Categorizing a field:
The use of the nanotechnology label across communities

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Field Emergence

- A field is “those organizations that, in aggregate, constitute a recognized area of institutional life: key suppliers, resources, and product consumers, regulatory agencies, and other organizations that produce similar services or products” (DiMaggio and Powell, 1983)
- Recent research emphasize the role external audiences play in constructing organizational form (Hsu and Hannan 2005)
- Fields breed new fields (Davis 2006)
- Multiple communities interact in the construction of new fields (Rao 1994; Bijker et al. 1987)
- Communities are “a set of individuals and organizations that have the same or identical political, economic and social interests” (Arensberg 1954)
- An important aspect of field emergence is the construction of a category that identifies the field (Hannan, Polos and Carroll 2007)
Labels and Field Emergence

• Some studies have addressed the role of language in field categorization processes.
• Ruef (2000) shows how linguistic categories influence the emergence of new organizational forms.
• Studies do not address the genealogy of a label.
Language

- Language plays a central role in categorization processes (Vygotsky 1987)
- Categorization is socially negotiated (Berger and Luckman 1966)
- Categories emerge and exist in language communities (Becker 1982)
- Labels are a crucial element in the categorization process (Vygotsky 1987; Hsu and Hannan 2005)
Labels

• A label is “a term for categorizing a person, group, or organization on the basis of actual or perceived similarities” (OED 2006)

• One of the earliest events in meaning creation (Hannan et al. 2006)

• Enables categorization (Vygotsky 1987)

• The transfer of information (Glynn and Abzug 2002)

• Disparate groups to organize (Galison 1997)

• Foundation of a category (Hsu and Hannan 2005)
Linear Model of Commercialization

Science  ➔  Commerce  ➔  Service Providers  ➔  Government
• What are the mechanisms that drive the use of labels across communities in emerging fields?
Nanotechnology

• Nanotechnology was still emerging at the time of data collection which enabled real time data collection
• Nanotechnology label was novel and genealogy could be studied and traced
• Current definition of nanotechnology: Technological capability between 1 and 100 nm.
Analysis

- Hsu and Hannan (2005) call for “analyzing the perceptions and beliefs of actors through semantic analysis of archival documents”.
- Grounded theory (Glaser and Strauss 1967)
- A goal of the analysis was to identify social mechanisms that facilitated community use of a label (Hedström and Swedberg 1996a; 1996b)
Nanotechnology: Data Structure

- Ethnographic observations
- Interviews
- Archival data

Time: 1984 to 2000
Ethnography

• 25 conferences and networking events
• Took notes, recorded and transcribed presentations
• Identified speech communities (Labov 1972)
  – Scientists
    Concrete vision:
    Nanotech focused on chemistry, materials science, biotech, buckyballs and nanotubes
Ethnography

• 25 conferences and networking events
• Took notes, recorded and transcribed presentations
• Identified speech communities (Labov 1972)
  – Scientists
  – Companies

Concrete vision:
Creating commercial products
Ethnography

- 25 conferences and networking events
- Took notes, recorded and transcribed presentations
- Identified speech communities (Labov 1972)
  - Scientists
  - Companies
  - Futurists
Grand vision:
Microscopic nanobots
Ethnography

- 25 conferences and networking events
- Took notes, recorded and transcribed presentations
- Identified speech communities (Labov 1972)
  - Scientists
  - Companies
  - Futurists

Grand vision:
Microscopic nanobots
Ethnography

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Grand vision:
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  – Scientists
  – Companies
  – Futurists
  – Service Providers

Mixed vision:
Change the world +
make money
Ethnography

- 25 conferences and networking events
- Took notes, recorded and transcribed presentations
- Identified speech communities (Labov 1972)
  - Scientists
  - Companies
  - Futurists
  - Service Providers
  - Government

Mixed vision: Create economic growth
## Interviews

<table>
<thead>
<tr>
<th>Interviews</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Futurists</td>
<td>13</td>
</tr>
<tr>
<td>Government</td>
<td>11</td>
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<tr>
<td>Service providers</td>
<td>18</td>
</tr>
<tr>
<td>Companies</td>
<td>24</td>
</tr>
<tr>
<td>Scientists</td>
<td>11</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>77</strong></td>
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</table>
## Archival data

