Lateral Thinking

- ▶ Linear thinking categorizes information and draws appropriate information when needed.
- ▶ Lateral thinking makes connections between seemingly unrelated pieces of information.



Creativity is Mostly Lateral Thinking

"Creativity doesn't create something out of nothing but, rather, recombines ideas that already separately exist."

-- Arthur Koestler

Creative Associativity

...the blending of different (sometimes even opposing) ideas that result in highly innovative solutions.

Examples of Creative Associativity

- ▶ Wine press + coin punch = Printing press (Gutenberg)
- ▶ Auction + web = ebay (Pierre Omidyar)
- ▶ Rubber + waffle iron = Sole for Nike shoe (Bill Bowerman)
- ▶ Tablet PC + cell phone = iPhone (Steve Jobs)

Enhancing Associative Creativity

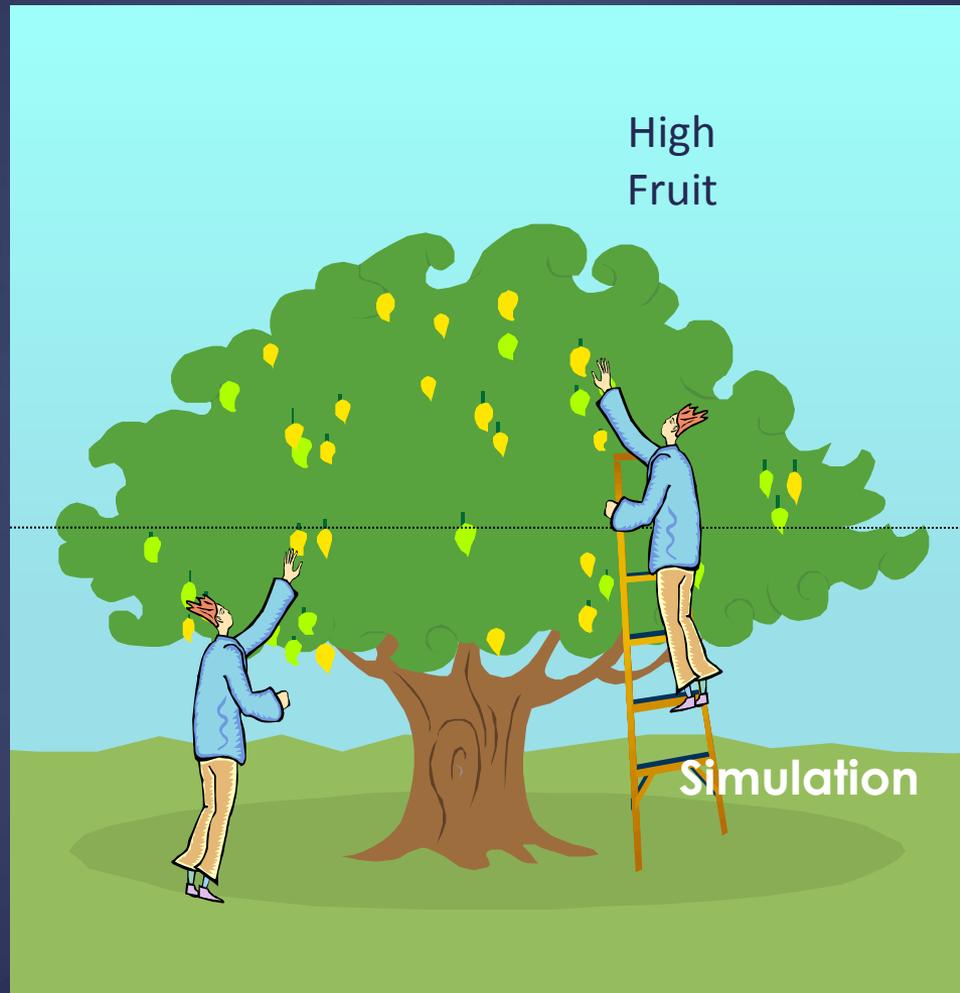
- ▶ Learn about and **appreciate** other processes, industries, cultures, etc.
- ▶ Try doing routine things differently
- ▶ Practice thinking the unthinkable
- ▶ Collaborate as much as possible

“Share a starting idea or piece of creative work with the crowd and let the crowd edit, change, or rank it to create the final version.”

