

# Integrating Traditional Evaluation with Agent-Based Simulation of Complex Behavior

Presented at  
The Evaluation Centre for Complex Health Interventions  
Li Ka Shing Knowledge Institute,  
St. Michael's Hospital  
University of Toronto  
December 6<sup>th</sup>, 2013

*Download slide deck from: [www.jamorell.com](http://www.jamorell.com)*

Jonathan A. Morell, PhD  
Director of Evaluation  
[Fulcrum Corporation](http://www.fulcrum-corp.com)  
[jmorell@fulcrum-corp.com](mailto:jmorell@fulcrum-corp.com)  
Website: [www.jamorell.com](http://www.jamorell.com)  
Blog: <http://evaluationuncertainty.com/>

Van Parunak, PhD  
Senior Scientist  
[SoarTech](http://www.soartech.com)  
[van.parunak@soartech.com](mailto:van.parunak@soartech.com)

## Outline

1. An evaluation scenario – traditional approach
2. Why use executable models as part evaluation?
3. Why use agent based models?
4. What would combining traditional evaluation and an agent based model look like?

# Scenario: Getting a Novel Best Practice Implemented

## Hypothesis About New Practice

- Clinical outcome improves with therapist adoption
- Use influenced by organizational, psychological, and social factors.

## Organization

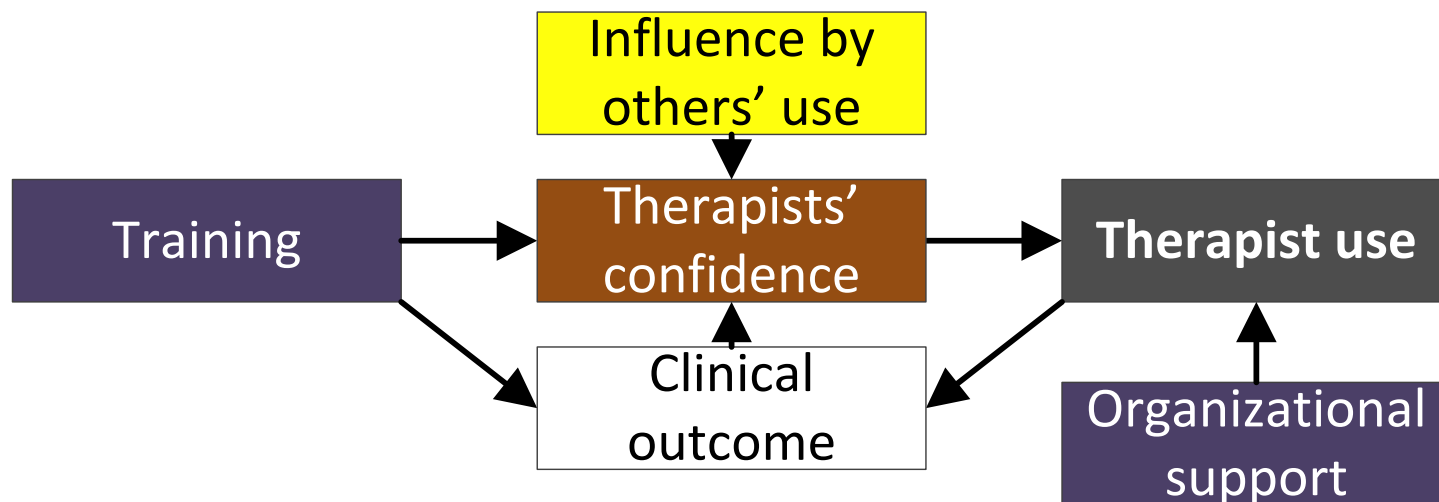
- Training,
- support from managers

## Psychological

- Therapist belief new treatment is better
- observed clinical outcome

## Social

- Use of new therapy by peers



Caveat: We constructed this model up for the demonstration. It does not represent what a thorough literature review might reveal as the best program theory

# Accepted Practice for Evaluating a Scenario Like This

Develop a logic model reflecting the program theory

- Expert opinion
- Research literature

Devise metrics as indicators of the constructs in model

- Rating scale for clinical outcome
- Questionnaire for training quality
- Observation protocol for “organizational support”
- Etc.