<table>
<thead>
<tr>
<th>Community</th>
<th>Source</th>
<th>Years</th>
<th>Nr. of articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Futurists</td>
<td>Newsletter</td>
<td>1987-2004</td>
<td>926</td>
</tr>
<tr>
<td>Government</td>
<td>Congressional hearings</td>
<td>1991-2005</td>
<td>925</td>
</tr>
<tr>
<td>Service providers</td>
<td>Business press</td>
<td>1984-2005</td>
<td>494</td>
</tr>
<tr>
<td>Companies</td>
<td>Press releases</td>
<td>1988-2005</td>
<td>4,085</td>
</tr>
<tr>
<td>Science</td>
<td>Journal “Science”</td>
<td>1956-2005</td>
<td>2,509</td>
</tr>
<tr>
<td>Newspapers</td>
<td>Top 50 US newspapers</td>
<td>1984-2005</td>
<td>3,763</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>12,774</strong></td>
<td></td>
</tr>
</tbody>
</table>
Articles referring to “nanotechnology”
Articles referring to “nanotechnology”
Articles referring to “nanotechnology”

% of Articles

Year

1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005

Futurists
Government
Brokers
Business
Science
## Overview of Findings

<table>
<thead>
<tr>
<th>Year</th>
<th>1984 - 2000</th>
<th>2000 - 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase</td>
<td>Mobilization</td>
<td>Institutionalization</td>
</tr>
<tr>
<td>Communities</td>
<td>Futurists, Government, Service providers</td>
<td>Government, Service providers, Companies, Scientists</td>
</tr>
<tr>
<td>Mechanism</td>
<td>Symbolic capital</td>
<td>Symbolic capital, Economic capital, Boundary pressure</td>
</tr>
<tr>
<td>Label use</td>
<td>Vision creation</td>
<td>Concretization</td>
</tr>
</tbody>
</table>
Mechanisms: Mobilization

- Symbolic capital facilitated label use
  - Symbolic capital is interpretative and defined by the community in which it is valued (Bourdieu 1991)
  - The five communities attached different symbolic capital to the label depending on the perceived alignment between the label’s symbolic structure and the communities language practices
  - The variance of symbolic capital across communities influenced their use of the label
Trends in Federal Research for Selected Disciplines

- Life Sciences
- Engineering
- Physical Sciences

Research Budgets – Billions of Constant Dollars

Year

# Mechanism: Symbolic Capital

<table>
<thead>
<tr>
<th>Community</th>
<th>Symbolic alignment w. label</th>
<th>Label use: Vision creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Futurists</td>
<td>Created label. Strong alignment with linguistic norms of constructing future visions</td>
<td>Yes</td>
</tr>
<tr>
<td>Government</td>
<td>Symbolic alignment with political discourse. Creation of political vision</td>
<td>Yes</td>
</tr>
<tr>
<td>Service providers</td>
<td>Alignment with their expert position, and visionary discourse</td>
<td>Yes</td>
</tr>
<tr>
<td>Companies</td>
<td>Discrepancy with focus on technological accuracy</td>
<td>No</td>
</tr>
<tr>
<td>Scientists</td>
<td>Discrepancy with scientific norms of purity in the language of science</td>
<td>No</td>
</tr>
</tbody>
</table>
Symbolic Reinforcement

Symbolic capital ➔ Community use

Reinforcement
## Institutionalization – Economic Capital

<table>
<thead>
<tr>
<th>Community</th>
<th>Economic capital</th>
<th>Label use:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Concretization</td>
</tr>
<tr>
<td>Futurists</td>
<td>Futurist tried to obtain funding but failed</td>
<td>Yes</td>
</tr>
<tr>
<td>Government</td>
<td>Influenced use within the agencies</td>
<td>Yes</td>
</tr>
<tr>
<td>Service providers</td>
<td>Service providers increasingly used the nanotechnology label to attract attention</td>
<td>Yes</td>
</tr>
<tr>
<td>Companies</td>
<td>Companies renamed their activities in order to secure funding</td>
<td>Yes</td>
</tr>
<tr>
<td>Scientists</td>
<td>Scientists renamed their activities in order to secure funding</td>
<td>Yes</td>
</tr>
</tbody>
</table>
I think [government funding] has just changed what people call it. I think we saw a lot of people change the name of what they are working on. Now they say that they work on nanotechnology and all that really happened is the scale that we pattern accurately decreased and people changed names around to get funding…..Instead of people getting a normal NSF grant they got an NSF grant that had nanotechnology in the title.
What's a nine-letter word for Nanotechnology?