- Roy Price, Director, Amazon Studios



Simulation gets at the high-hanging fruit



Fruits of Simulation

- ▶ A lot of high hanging fruit goes unnoticed. Simulation exposes it and helps harvest it.
- ▶ Simulation enables experimentation over a broader range of possible solutions. Assumptions are challenged innovative solutions are explored.
- ▶ Cultural and managerial aspects are as important as the solutions. Dynamic models get everyone involved in the process and serve as a benchmark or touchstone for agreed process change.

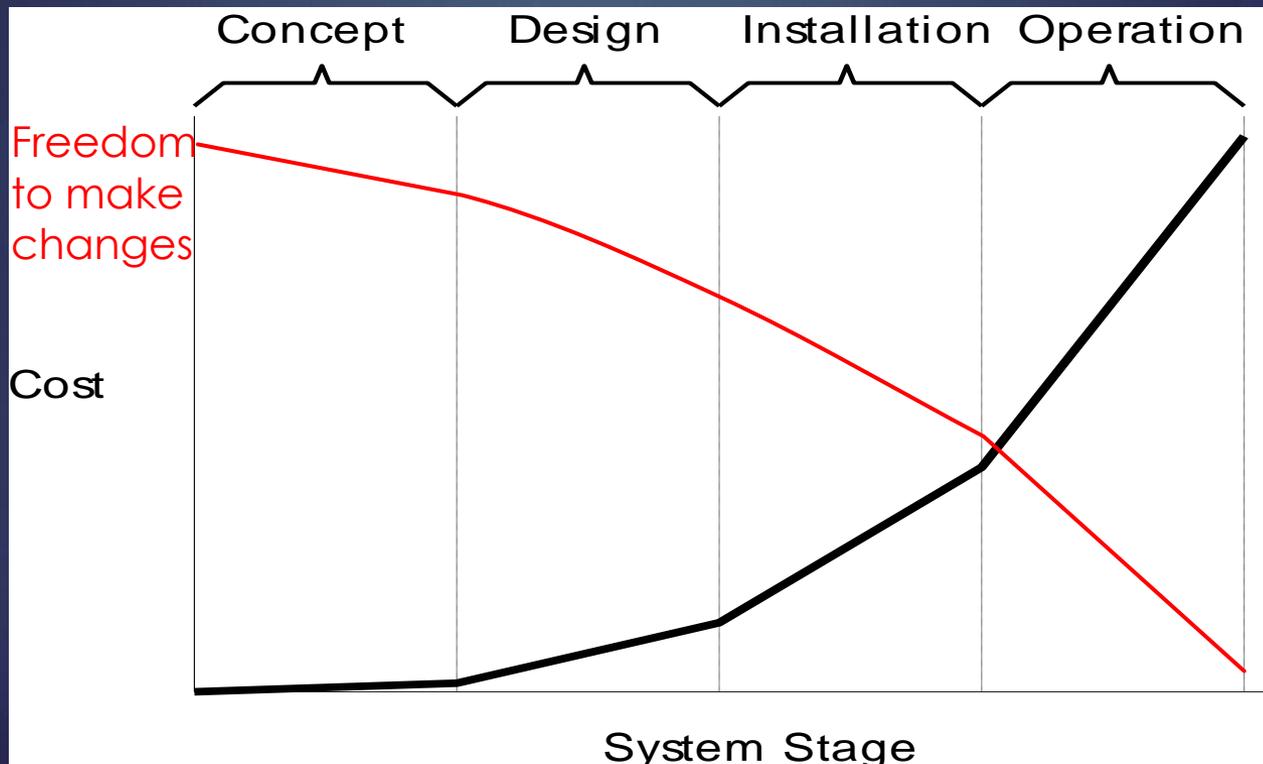
Simulation Animation

- Visually shows how an idea works
- Stimulates interest
- Sparks creative thinking



Rule of Tens

The cost to correct mistakes increases by a factor of ten for each stage it goes uncorrected.





