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Nordic Institute for Studies in Innovation, Research and Education

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Knowledge dynamics of interdisciplinary research in science-based technologies

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Science-based technologies

- Term is used by Meyer-Krahmer and Schmoch (1998:836) based on Freeman (1982) and Pavitt (1984)
- Technologies with close links to the developments in scientific knowledge as well as the practical requirements of users
- Examples micro-electronics, biotechnology and nanotechnologies
- Development requires collaboration across disciplinary boundaries
- Challenge of “Big” interdisciplinarity

Aims of this paper

- To gain a better understanding of *how* different disciplines contribute to the development of new science-based technologies.
- To gain a better understanding of how people in different disciplines learn from each other while doing research
- To review the potential implications for research policy.

Methods

- Discourse analysis
- Review of literature on research practice
- Empirical cases

What do we know about interdisciplinary research collaboration?

- Theory
  - Projects initiated by OECD in the 1970s – produced models of interdisciplinary collaboration
  - The New Production of Knowledge 1994 – Mode 2

- Practice
  - Contributes to creative problem solving
  - Practice varies e.g. differing degrees of closeness in collaboration
  - Differing degrees of cognitive distance “big” interdsiciplinarity is particularly challenging
  - Klein’s Integrative model of interdisciplinary research practice

Gaps in our knowledge about interdisciplinary research

- We lack detailed descriptions of interdisciplinary practice, particularly “big” interdisciplinarity

- Limited understanding of how different disciplines contribute to interdisciplinary research projects

- Lack of knowledge on how ways of working might affect the process of knowledge creation?

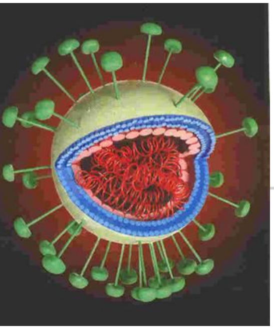
Case Design & Methods

- Cases selected where participants from different disciplines were working together to develop new science-based technologies.
- Longitudinal studies in the laboratory, data gathered via interviews and visits to the various sites and laboratories.
- Supplemented by available documentation.
- A socio-cultural approach is taken in the interpretation and analysis of empirical data.
- The concept of mediation was used both to identify and to interpret instances where people from different disciplines interact.

Cases

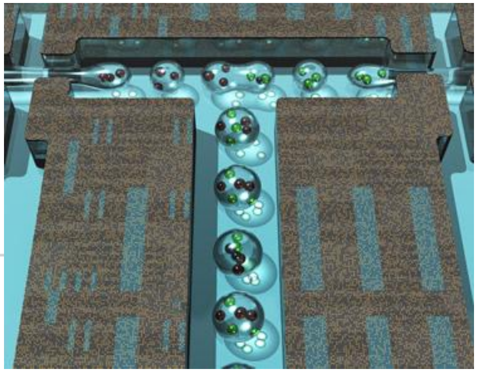
Making anti-viral nanomaterials

- R&D Project
  - 2 MNCs
  - 2 SMEs
  - 2 Universities
  - Regional funding body
  - Material engineers
  - Biologists



Making nanodroplets for more efficient testing in biology (microfluidics)

- Academic research laboratory
  - 9 nationalities
  - Biologists
  - Chemists
  - Physicists
  - Electro-engineers



How do the different disciplines contribute?

- Providing wider range of solutions to everyday problems.
- Making requests to the other discipline, thus stimulating a search for new solutions.
- Bringing in instruments from other fields.
- Influencing the research agenda.

How do the different disciplines contribute?

Influencing the research agenda

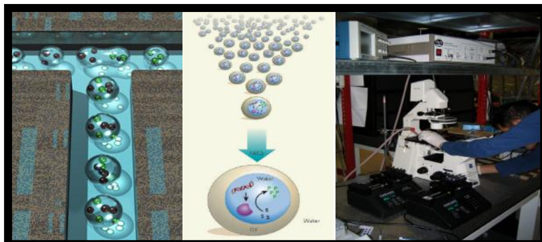
Stage 1	**Biologist's original object of enquiry**: To develop vaccines to protect against avian influenza *Becomes* ↓		**Material engineer's original object of enquiry**: To find a material that would prevent small viruses passing through face-masks *Becomes* ↓
Stage 2	**Common object of enquiry**: to make an anti-viral nanomaterial for use in a future avian influenza pandemic		

How do the different disciplines contribute?

