

Synergetics and Model Thinking

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On-line version of this presentation:

<http://www.CJFearnley.com/Asheville.Synergetics.Model.Thinking.pdf>

What is Synergetics?

Synergetics is the system of comprehensive thinking which R. Buckminster Fuller introduced, primarily, in his two volume magnum opus, **Synergetics: Explorations in the Geometry of Thinking**, 1975, 1979.

“Synergetics, in the broadest terms, is the study of spatial complexity, and as such is an inherently comprehensive discipline. ... Experience with synergetics encourages a new way of approaching and solving problems. Its emphasis on visual and spatial phenomena combined with Fuller’s wholistic approach fosters the kind of lateral thinking which so often leads to creative breakthroughs.”

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- Joe Clinton (2007) defines it as a kind of **synergism** with elements of self-similarity (fractal) and self-organizational behavior.

SynergeticsCollab video: Synergetics 101:

<http://www.youtube.com/watch?v=y-mpwMPeCm8>

- It is one comprehensive thinker's vision for a discipline of "synergy"; a vision for a system of thinking about the "behavior of whole systems unpredicted by the behavior of their parts taken separately."

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Resources

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- Both volumes of *Synergetics: Explorations in the Geometry of Thinking* are on-line at

<http://www.rwgrayprojects.com/synergetics/synergetics.html>

- Amy Edmondson's book *A Fuller Explanation: The Synergetic Geometry of R. Buckminster Fuller*

<http://bfi.easystorecreator.com/items/books/a-fuller-explanation-the-synergetic-geomet>

- *Reading Synergetics: Some Tips*

<http://www.cjfearnley.com/synergetics.essay.html>

What is Model Thinking

- **Model Thinking** is an attempt by Scott E. Page to synthesize the modern approach of complex systems which has transformed our understanding of the social sciences over the past 40 years into a new intellectual discipline.
- Model Thinking provides a toolkit for understanding, decision-making, prediction, strategy, and design.

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Model Thinking MOOC

I took a MOOC (Massive Open Online Course) on Model Thinking led by Scott E. Page last spring wherein he explains how models can help us **understand**, **strategize**, **predict**, **re-design**, and **make decisions** in our worlds!



<http://www.modelthinker-class.org/>

Model Thinking Helps us Change the World

“So if you want to be out there helping to change the world in useful ways, it’s really really helpful to have some understanding of models.”

— Scott E. Page



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Study Model Thinking Now!

- The Model Thinking MOOC is running again now (92,000 students!). It started early this month. The second homework is due Tuesday. But I think you can catch up: the course runs with liberal deadlines.
- My review of the course is at

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What is a Model

- A model is a (simplified) conceptual representation of the world or of part of the world.
- Effectively, any conceptuality provides a model (Page does not say this).
- But most models provide little discernability, no predictive leverage, and no deeper understanding.
- Consider the case of **Opposite Proverbs**:
 - Nothing ventured, nothing gained
 - Better safe than sorry

Most (all?) proverbs have an opposite. No discerning power there!!!

- What we want to do with models is find leverage to discern how the world or at least a sub-system in the world operates.

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Models Right and Wrong

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— George E. P. Box
- Also, I suspect all models are right, but some provide better leverage or clarity or insight in some aspects of the system modeled than others.
- That is, the question with models is in what ways does it provide a better understanding than the several other models of the given system? Or, what are the models’ strengths and weaknesses?

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Formal Models

- A formal model is a written out characterization that defines the parts and their behavior or interrelationships. From this we explore how this idealized system works with a view to understanding the real system it models.

- 900.21 “Synergetics is a book about models: humanly conceptual models; lucidly conceptual models; primitively simple models; rationally intertransforming models; and the primitively simple numbers uniquely and holistically identifying those models and their intertransformative, generalized and special case, number-value accountings.”

<http://www.rwgrayprojects.com/synergetics/s09/p0000.html#900.21>

- 900.31 “Model is generalization; form is special case.”