Develop methodology

- Are there control group clinics?
- Is there historical data for time series?
- Can we interview therapists?
- Can we access clinical records?
- Etc.

# Accepted Practice Has its Problems

The act of developing a program legitimizes the program

- Implementation takes money, time, and commitment. Once started, hard to change
- Having a model confirms the program theory. People like it, show it, commit to it.

This is why we work so hard at getting stakeholders to question assumptions

- Interviews
- Delphi methods
- Literature reviews
- Group deliberations

But the tactics are limited and we miss a lot

- Time
- Imagination
- Diversity of expertise available
- Knowledge base

Because we get do much wrong

- Program behavior surprises us
- Our methodologies are unprepared to assess unexpected change

# Challenge to Standard Evaluation Methodologies

We will never have a problem if we only use qualitative, post-test only, non-comparative designs.

- No sunk costs in the evaluation mechanism
- Minimal time and effort to change interview questions
- No methodological system whose integrity needs to be protected

But do we want give up methods that require time and effort to establish and maintain? How much would we loose if we did not invest in

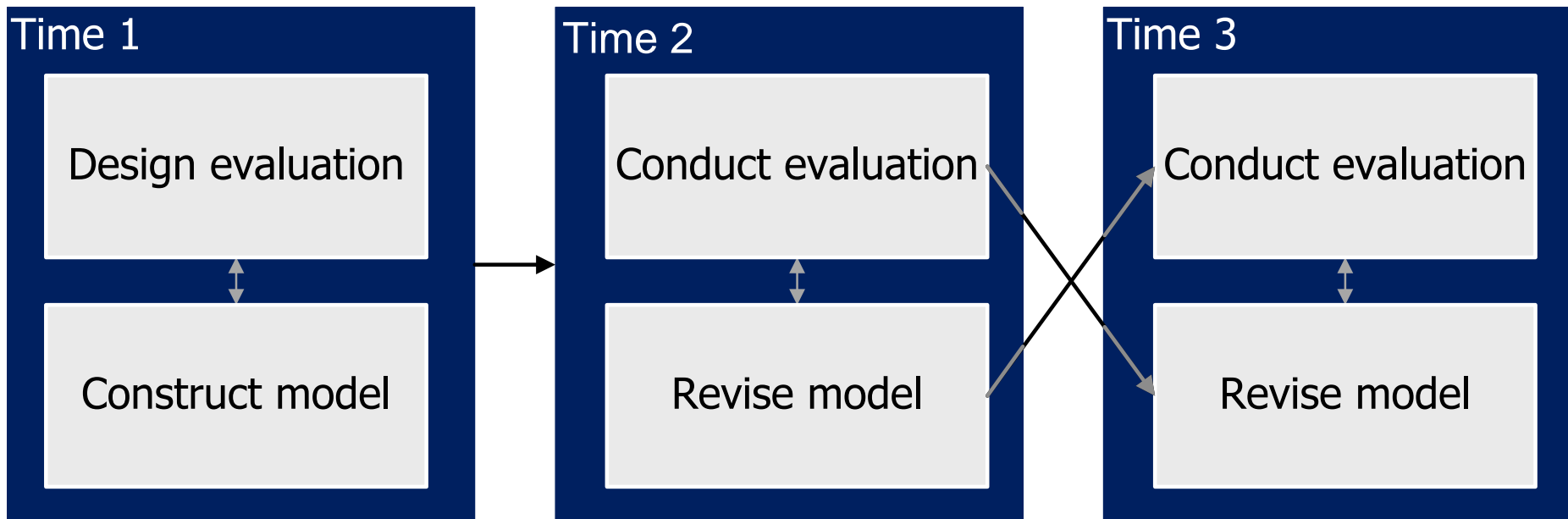
- Negotiating access to data
- Recruiting comparison groups
- Developing and validate scales
- Developing observation protocols
- Constructing content analysis schema
- Etc.

