The evolution of knowledge landscapes – measurement, visualization, models and simulations

Andrea Scharnhorst
Analogous spaces, Ghent, May 14-17, 2008

Courtesy of Charles van den Heuvel
Modelling and simulating learning agents

Annimation by Thomas Huesing, Berlin
Outline

• Present the concept – general level

• Present of different re-specifications
  – Competences
  – Technologies
  – Research practices
Evolution in a landscape

Wright 1932: Species in an adaptive landscape (fitness landscape)

Complexity theory: stable states of a system are specific points in an “energy or entropy landscape” - Prigogine

\[ \frac{dx}{dt} = -x^2 + \lambda x + \mu = -\frac{dU}{dx} \]

**Landschaften in der Analyse komplexer dynamischer Systeme**

**Potentialfunktion**

**Strukturbildung als Suche nach stabilen Zuständen**

**Evolution als Folge von Selbstorganisationsschritten**

**Innovation als Folge einer Instabilisierung eines bestehenden Zustandes**

**Evolutionslandschaft, lokal definierte Fitness**
Self-organized learning in a problem space

- People use different “competences” differently in different situations when they need to solve a problem – can be measured

- Project together with Anne Beaulieu, John Erpenbeck, Werner Ebeling, Thomas Hüsing

- EVOLINO
Agents which use fact knowledge (selection – comparing solutions), creativity (mutation – creating/testing solutions), imitation (social selection – talking, communicating)
EVOLINO – a web based simulation

Go to Andrea Scharnhorst -> Current activities -> Evolino
Function of the model

- Re-specification: related to concepts in management theory, organization theory and psychology
- Used as tool to link up different concepts as learning and use and change of competences
- Used as training tool introducing into complexity theory (self-organized learning)
Technological evolution as search in an Innovation landscape

• Project together with Lutz Marz, Thomas Aigle, Ante Krstacic-Galic

• Wissenschaftszentrum für Sozialforschung Berlin, working paper
Measuring the occupation of a technological space – the air plane case – Saviotti, Bowman 1984

### Innovation matrix

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<th>Kraftstoff (k)</th>
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**Stagnative Innovationen**  
**Inkrementale Innovationen**  
**Inkrementale Innovationen 1. Grades**  
**Radikale Innovationen 2. Grades**

X Technologisch ausgeschlossen  
/ Inventionsräume

Abbildung 5, Quelle: Aigle/März 2007, S2
Innovation landscape

Possible trajectories?

Critical mass/population?
Function of the model

- Related to concepts innovation theory
- Used as tool to order and interpret qualitative data
- Used as tool to develop quantitative indicators (critical market size, early markets)
Simulation landscape

• Project together with Anne Beaulieu, and Matt Ratto
Competence project: In search for the best interface

Racing for solutions in the problem space
The simulation landscape

**CONCEPT**

- **Rule based**
  - Archeology, architecture, Computational humanities

- **Visual simulation**
  - Virtual reality

- **Metaphoric simulation**
  - Interactive visualization of concepts by means of game rules

- **Symbolic simulation**
  - Visualization of concepts by means of equations

- **Systems dynamics**
  - Interactive learning of complex dynamics

- **Computational sociology**

- **Behavioral simulation**
  - Rule-based description of complex dynamics

**PHENOMENON**

- **Scenarios simulation**
  - Interactive learning of complex dynamics

- **Numeric simulation**
  - Equation based description of complex dynamics

- **Physical of complex systems**

- **Philosophical system theory**

Purpose

- ‘Closed’ description

- ‘Open’ description
Function of the model

• Related to concepts in science and technology studies about the role of models and simulations in different disciplines and different epistemic values

• Understand better the potential of innovation and barriers to use them (for instance virtual reality in archeology)
Models as heuristic devices

• Ocupation space: taxonomy, measurement – model used as a mirror against which we order observations

• Changing occupation: time, dynamic processes – model a producer of explanations

• Simulation – model as experiment
Analogous space

G-Model

(Re-)Generalisation

“Trading zone” – Trading epistemic values

S-Model

(Re-)Specification
Simulation collaboratory at the VKS

Simulation of innovation in knowledge processes

• What add models and simulations to the understanding of innovation?
• How models and simulations are used as research instruments to structure research agendas, research processes in interdisciplinary teams, negotiations?
Current and future activities around the simulation collaboratory

- CREEN (Critical events in evolving networks) www.creen.org
- The Heraeus workshop “Physics and Evolution”, January 2008, with a stream on modelling social, economic and information processes
- Book “Innovation networks” (with Andreas Pyka, Springer)
- Special issue Journal of Informetrics “Science of science” (Concepts and models of science development) (with Katy Börner)
THANKS!