Paradigms Underpinning a Digital Business Ecosystem

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Workshop
“Towards a network of digital ecosystems: which technology, which research and which instruments?”

Bruxelles, 18 May 2005
An Underlying Assumption

- 99% of all companies in Europe are SMEs
- 93% have less than 10 employees
- SMEs account for ~50% of EU GDP

Thus, our starting assumption is:

Any research & development strategy that claims to address the Lisbon objectives must focus on SMEs
Overview

• Summary: What is a DBE?

• Lisbon objectives, FP research and SMEs

• Natural science, social science and ICTs

• Embeddedness: markets, hierarchies and social networks

• Managing information infrastructures

• The economics of Open Source

• Evolution, autopoiesis and the syntactical structure of society

• Industrial districts, knowledge and digital ecosystems

• An architecture for the Knowledge Economy
What is a Digital Business Ecosystem?

Knowledge Economy

Business Ecosystems and Regional Economies

Socio-economic research

Suggested FP7 Research areas

Formalisation of Knowledge (Languages)

Infrastructure

Business rules and Regulatory Framework

Semantics of services

Syntax of economic behaviour

Service Factory

Execution Environment

Evolutionary Environment

Open-source service-oriented architecture
Three Problems

1 - ICTs and regional growth:
Everyone agrees that ICTs are essential for reaching the Lisbon objectives, but:

- how and why this is the case is not clear
- the best methodology to achieve ICT adoption is still under debate
- regional growth remains elusive

2 - Involving SMEs:
Since the beginning of the Framework Programmes, a very large number of IST projects either funded directly or addressed ICT adoption by SMEs. Virtually none of them has led to sustainable networks of SMEs that persisted beyond the life of the projects.

3 - Communication across disciplines:
A lot of public funds were invested in socio-economic research in FP4 and FP5, but very few projects (~ 10%) are regarded to have yielded a worthwhile ROI. How is this possible? What can we do about it?
Three Research Challenges for FP7

1 - We need to develop new paradigms for the integration of technology and socio-economic systems: Digital Ecosystems?

2 - We need to involve SMEs in FP research: revise co-funding structure, decreasing the 50% contribution for micro-SMEs (< 10 employees)?

3 - We need to address the language and cultural divide between

Natural Science & Technology  
and  
Social Science

...WITHIN interdisciplinary projects.
The ecosystem metaphor is appealing at an intuitive level, but comes with some baggage:

- It is difficult to pin down what the metaphor means exactly because our understanding of biological ecosystems is limited
- It places natural science at the centre of software and ICT adoption research

This situation is potentially confusing and definitely uncomfortable:

- is an ecosystem necessarily based on evolution and natural selection?
- by “evolution” do we mean only genetic algorithms as an optimisation method, or do we mean more?
- what does it mean for software to evolve?
- how does the concept of evolution apply to business?
- do we assume that evolution in the economic life of firms applies in the sense of the new institutional economics (organisational forms dictated by economic efficiency)?

We need to start addressing ontology, semantics, epistemology, and methodology
The Epistemological Problem

The way we construct knowledge about the natural and physical world is very different to how we construct knowledge about ourselves.

**Natural Science**
- “Structure and Function”
  - Hollow bone structure ↔ Flight
  - Protein shape ↔ Catalytic reaction
  - Organism shape ↔ Efficient propulsion
  - Fur ↔ Thermal insulation
  - Flat teeth ↔ Eating grass
  - DNA ↔ Successful reproduction
  - DNA ↔ Metabolism
  - ...

**Social Science**
- “Structure and Action”
  - Social institutions
  - Cultural institutions
  - Political institutions
  - The corporation
  - Regulatory bodies
  - The army
  - The market
  - NGOs
  - Work
  - Rituals
  - Play
  - War
  - Theft
  - Commerce
  - Creative arts
  - Communications
  - ...

**Natural Science tends to be “Objective”, outward-focused, and has a concrete ontology**

**Social Science tends to be “Subjective”, inward-focused, and has an abstract ontology**
Can we put natural and social science on the same page?

(This is difficult, and the subjective/objective dichotomy is an oversimplification)

ICT allows us to suspend E&O issues while we build something together

Computer Science

Natural & Physical Science

Networks & hardware

Software, ICT

More abstract

More physical

Creative Arts

Humanities

Anthropology

Language

Sociology

Social Science

Mathematics

Chemistry

Physics

Engineering

Biology

Economics

Media

Can we put natural and social science on the same page?