Modeling can help by providing

- More insight into what a program may do, and
- Greater lead time in revealing surprises

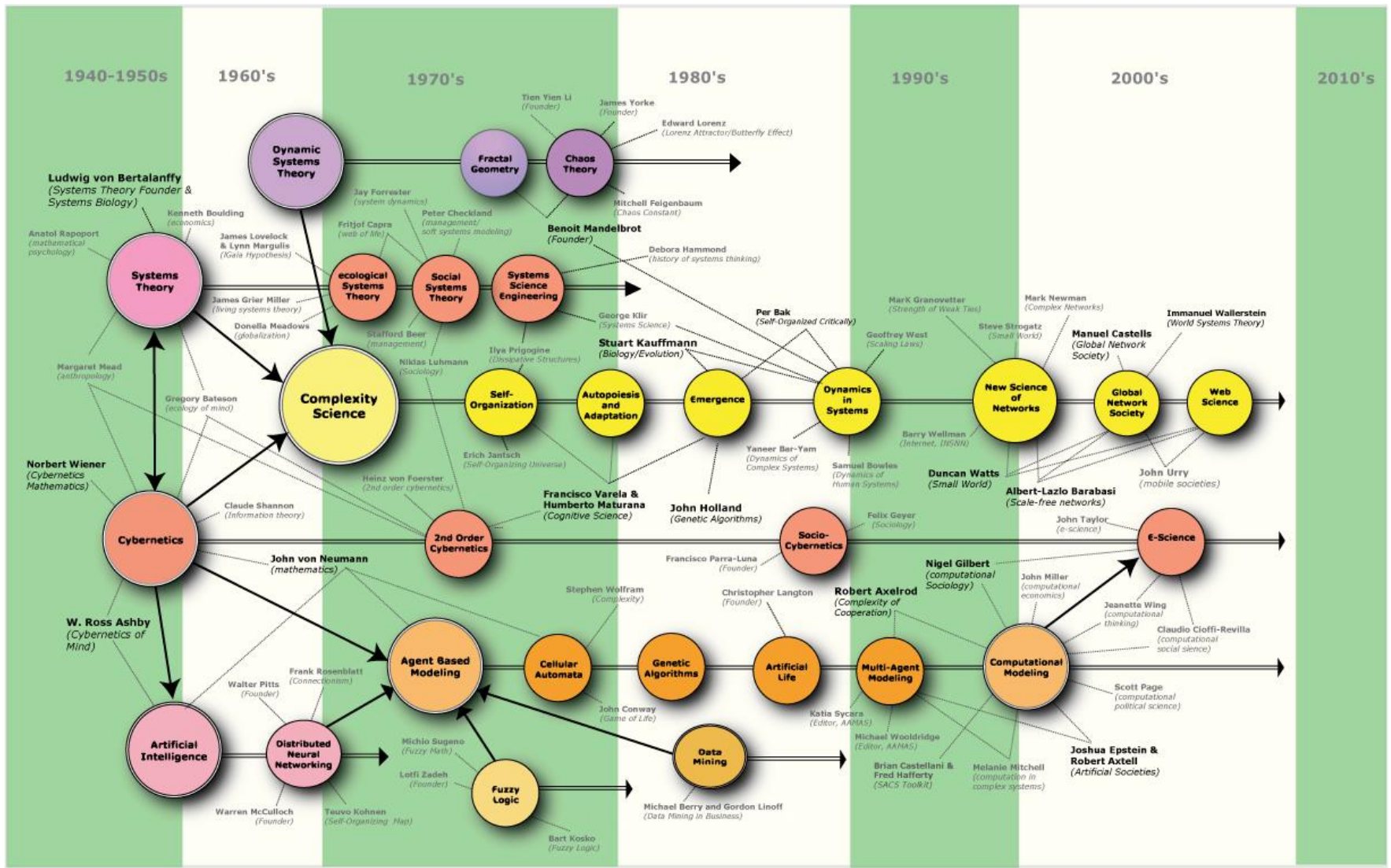
# Our Vision of Improving on Standard Practice

- Over the course of the evaluation
- Empirical data are used to inform the model
- Model behavior informs the evaluation design



But why a focus on complex systems and agent based modeling?  
A very brief discourse about a very big topic

- “Complex systems” is an enormous topic
- What matters to us are a few characteristics of these systems.



[Historical / intellectual map of complexity studies: http://en.wikipedia.org/wiki/Complex\\_systems](http://en.wikipedia.org/wiki/Complex_systems)



# Some Aspects of Complex System Behavior: Emergence

Interactions among individual elements can result in system-level behavior more than the sum of its parts.