By making instruments from other disciplines available & usable

Tool arrives from external domain →

Tool may be moved to new domain →



Used as designer intended

Used wrongly or differently
- New knowledge created
- Often tacit or situated

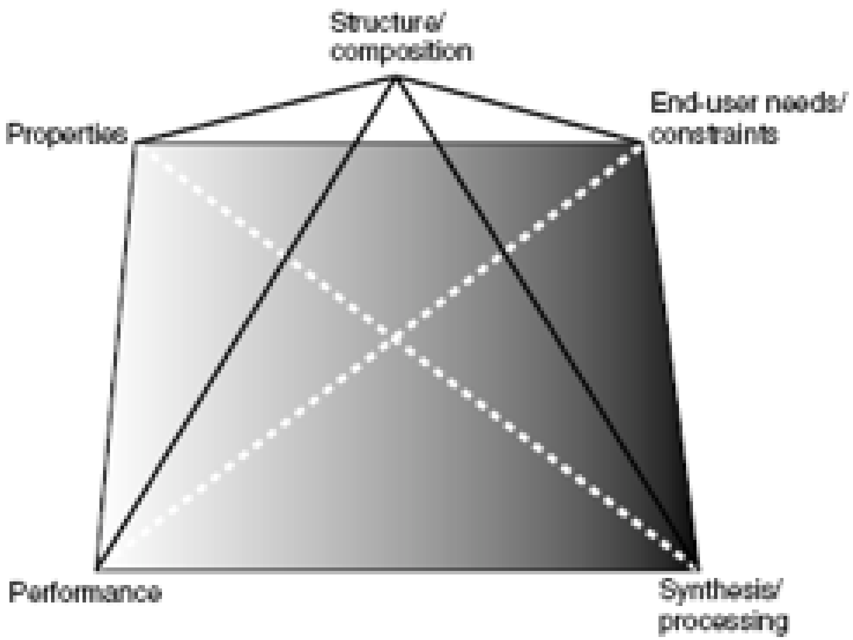
Deliberately Adapted
- New knowledge created
- Encapsulated for future use

<table>
<tr><th>Tool use</th><th>Example</th></tr>
<tr><td>Using wrongly</td><td>Putting fluid through a microchip</td></tr>
<tr><td>Using differently</td><td>Biologist changing fluid concentration and inadvertently finding a new way of making droplets coalesce</td></tr>
<tr><td rowspan="3">Adapting</td><td>Chemist working with new substances requires a higher throughput resulting in a new motor.</td></tr>
<tr><td>Biologist using smaller samples requires new optics.</td></tr>
<tr><td>Physicist attempting to solve a problem for biologists merging droplets. Designs a new chip, solves the problem and discovers new nanoparticles and a new way of producing them.</td></tr>
</table>

How do different disciplines learn from one another?

Example from cases	Process
Physical co-location, discussing work and developing a common object	1. Intertwined practice
Intertwined practice, shared tasks, working closely together	
Adapting tools and instruments from different disciplines	
Transferred practice based on codification and common conceptual tools	2. Short-cuts
Using conceptual tools to build bridges between concepts	
Relying on a trusted colleague or go-between	
Learning by using tools, based on knowledge being encapsulated in the tools	

Taking short-cuts
Use of conceptual tools to build bridges



- Conceptual model used by material engineers was expanded to include the concept of anti-viral

Taking short-cuts
Documenting ways of working

Activities / Phase in time	Designing device	Making device
Start up of the lab	Physicists	Physicists
Development phase	Physicists/Biologists	Physicists
Current established and documented practice	Biologists (with some advice from physicists)	Biologists