(This is difficult, and the subjective/objective dichotomy is an oversimplification)
A Map of Social Science*

(The “Understanding” column is much narrower than the “Explanation” column in terms of constituency)

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Systems</td>
<td>Games &amp; Rules</td>
<td></td>
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<tr>
<td>Evolution &amp; Autopoiesis</td>
<td>Syntax of Society</td>
<td></td>
</tr>
<tr>
<td>(Some of the topics to be discussed)</td>
<td>Communities of Practice</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Individualism, Action, “Bottom-up”</th>
<th>Agents</th>
<th>Actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Efficiency Neoclassical Economics Game Theory</td>
<td>Social Roles</td>
<td>Communities of Practice</td>
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Markets and Hierarchies*

One of the positions of New Institutional Economics (1940-60):

Markets consolidate into hierarchies to offset transaction costs

Granovetter (1985):

SMEs persist in a market setting because a dense network of social relations is overlaid on the business relations and reduces pressures to integrate

Markets and Hierarchies

Embeddedness of economic life in social relations

Social Networks of SMEs
Economic analysis of infrastructures shows that large set-up costs, learning effects, coordination effects, and adaptive expectations lead to self-reinforcing processes that cause path-dependence, lock-in, and possible sub-optimal end-results.

While from a technical and managerial point of view the business is to design, build, align and control an infrastructure, the economic understanding of the dynamics of infrastructures points out that "cultivating" an installed base is a wiser and sounder strategy.

That is, technological systems are "organisms with a life of their own".

Consequently, infrastructures should be built by establishing working local solutions supporting local practices which subsequently are linked together, rather than by defining universal standards and subsequently implementing them.

...Regional ecosystems?

Managing Information Infrastructures

Systems

“Infrastructure is an external Tool we manage and control”

Games & Rules

“We are part of the infrastructure, we are inside it!”

Agents

From “Tool” to “Enframing”

Actors

Digital Business Ecosystem
The Self-Reinforcing Economics of Open Source

As stated above, one of the positions of New Institutional Economics is*:

![Diagram: Markets (Networks) → Increasing transaction costs → Hierarchies (Monoplies)]

Benkler explains the rise of Open Source as an economic model of production on the grounds that ICTs have decreased transaction, communication, and management costs**

But Open Source decreases the cost of ICTs

Thus Open Source reinforces its own growth!


Lessons Learned and Challenges Posed by Open Source*

• The open source paradigm has showed that community software projects can become sustainable by relying predominantly on networked volunteer labour, motivated and organised through the value of reciprocity (the gift economy)

• Some of these communities have evolved into new kinds of commercial actors, cultivating relationships with companies and therefore becoming more intensively part of the exchange economy

• At the same time large and small companies are benefiting from the work of these communities and developing business models suited to the open source model

• Open source software is also increasingly adopted at the regional level to boost ICT adoption and development (the case of Extremadura)

**Challenge:** can we develop a socio-technical infrastructure and a policy framework that integrates the interests and models of organisation of all these different actors in a more cohesive way than is currently being done?

*I am grateful to Evangelia Berdou, LSE, for providing this slide.
Darwinism vs. Autopoiesis

Ontogeny and phylogeny according to neo-Darwinism

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<thead>
<tr>
<th></th>
<th>Cause, instruction</th>
<th>Mechanism</th>
<th>Effect</th>
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<tbody>
<tr>
<td><strong>Ontogeny</strong></td>
<td>DNA</td>
<td>GENE expression</td>
<td>METABOLIC CYCLES, MORPHOGENESIS</td>
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<tr>
<td><strong>Phylogeny</strong></td>
<td>ENVIRONMENT</td>
<td>NATURAL SELECTION</td>
<td>GENOME</td>
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Ontogeny and phylogeny according to autopoiesis*

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<thead>
<tr>
<th></th>
<th><strong>Actor 1</strong></th>
<th><strong>Mechanism</strong></th>
<th><strong>Actor 2</strong></th>
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<tbody>
<tr>
<td><strong>Ontogeny</strong></td>
<td>DNA</td>
<td>STRUCTURAL COUPLING</td>
<td>CELL</td>
</tr>
<tr>
<td><strong>Ontogeny</strong></td>
<td>ENVIRONMENT</td>
<td>STRUCTURAL COUPLING</td>
<td>ORGANISM</td>
</tr>
<tr>
<td><strong>Phylogeny</strong></td>
<td>Ecosystem</td>
<td>NATURAL DRIFT</td>
<td>SPECIES</td>
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## Fundamental Dichotomy of DBE