“We are more ready to try the untried when what we do is inconsequential. Hence the fact that many inventions had their birth as toys.”

- Eric Hoffer

Simulation Inspires Creativity

Simulation promotes a try-it-and-see attitude.



“To have a great idea, have a lot of them.”
- Thomas Edison

“The way to get good ideas is to get lots
of ideas and throw the bad ones away.”
- Linus Pauling



Make Connections

After thinking of as many ideas as you can, think about possible connections and combinations of these ideas.



“Nothing is more dangerous than an idea when it is the only one you have.”

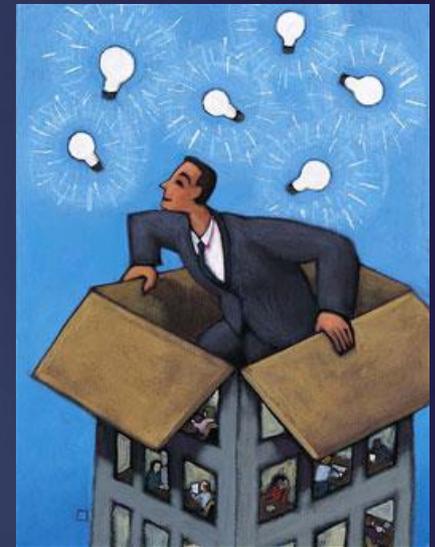
- Emile Charter



Examples

Virtual Kaizen

A recent simulation project involved modeling an existing batch process and a future-state Lean flow line (see model). For a small company using traditional batch manufacturing, a flow line was complete “out-of-the-box” thinking.