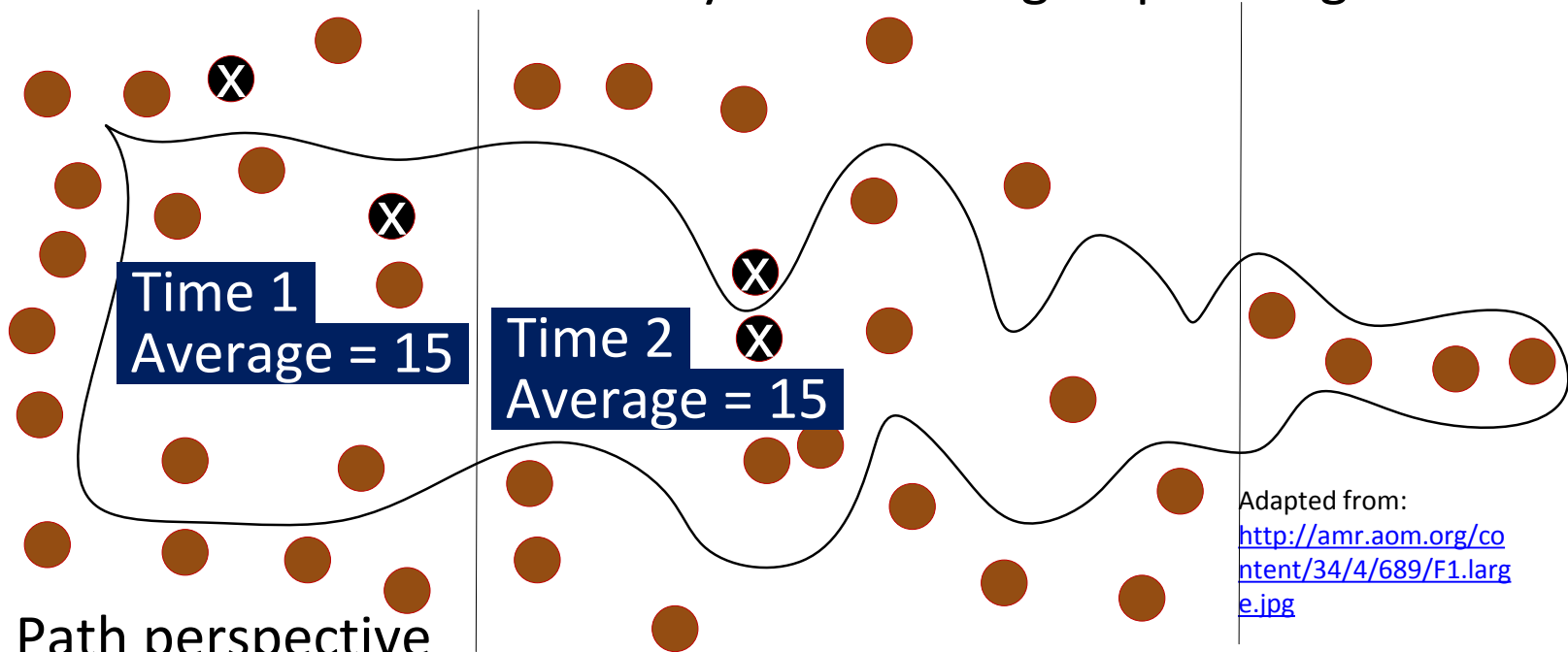
Group behavior be inferred from knowledge of individual behavior



# Some Aspects of Complex System Behavior: Path Dependence

## Statistical perspective

All circles the same. We only care about group average.



## Path perspective

Circles **not** the same. Average does not explain system behavior.

Previous states limit available states  
in the future

All variation can matter

# What is an agent? What is an Agent Based Model?

An “agent is an entity that can

- Sense its environment
- Respond to set rules

What can an agent be?