CHEMISTRY

The American Chemical Society's Spring National Meeting will feature more than 1,000 presentations on Nanotechnology
The Economic and Symbolic Dynamic

Symbolic capital → Community use

Change

New Community use ← Economic capital
The Economic and Symbolic Dynamic

Symbolic capital $\rightarrow$ Community use

Change

New Community use $\leftarrow$ Economic capital
“Nanotechnology - using a combination of biology and computers to create microscopic "assembler robots" that could build a new car or maybe a new being” The San Francisco Chronicle, June 1989
"Nanotechnology - the science of creating things on a molecular level"

*Chicago Sun-Times, November 2005*
## Device, material and smallness

### Reference to the device, material and small category

<table>
<thead>
<tr>
<th></th>
<th>Dependent var:</th>
<th>Dependent var:</th>
<th>Dependent var:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Device</td>
<td>Material</td>
<td>Small</td>
</tr>
<tr>
<td>Intercept</td>
<td>373.9</td>
<td>-641.2</td>
<td>-103.8</td>
</tr>
<tr>
<td>Years</td>
<td>.83***</td>
<td>1.38***</td>
<td>1.06</td>
</tr>
<tr>
<td>N</td>
<td>147</td>
<td>147</td>
<td>147</td>
</tr>
</tbody>
</table>

*** p<.001
<table>
<thead>
<tr>
<th>Community</th>
<th>Symbolic alignment w. label</th>
<th>Label use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Futurists</td>
<td>Change in symbolic structure meant a discrepancy between the label and futurist’s discourse.</td>
<td>Diminishing</td>
</tr>
<tr>
<td>Government</td>
<td>Symbolic alignment with political discourse. Creation of political vision around concrete science</td>
<td>Yes</td>
</tr>
<tr>
<td>Service providers</td>
<td>Alignment with expert position of service providers. Service to companies around concrete vision</td>
<td>Yes</td>
</tr>
<tr>
<td>Companies</td>
<td>Change in symbolic structure meant a decrease in discrepancy with technological accuracy</td>
<td>Yes</td>
</tr>
<tr>
<td>Scientists</td>
<td>Change in symbolic structure meant a decrease in discrepancy with the language of science</td>
<td>Yes</td>
</tr>
</tbody>
</table>
## Boundary pressure

<table>
<thead>
<tr>
<th>Community</th>
<th>Boundary pressure</th>
<th>Label use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Futurists</td>
<td>Felt pressure from government and service providers to terminate label use</td>
<td>Diminishing</td>
</tr>
<tr>
<td>Government</td>
<td>Exerted pressure on companies and scientists to join and on futurist to terminate label use</td>
<td>Yes</td>
</tr>
<tr>
<td>Service providers</td>
<td>Exerted pressure on companies and scientists to use the label and for futurists to terminate label use</td>
<td>Yes</td>
</tr>
<tr>
<td>Companies</td>
<td>Felt pressure from government and service providers to use the label</td>
<td>Yes</td>
</tr>
<tr>
<td>Scientists</td>
<td>Felt pressure from government and service providers to use the label</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Old Model of Commercialization

Science → Commerce → Service Providers → Government

?
New Model of Field Creation

Science  →  Commerce  ←  Service Providers  ←  Government
Conclusion

- Field emergence is characterized by two stages: mobilization and institutionalization.
- During mobilization communities use labels due to the labels perceived symbolic capital.
- During institutionalization communities use labels due to both boundary pressure, symbolic and economic capital.
- The technological development and the linguistic development were initially decoupled. Emergence happened through labeling of technological activities.
Theoretical contribution

• External stakeholders began to use the label before commercial enterprises and contributed to the labeling of commercial enterprises

• Commercial enterprises and scientists started to use the label through renaming existing practices

• Field emergence is a *categorization process* fueled by *political contestation*
Questions