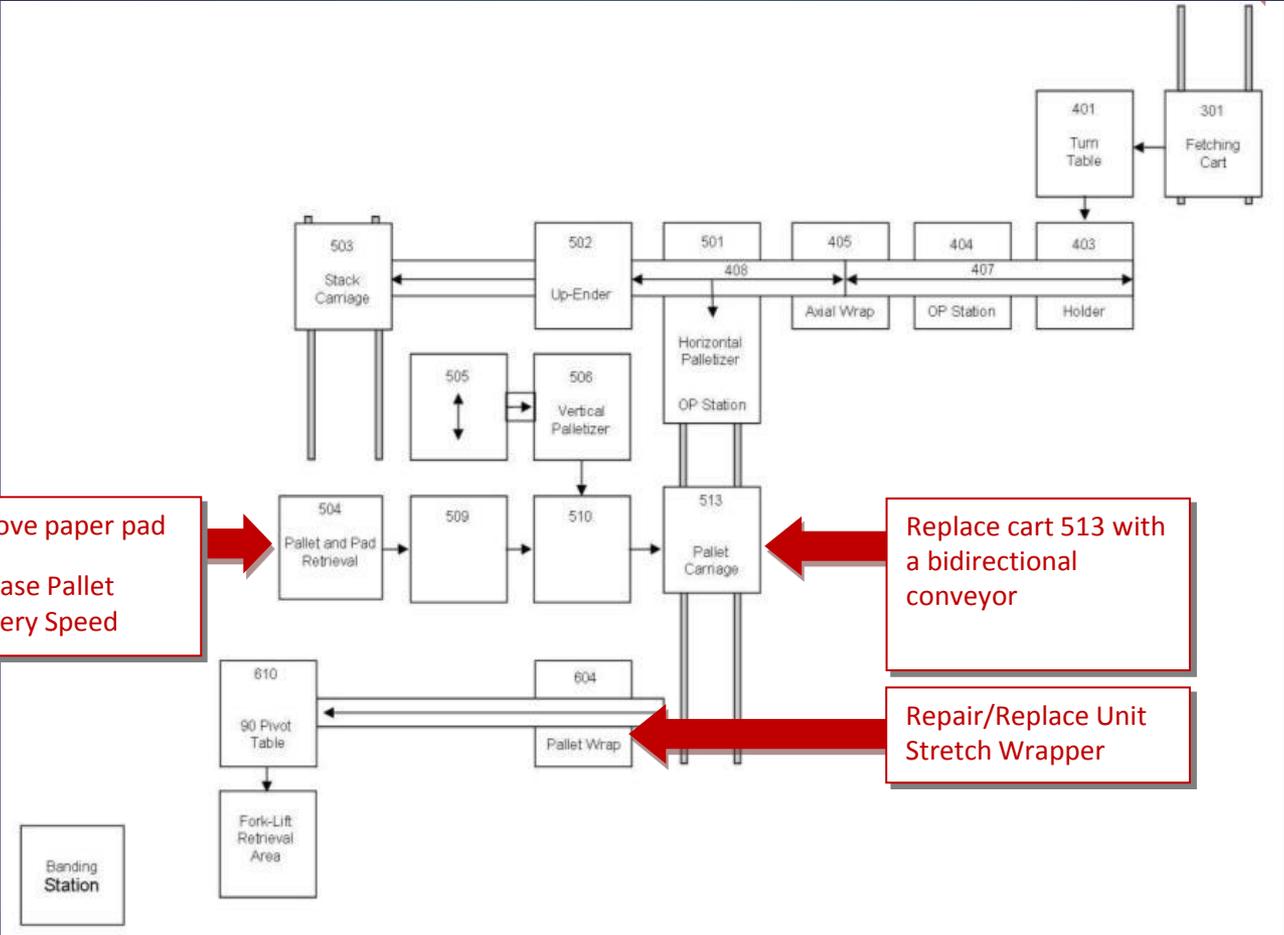
Pesmel System Challenge

54

- ▶ System was under capacity by **20%**.
- ▶ Different ideas about what would increase throughput capacity.
- ▶ Simulation showed that by changing from a cart to conveyor and changing scheduling, throughput increases by **31%**.
- ▶ Proposed system would result in **\$3M** savings the first year.

Brainstormed Ideas

Change Scheduling Strategy



Remove paper pad
Increase Pallet Delivery Speed

Replace cart 513 with a bidirectional conveyor

Repair/Replace Unit Stretch Wrapper

Banding Station

Don't Become a Slave to Common Sense!

- ▶ *Problem*: How to handle increased throughput in an automated guided vehicle system (AGVS).
- ▶ *Obvious Solution*: Add more vehicles.
- ▶ *Simulation Analysis*: More vehicles actually reduced throughput because of congestion.
- ▶ *Final Solution*: Re-layout guide path with no additional AGVs.

Improvise Don't Modernize

- ▶ GE Nuclear Energy increased output 80% and reduced cycle time 50%.
- ▶ A large manufacturing company with stamping plants improved machine utilization by as much as 37 to 60%.
- ▶ A diagnostic radiology department faced with increasing demand avoided a major expansion by revamping procedures.



"A fool with a tool is still a fool"

- Unknown

Six creativity killers

1. There is only one right answer
2. Always follow the rules
3. Don't rock the boat
4. Don't make a mistake
5. Be entirely practical
6. Focus only on your specialization

Barrier to Innovation: *Mistakes are bad*

- ▶ Columbus thought he was finding a shorter route to India but ended up discovering the Americas.
- ▶ “I haven't failed, I've found ten *thousand ways that don't work.*”