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<tr>
<th>*</th>
<th>Evolutionary Biology</th>
<th>Cognitive Science</th>
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<tbody>
<tr>
<td>Symbols</td>
<td>Neo-Darwinism</td>
<td>Cognitivism</td>
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<td></td>
<td>Genetic Determinism</td>
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<tr>
<td>Behaviour</td>
<td>Autopoiesis</td>
<td>Connectionism</td>
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<tr>
<td></td>
<td></td>
<td>Emergent Systems</td>
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</tbody>
</table>

* Autopoiesis of social systems**

** Formal languages

*** Languages: DNA

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<tr>
<th>Collective Intelligence</th>
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<tr>
<td>Communications as semantics</td>
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<td>Rules as syntax***</td>
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Digital Business Ecosystem
Industrial districts of 50-100 years ago brought together similar and complementary industries and became the engines of regional economic growth.

Tacit and explicit knowledge was embedded in the firms and in the business and social networks, leading to self-reinforcing network effects.

ICTs promise to provide a similar repository of knowledge that supports economic growth and social development, but they must be able to capture, formalise and retain knowledge so that it can remain a public good at the sectoral and regional level.

In the DBE project we believe that open-source digital ecosystems provide such a public good in the form of an adaptive environment that retains and distributes locally the knowledge created by its users.

Because digital ecosystems are owned by their users, they cannot be moved or shut down.

Their distributed architecture makes them resilient and scalable, so they will grow with the regional and sectoral economies they support.
Putting DBE on the Map

Naturalist philosophy: “Explanation”
- Systems
  - DBE Computing
  - (Marx, Durkheim, Luhmann)

Meaning of action: “Understanding”
- Games & Rules
  - SBVR*
  - (Weber, Wittgenstein)

Holism Structure “Top-down”
- Macroeconomics
- Ideological forms as self-generating structures of rules
- (Weber, Wittgenstein)

Individualism Action “Bottom-up”
- Agents
  - Game theory
  - Microeconomics
  - Empiricism, Positivism,
  - Classical & Neoclassical economics
  - (JS Mill, Smith, Friedman)

- DBE Business
- Integrated DBE
- Intersubjectivity
- Social constructivism
- Communities of practice
  - (Giddens)

- Open Source
- Actors
- Use Cases
- Social roles
  - (Elster)

An Architecture for the Knowledge Economy

Knowledge Economy

Regional Economy

Regional Economy

Regional Economy

(Syntax of socio-economic system) ← Business Rules & Regulatory Framework → (Semantics of information system)

Open Source Regional & Sectoral Digital Ecosystem

Open Source Regional & Sectoral Digital Ecosystem

Open Source Regional & Sectoral Digital Ecosystem

DBE
Open-source digital ecosystems

Self-reinforcing growth of Open Source based on lower transaction costs

Regional growth catalysed by ICTs

Sustainable, open-source regional and sectoral Digital Business Ecosystems

Knowledge Economy

Business rules and regulatory framework as syntax of knowledge economy and semantics of infrastructure

DNA as solution to symbols/behaviour dichotomy

Economic costs and human factors in managing infrastructure

Centrality of SMEs to European economy

Embeddedness of economic life in social networks

Resilience of SME networks

Formalisation of shared knowledge

Communications as semantic autopoiesis of society

Social rules as syntax of society

Evolutionary and autopoietic view of ICT infrastructure and e-Business services

Open-source digital ecosystems

Self-reinforcing growth of Open Source based on lower transaction costs

Adaptive, dynamic, resilient, learning, self-optimising, distributed, affordable infrastructure and e-Business services

Embeddedness of economic life in social networks

Communities and business models organised around the gift economy

Organic view of decentralised infrastructure with a life of its own

Evolutionary and autopoietic view of ICT infrastructure and e-Business services

Communications as semantic autopoiesis of society

Social rules as syntax of society

Economic costs and human factors in managing infrastructure

DNA as solution to symbols/behaviour dichotomy

Economic costs and human factors in managing infrastructure

Centrality of SMEs to European economy

Digital Divide

Economic costs and human factors in managing infrastructure

Centrality of SMEs to European economy

Digital Divide
Constructive Cycles of DBE

Regional economy

Socio-Economic Environment (SEE)

Policy

Design

Emergence

Network

U SME

SW SME

U SME

Business Ecosystem

Semantic layer: formalisation of knowledge

Execution Environment (ExE)

DBE Service

DBE Service

Model Driven Architecture

Service

Factory (SF)

Service chain optimisation, code segments, digital proteins

Feedback

Evolutionary Environment (EvE)

Digital Business Ecosystem
Global Communication Diagram of DBE
Evolutionary Environment (EvE)*

*Gerard Briscoe, Imperial College London