‘Don’t Change Something Unless It’s Broken’ – Stretching as an Interorganizational Practice in a Semiconductor Industry Network

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Technological development in interorganizational networks faces usually high degrees of uncertainty.

**Uncertainty in networks**
- Networks as...
  - ... omnipresent phenomenon
  - ... the locus of innovation (Powell et al. 1996)
- Uncertainty vs. risk (Knight 1921)

**Open issues**
- A network governance perspective cannot remedy everything (e.g. agreeing upon a joint agenda)
- Despite different interests and capabilities

**Guiding research question and managerial challenge**
How do interorganizational networks deal with extremely high levels of uncertainty when pursuing differing technological options in science-based industries?
Interorganizational networks and uncertainty: From governance to practices

• *Interorganizational networks* (Powell 1990)
  - three or more organizations
  - reflexive coordination on a repeated basis in time-space
  - key approach to face uncertainty: „network governance“ (Provan, Kenis 2008)

• *Uncertainty vs. risk* (Knight 1921)

• Managing firm-specific and market-level uncertainty by deepning and/or broadening network relations (Beckman et al. 2004)

• ‚*Practicing uncertainty‘* (Giddens 1984)
  Recurrent social activities by (in this case organizational) actors re: the monitoring/making sense of and actually coping with uncertainty

→ From dealing with uncertainty with the help of *network governance* to *network (management) practices* (Sydow et al. 2013)
We researched the ITRS*, a global network and roadmap by the same name, that coordinates the semiconductor industry

- **Founded** by the U.S. government, nowadays a global network with 32 member organizations and one consortium (SEMATECH)

- **Objective**: providing an arena for pre-competitive, joint research and development for CMOS and, nowadays, Beyond CMOS

- **Heterarchical** network, organized in Technological Working Groups (TWGs) and overseen by the International Roadmap Committee

- **Data collection and analysis in two consecutive projects**
  - field documents, semi-structured interviews (143, out of which 38 were exclusively devoted to Beyond CMOS, including panel interviews), and participant observation at conferences between 2001 and 2011)

*ITRS = International Technology Roadmap for Semiconductors.*
Stretching allows to „bridge“ technological paradigms

**CMOS**
- **Objective**: scaling
- **Innovativeness**: relatively low
- **Uncertainty**: high
- **Composition of the org. field**: known

**Beyond CMOS**
- **Objective**: alternative approaches
- **Innovativeness**: extremely high
- **Uncertainty**: high
- **Composition of the org. field**: unknown

**Stretching practice**
Recurrent activities that aim to transfer a common way of dealing with the uncertainties of an existing (in our case: technological) paradigm to an as yet unknown (technological) paradigm.

Stretching practices represent an activity that allows for adaptation and transformation at the same time.
Development of technological options over time

Legend:
EUV = Extreme Ultraviolet Lithography
RF = Radio Frequency
HV = High Voltage
QCA = Quantum Cellular Automata

193 nm Optical Lithography & Enhancements
EUV Lithography & Enhancements

CMOS paradigm
- PXL
- EPL
- PEL
- IPL

Beyond CMOS paradigm
- Carbon-based Nano-electronics
- Molecular Devices
- Spin-state Transistors
- Capacitance-based Memory
- Resistance-based Memory

Unconventional/Non-standard CMOS
Evolution of technological working groups over time

- Assembly and Packaging
- Modeling and Simulation
- Metrology
- Defect Reduction
- Lithography
- ORTC
- Factory Integration
- Interconnect
- Front End Processes
- Process Integration, Devices & Structures
- Design
- Design and System Drivers
- Design and System Drivers - Technology Pacing Session
- Design and System Drivers - More than Moore Session
- Test
- Test and Test Equipment
- Environment, Safety and Health
- Emerging Research Devices
- Emerging Research Materials
- Timing and Chip Size
- Yield Enhancement
- RF and AMS Technologies for Wireless Communication
- Nano CMOS
- IRC Rollout
- SSI
- The Future of Innovation
- Macro-Trends facing the Semiconductor Industry
- More than Moore
- MEMS


- = CMOS  - = Beyond CMOS  - = Others*  

* Not geared towards any specific existing or alternative technological paradigm and only ephemeral TWGs.
The stretching practice differs according to the technological uncertainty targeted.

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**Identified key stretching practice: Roadmapping <-> FCE**

- **CMOS activities**
  - regular meetings
  - optimizing supply chains
  - reducing tech. uncertainty

- **Beyond CMOS activities**
  - introducing new 'Chapters'
  - modifying the roadmap in meetings
  - inducing uncertainty (e.g. new partners)
An initial framework for collaborative stretching practices for facing uncertainty on the whole network level

Exploring an existing technological path

- **Strategic focus**: exploration of existing technological paths
- **Encountered uncertainty**: technology-related
- **Reproduction** of a practice

Exploring unchartered technological landscapes

- **Strategic focus**: exploration of unchartered technological landscapes
- **Encountered uncertainty**:
  - technology-
  - partner- and
  - procedure-related
- **Transformation/adaption** of a practice
Contributions

- **Managing uncertainty** on a *(whole) network level* (Provan et al. 2007)

- Identifying *consensus-driven arenas / interorganizational practices* (e.g. jointly defining future technological milestones) vis-a-vis hierarchical settings

- More nuanced, process-based understanding of *uncertainty* (Knight 1921)
  - not only *technological* uncertainty, but also...
  - *partner and procedural* uncertainty

- **Stretching** as a key *practice* to...
  - ...*reduce* and in parallel
  - ...*induce* uncertainty *(despite the risk to overstretch!)*