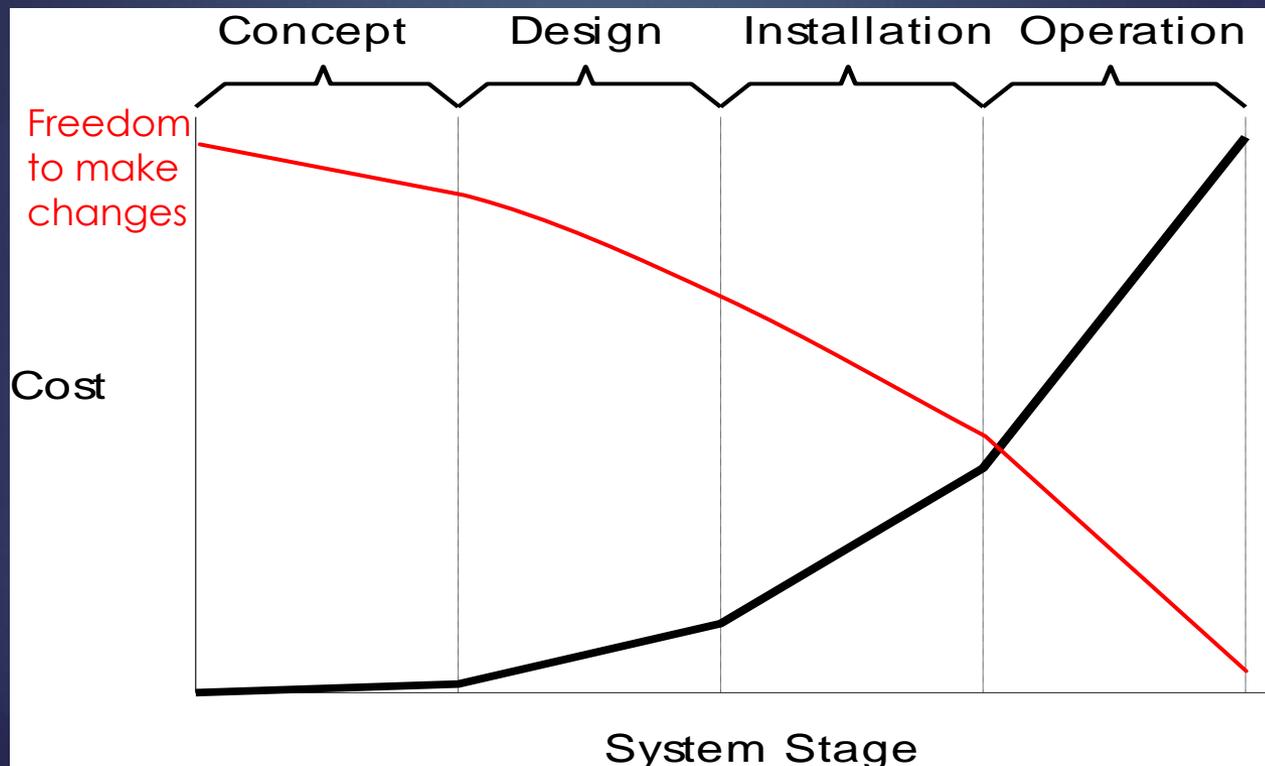
-- Thomas Edison

“Fail early, fail often”

- Mantra of IDEO Corporation

Fail early and often

Simulation affords ample opportunity to **fail early and often**...all risk free.



Sustaining Innovation

“After civilizations have reached a peak of vitality, they tend to lose their cultural steam and decline. An essential element in this cultural breakdown is a loss of flexibility...Whereas growing civilizations display endless variety and versatility, those in the process of disintegration show uniformity and lack of inventiveness.”

- *The Turning Point*, Fritjof Capra

It's harder to sustain creativity than to achieve an initial creative breakthrough.



Creating a Culture of Innovation

- ▶ Challenge Everyone, Everyday on Everything
- ▶ Establish a Process that Involves Everyone
- ▶ Allow Time for Experimentation
- ▶ Require Multiple Possible Solutions
- ▶ Require Feedback to be Obtained

Concluding Thought

"A fool with a tool is still a fool"

- Unknown

*"An innovator using simulation
can be **HYP**ER innovative"*

- C. Harrell



Obrigado