Generating Knowledge in a Connected World: The Case of the ATLAS Experiment at CERN

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The ATLAS Experiment at CERN

• The ATLAS experiment at CERN is one of four that, working with the Large Hadron Collider (LHC), will explore new physics in the 14 TeV energy range.

• The ATLAS detector is one of the largest and most complex experimental machines ever built.

• Its construction involved over 3000 physicists from 174 research institutes spread across 38 countries
How is coordination achieved in an organization as extended and complex as the ATLAS Collaboration?

What lessons does the ATLAS experience hold for other complex organizations such as cities?
The Large Hadron Collider (LHC)
ATLAS is one of four detectors located on the LHC
The ATLAS Detector
The Performance Spidergraph
For ATLAS

Luminosity (Collision Rate)

Data acquisition

Detection
The ATLAS Puzzle

- The Collaboration is held together by *MoUs*
- Decision making is mostly *bottom-up*
- Decision making is mostly *distributed*

*How does Collaboration manage to reach the tips of the performance spidergraph?*

*What lessons for the rest of us?*
Three Kinds of Knowledge

- **Experiential** – what can I see, hear, feel, smell, or touch?
- **Narrative** – what can I say about it?
- **Abstract Symbolic** – what can I extract from it which is stable or durable?
Structuring Information

- Codified and Abstract
- Abstract Symbolic Knowledge
- Narrative Knowledge
- Uncodified and Concrete
- Experiential Knowledge
The I-Space: The Key Concept

Structuring Information

Codified and Abstract

Uncodified and Concrete

Abstract Symbolic

Narrative

Experiential

Undiffused Sharing Information Diffused
The I-Space: The Key Concept

- **Codified and Abstract**
- **Structuring Information**
- **Uncodified and Concrete**

**Bond Traders**

**Zen Buddhists**

**Sharing Information**

**Undiffused**

**Diffused**
The Paradox of Value

Scarcity

Codified and Abstract

Uncodified and Concrete

Maximum Value Region

Utility

Uncodified and Concrete

Undiffused Diffused

Scarcity
Codifying Knowledge

- You gain manipulability and predictability
- It behaves like an *object*
- You can store it
- You can write contracts
- You can sell it

*But:*
- You may lose contextual richness, feeling, and understanding
Lost for Words?
Institutions and Cultures in the I-Space

- Codified and Abstract
- Uncodified and Concrete

- Bureaucracies
- Markets
- Clans
- Fiefs
Institutions and Cultures in the I-Space

- Codified and Abstract
  - Bureaucracies
  - Markets
- Uncodified and Concrete
  - Fiefs
  - Clans
- Diffused
  - Complexity
  - Chaos

Order

Undiffused
The Impact of ICTs on the Diffusion Curve

- Codified
- Uncodified

- Diffused
- Undiffused

- Diffusion Effect
- Bandwidth Effect
Distributed Networks & Adhocracies: A New Hypothesis?

- Codified and Abstract
- Uncodified and Concrete

- Bureaucracies
- Clans
- Markets

The ATLAS Adhocracy?
Why Doesn’t ATLAS Fly Apart?

Order
- Bureaucracies

Complexity
- Clans

Chaos
- Markets
- Fiefs

Codified and Abstract
Uncodified and Concrete

Undiffused
Diffused
Traffic Lights as Hierarchical Coordination and Control
Hierarchical Control Can Get Complicated!
The Traffic Roundabout as a Boundary Object
The Detector as a Collection of Boundary Objects?
Distributed Networks & Adhocracies: The Role of Boundary Objects

- Codified and Abstract
- Undiffused
- The ATLAS Detector
- Bureaucracies

- Uncodified and Concrete
- Diffused
- Adhocracies
- Fiefs
- Clans
- Markets
Organization Structures vs Organization Ecologies

The NASA Matrix

The ATLAS/CERN Ecology
Some Hypotheses Concerning ATLAS:

• The ATLAS Collaboration has to navigate multiple stakeholder cultures, each operating with different cognitive and affective conditions.

• The ATLAS challenge is to manage a complex cultural ecology.

• The binding agents are trust based on shared values and shared interactions with a boundary object: the detector

Hypothesis:
The Detector thus acts as a boundary object that binds the cultural ecology into a complex adaptive system (CAS)
Figure 4. Locations of 65 Societies on Dimensions of Interpersonal Trust and Economic Development, by Cultural/Religious Tradition

Note: GNP per capita is measured by World Bank purchasing power parity estimates in 1995 U.S. dollars. Trust is correlated with GNP per capita at $r = .60$ ($p < .001$).
Some Hypotheses Concerning Glasgow

• The city is a complex adaptive system that sits at the so-called ‘edge of chaos’

• Its physical, social and institutional features act as a collection of boundary objects

• The ‘Glasgow effect’ suggests that the binding agents of trust, based on shared values and shared interactions with a boundary object, need further developing