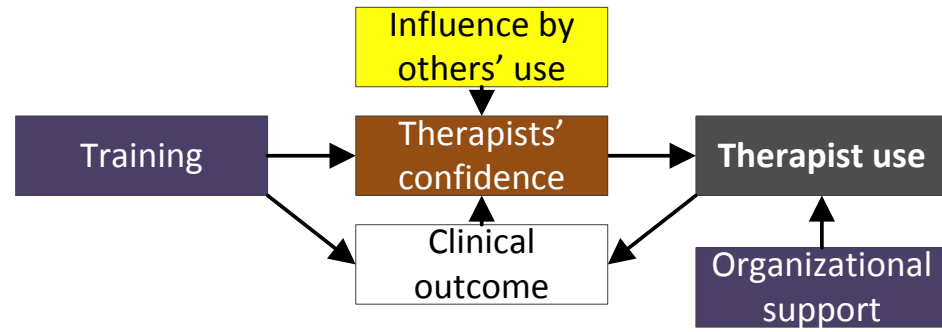
- Person
- Animal
- Wetland
- Hospital
- School room
- County government
- Etc.

What is in an agent based model?

- Numerous agents (sometimes at different scales (e.g. teachers, schools))
- Decision rules (e.g. “Do this if your neighbor does it.”)
- Learning rules (e.g. If you do it twice in a row, continue to do it 90% of the time)
- Environment specifications (e.g. “New treatment is 25% better.”)

# Review the Bidding and Show the Executable Model

- We have an evaluation scenario
- We have a logic model / program theory
- We know the limitations of traditional evaluation methods
- Let's see how an executable model might help



## But some caveats before we do

- The program theory is artificial. Conjured for the sake of demonstration
- A thorough review of the literature might lead us to a different model
- Parameters in model are only mathematical formulae. They are not based on research, e.g.
  - What does “confidence” mean and how can we measure it?
  - What is “training quality” in real world settings/
  - Etc.
- It is very dangerous to use models to predict anything. They are useful for getting a feel for how a system might behave.

## Let's get a Feel for the System by Running Two Scenarios

### Scenario 1

- New treatment 25% better than the old
- Vary organizational support from high to low
- All other parameters fixed at medium levels

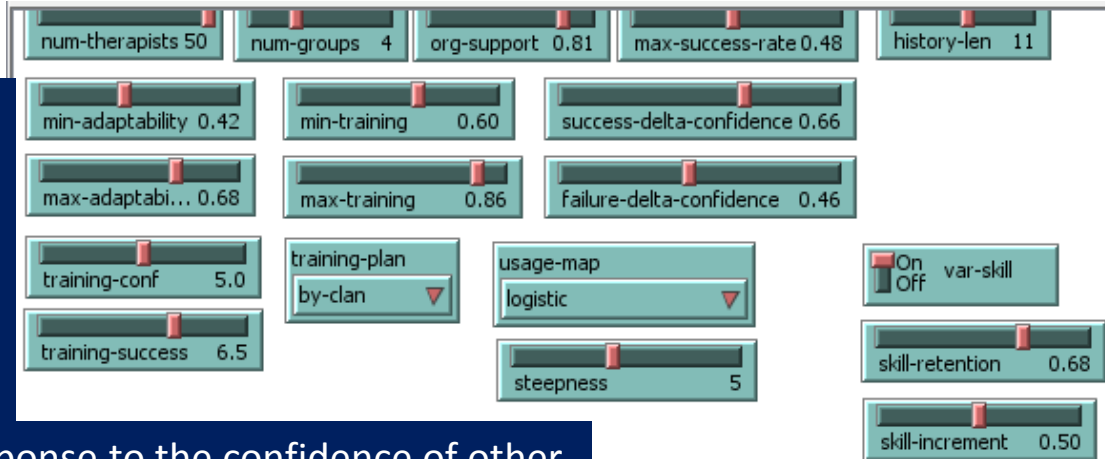
### Scenario 2

- Organizational support stays high
- Success rate varies from high to low
- All other parameters fixed at medium levels