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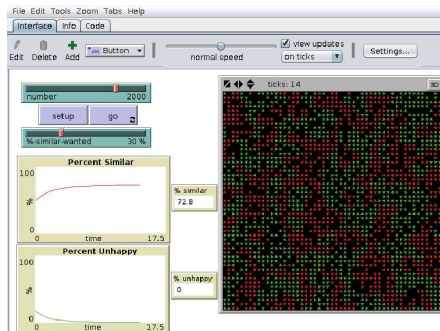
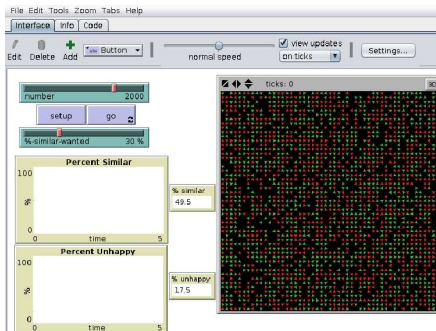
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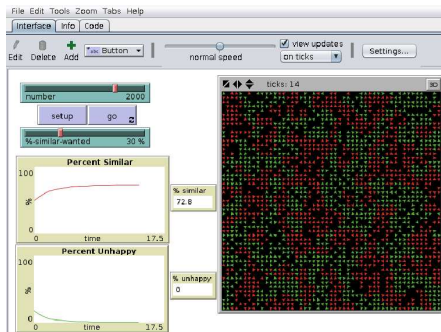
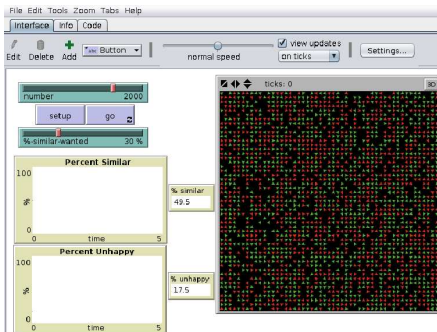
An Elementary Model: Schelling's Segregation Model

- Agent-Based Models: many agents or individuals (the objects of the model) are programmed with behaviors (rules) and interact in a computer simulation.
- Schelling *Dynamic Models of Segregation* (1971)



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Schelling and Synergy

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The Nature of Model Thinking

- Scott E. Page discusses more than 20 models like Schelling's Segregation Model in his MOOC "Model Thinking"
- What is special about Scott E. Page's vision of *Model Thinking* is its emphasis on using a whole toolbox full of many models to help think through different situations.

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Why is it important to use multiple model thinking?

- Why is it so important to use multiple model thinking?

The Problem with Experts

- Dawes (1979): “The Robust Beauty of Improper Linear Models in Decision Making”: Even “improper” linear models outperform experts
- Tetlock (2005): twenty-year study with some 284 experts and 28,000 predictions: even crude extrapolation is more reliable than human prediction in every domain studied.
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A Model for Problem-Solving

- Hong and Page (2005): Groups of diverse problem solvers can outperform groups of high-ability problem solvers
- The problem space is modeled as a complex 3D **landscape**
- A **perspective** is the representation of the problem space used by any given problem solver
- A **heuristic** is the particular way a given problem solver searches for solutions from their perspective in the landscape
- Many antecedents for the result: 1) difficult problems 2) local optima must be rankable 3) For any local optimum, someone else can do better and 4) there must be many problem-solvers in the pool.

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No Free Lunch Theorem

- Wolpert and Macready (1995, 1996, 1997): For problems of search, optimization, and machine learning, there is no “best” algorithm (no best heuristic).
- Corollary: Your favorite model is suboptimal at least some of the time.
- Corollary: Bucky’s Vector Equilibrium model is suboptimal at least some of the time.
- Corollary: You need multiple tools, heuristics, perspectives, and models to understand, decide, predict, strategize, and design effectively.

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Diversity Prediction Theorem

- $CE = AE - D$
Crowd Error = Average Individual Error – Diversity
- Diversity is just variance.
- It is a mathematical identity.



$$(c - \theta)^2 = \frac{1}{n} \sum_{i=1}^n (S_i - \theta)^2 - \frac{1}{n} \sum_{i=1}^n (S_i - c)^2$$

where c is the crowd's prediction ($\frac{1}{n} \sum_{i=1}^n S_i$), θ is the real outcome ("truth"), S_i is individual i 's prediction, and diversity is just the variance.

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Understanding the Diversity Prediction Theorem

- $CE = AE - D$
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- **The wisdom of crowds:** if CE is small and AE is large, then D (diversity) must be large to balance the equation.
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- Mathematically speaking, diversity is very important!!!

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Replicator Dynamics

- Replicator Dynamics models learning in psychology, population learning in economics, and ecology in evolutionary biology. (It is related to the generalized Lotka-Volterra Theorem and the Price Equation.)
- Fisher's fundamental theorem (1930): higher variation increases the rate of adaptation
- But six sigma is an engineering practice to reduce variation that is responsible for low cost, high quality widgets of all sorts. Gawande (2009) shows how checklists (reducing variability) save lives in hospitals.
- When the landscape is changing, we should foster diversity; when a situation is well understood, we should eliminate variation.
- **Warning:** diversity is not always good!

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- Dawes and Tetlock observe that even “bad” models beat most experts most of the time.
- Hong and Page observe that diversity can trump ability.
- Wolpert and Macready say there is no best heuristic.
- The diversity prediction theorem shows the mathematical importance of diversity.
- Fisher’s fundamental theorem says diversity enhances adaptability.
- Conclusion: we need many, many diverse models to understand, decide, predict, strategize, and design effectively.