Implications for Research Policy

- Policy makers need to be aware that Interdisciplinary research collaboration may not result in disciplines learning from each other.
- In-depth knowledge of another field may be necessary and will require close contact over a period of time.(Intertwined practice)
  - Shared tasks, two people doing the work of one, mini-apprenticeship
- Various short-cuts may be used and could be deliberatly sought out.
- We should question how WEAK weak interdisciplinarity really is

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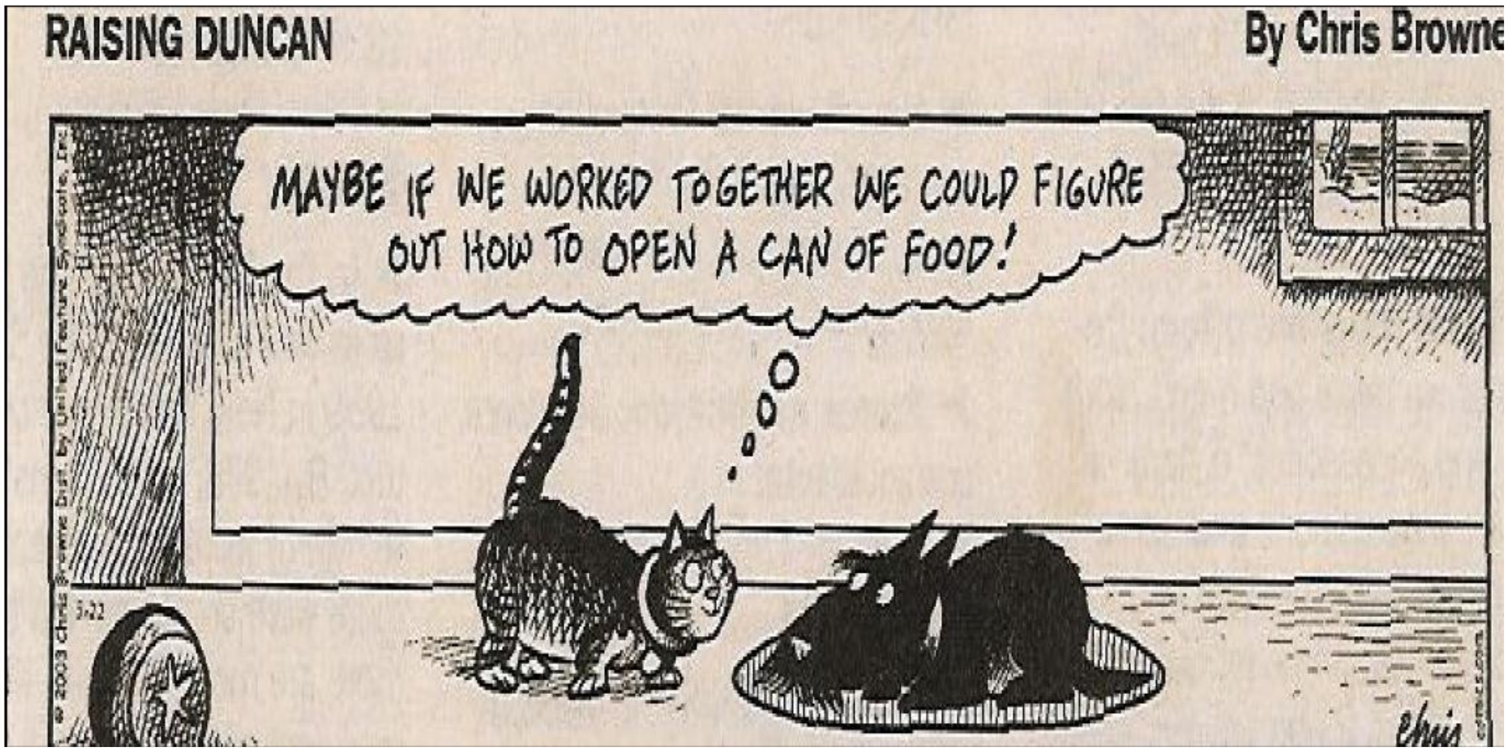
Based on idea that collaboration between disciplines enhances abilities and opportunities



….but is also misunderstandings