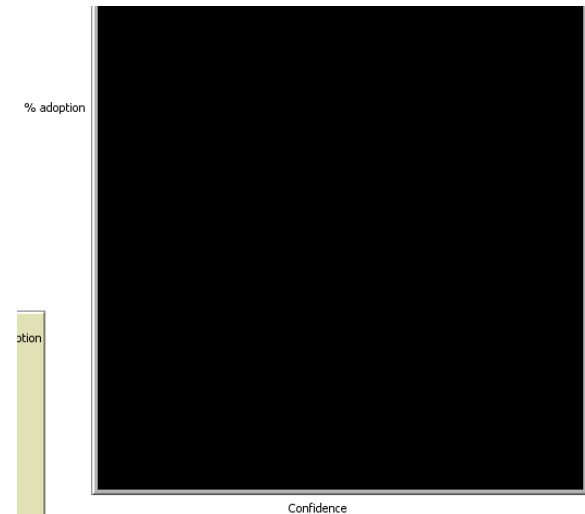
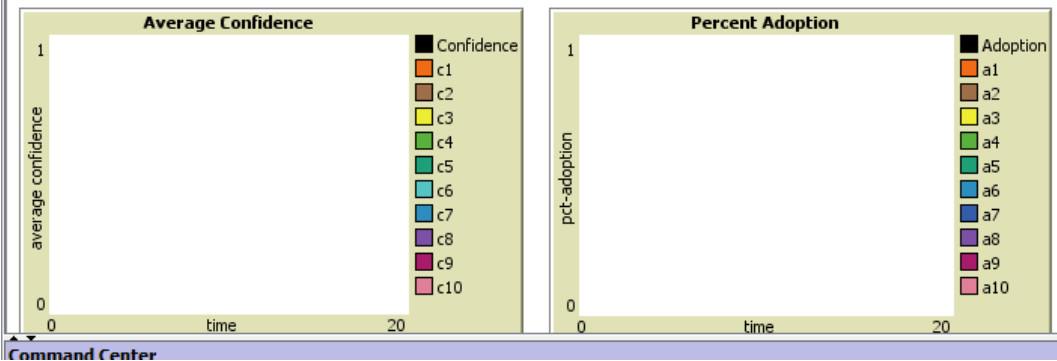
Requirements for evaluation that would never be known are revealed

- Consequences of a gap between levels of adoption and confidence in new treatment
- Evaluability assessment issues with respect to amount of improvement new treatment can deliver
- Importance of monitoring “organizational support”
- Determining why the same therapist can vary so greatly in his or her confidence

- num-therapists
- num-groups of therapists
- org-support: 0 (discouragement) to 1 (encouragement)
- % of patients that improve compared to % using old therapy
- adaptability: therapist adaptability in response to the confidence of other training
- success, failure – impact of outcome on patience on confidence
- confidence in training – impact on initial confidence in therapy
- success of training– impact on initial confidence in therapy



- Group average behavior
- Adoption of best practice
- Confidence in best practice



- Adoption and confidence for each agent

## Useful references

Morell, J.A., Hilscher, R., Magura, S. and Ford, J. (2010) [Integrating Evaluation and Agent-Based Modeling: Rationale and an Example for Adopting Evidence-Based Practices](#) *Journal of MultiDisciplinary Evaluation*, Vol. 6, No 14, 35 – 57  
[http://journals.sfu.ca/jmde/index.php/jmde\\_1/article/download/275/264](http://journals.sfu.ca/jmde/index.php/jmde_1/article/download/275/264)

Morell, J.A. (2010) [Evaluation in the Face of Uncertainty: Anticipating Surprise and Responding to the Inevitable](#) Guilford Press N.Y. [http://www.guilford.com/cgi-bin/cartsript.cgi?page=pr/morell.htm&dir=research/res\\_eval&cart\\_id=946812.24050](http://www.guilford.com/cgi-bin/cartsript.cgi?page=pr/morell.htm&dir=research/res_eval&cart_id=946812.24050)

Morell, J.A. (2005) Why are there unintended consequences of program action, and what are the implications for doing evaluation? *American Journal of Evaluation* , 26, 4, 444 - 463

Morell J.A. (ongoing) [Blog http://evaluationuncertainty.com/](http://evaluationuncertainty.com/)

Net logo <http://ccl.northwestern.edu/netlogo/>

Parunak H. Van Dyke , Morell Jonathan A. (under review), Emergent Consequences: Unexpected Behaviors in a Simple Model to Support Innovation Adoption, Planning, and Evaluation 2014 International Conference on Social Computing, Behavioral-Cultural Modeling, & Prediction