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Models in Synergetics

- 109.00–117 Chrome-Nickel-Steel Synergy model
- 401.00–401.07 Tetherball model (twelve vectors of restraint)
- 410.00–419.05 Closest Packing of Sphere model of Nature's Coordinate System
- 450.00–459.03 Great Circle models
- 460.00–465.30 Jitterbug model
- 506.00–506.30 Knot model (pattern integrities)
- 522.00–522.36 Deliberately Nonstraight Line model
- 700.01–707.03 Tensegrity model
- 910.00–924.20 Quanta Module model
- 986.00–986.874 Demass model
- 1009.80–1009.98 Gyroscope model
- **Synergetics is filled with models!!!**

Synergetics and Model Thinking

- Synergetics is Model Thinking.
- Model Thinking involves synergism . . . it is Synergetic.
- (Many) Model Thinking is a form of Integrative or Synergetic Thinking.
- (Many) Model Thinking adds to Synergetics the important idea that we need many diverse models to understand our worlds.
- 224.12 “unity is plural and, at minimum, is two.”
400.08 “unity is inherently plural”.

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- (Many) Model Thinking adds to Synergetics the important idea that we need many diverse models to understand our worlds.
- 224.12 “unity is plural and, at minimum, is two.”
400.08 “unity is inherently plural”.

The Nature of Science

- 161.00 “Science has been cogently defined by others as the attempt to set in order the facts of experience.”

<http://www.rwgrayprojects.com/synergetics/s01/p6000.html#161.00>

- “Science is basically culture’s answer to the big problem of epistemology, which is how can we know anything at all.”
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- The standard view of modern science is given by the **hypothetico-deductive model** which posits that a scientist proposes a hypothesis which is tested by experiments as part of a contest of alternative ideas to choose a winner which is dubbed Scientific Truth (or “the consensus view”).

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The Method of Multiple Working Hypotheses

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- “In the use of the multiple method, the re-action of one hypothesis upon another tends to amplify the recognized scope of each, and their mutual conflicts whet the discriminative edge of each. The analytic process, the development and demonstration of criteria, and the sharpening of discrimination, receive powerful impulse from the co-ordinate working of several hypotheses.”
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- Thomas Kuhn: “The Structure of Scientific Revolutions” (1962)
- Kuhn argues that science advances through revolution by “paradigm shift”.
- Was the Copernican Revolution an “overthrowing” of the Ptolemaic system? No, Carter Emmart, NASA, and others use Earth-Centered perspectives to good effect!
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Paradigm Shifts

- A paradigm shift is just a new model. From the perspective of Model Thinking, we need lots of models . . . lots of paradigms!
- But psychologically and sociologically new models often **feel** revolutionary!
- Steven Stearns tells how Stephen Jay Gould was bewitched by the allure of Kuhn's ideas and over-ambitiously argued that punctuated equilibrium was a revolution in evolutionary thought.
- Bucky also got a bit too carried away thinking that Synergetics was revolutionary. Synergetics has many profound insights and many exciting new models. Following Stearns, we should beware of over-ambitiously arguing that our ideas are revolutionary! It is usually more distorting than valuable to think we are revolutionary.

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A new more incisive science

- So if you want to advance science, don't try to revolutionize it with "paradigm change", just come up with some new models! That's all it takes!

Model Thinking and Synergetics

- Synergetics is filled with models. Effectively it is a form of Model Thinking.
- Model Thinking embraces the idea of synergy; it is Synergetic.
- Model Thinking adds to Synergetics (and to science) the idea that multiple models (and multiple hypotheses) are essential to really deepen our understanding, improve our decision-making, construct better strategies, predict outcomes better, and leverage our deep understanding as we re-design our worlds!!

Model Thinking and Synergetics

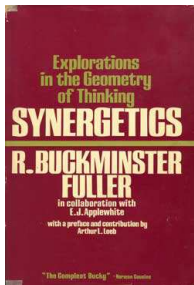
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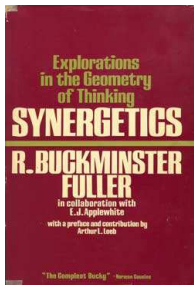
- Re-read Synergetics with a view to understanding Model Thinking.



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Study Model Thinking

Study Model Thinking with Scott E. Page: it is a grand vision for understanding how the world works, it refines the notion of models in Synergetics, it builds and expands on the vision of Synergetics. It may be the most Synergetic development in thinking deeply and incisively about how the world works since the publication of Synergetics itself.



<http://www.modelthinker-class.org/>

Thank You

Thank You!

Any Questions?

On-line version of this presentation:

<http://www.CJFearnley.com/Asheville.Synergetics.Model.Thinking.pdf>