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Information Technology-based Change in the Automotive Sector

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Introduction

- **Accelerated technological progress of information technology and computer science**
- **Pace of IT-driven innovations in the whole economy has increased significantly**
- **Mainly driven by players from the IT industry**

  e.g.: Google, Amazon, Apple, Facebook, Microsoft, etc.
- **Grown transformative impact of IT in several industries ➔ technology-based sectoral change**
- **Transformative impact of information technologies on sectoral change in the automotive sector?**

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Concept of Technology-based Sectoral Change

Socio-technical transformation – two factors:

Transformative capacity of a new technology

e. transformative impact on technological profile, knowledge base, innovation, production, market mechanisms, competition

interrelated

Sectoral change

anticipation and absorption of technology-driven pressure, institutional adjustments

Sectoral adaptability

Dolata (2008, 2011a,b)

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Concept: Transformative Capacity of Technology

Transformative capacity of IT and Internet technologies?

Sectoral change

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Transformative Impact of IT in the Automotive Sector: 2000s

2000s:

➔ **IT = mainly supportive technology:** used to reorganize procurement and logistic processes along the value chain and to improve WWW-representation, stepwise introduction

➔ **Automotive industry = highly innovative industry** used to deal with new technologies

➔ **Long history of IT-based innovations in automotive technology** (starting with electronic anti-lock braking systems, digital fuel injection systems)

➔ **Low transformative impact of IT**

➔ **High adaptability of the automotive industry**

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Transformative Impact of IT in the Automotive Sector: Today (1)

And today?

- Driver-less cars and driver assistance systems
- Electric vehicles / e-mobility
- Smartphone and multimedia applications
- Connected cars / internet of things
- Big data and cloud applications etc.

➔ **Just new applications for ‚old' technologies?**

or

➔ **Grown transformative capacity of information technologies?**

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The Example of Driver-less Cars

- **Long history of driver assistance systems**
  (first tests of robotic cars on European public streets in 1994)

  ➔ **Still high adaptability of automotive industry?**

- **Transformative capacity seems to be obvious**
  ➔ core concept of the car is put into question
  (today: driver replaced; 10 years ago: driving cannot be automated)

- **2009: Google starts development of driver-less cars**
  2010: first cars on the street
  2014: prototype without steering wheel and brake pedals

  2015: Apple and Uber reported to develop own cars

  ➔ **Google leapfrogged the automotive industry**

Transformative Impact of IT in the Automotive Sector: Today (2)

And today? Driverless cars are but one example:

- Driver-less cars and driver assistance systems
- Electric vehicles / e-mobility
- Smartphone and multimedia applications
- Connected cars / internet of things
- Big data and cloud applications etc.

From 2000 to 2015:

Why and how did the transformative capacity of information technologies change?

Two Theses

1. Automotive IT has changed from a technology with low transformative capacity to a technology with high transformative capacity

2. The automotive industry tries to adapt to the technology-based pressure, but its sectoral structures and institutions threaten to limit the industry's adaptability.

Thesis 1: High Transformative Capacity

1. Automotive IT has changed from a technology with low transformative capacity to a technology with high transformative capacity

Three arguments:

- ➔ Grown technical capabilities
- ➔ Cumulative effects in the use of IT
- ➔ Effects of technology pull and technology push

➔ Significantly grown transformative impact of IT

High Transformative Capacity (1): Grown Technical Capabilities

- **Moore's Law: exponential growth of capabilities of electronic components**
  dramatic improvements with regard to microchip density, processing speed, storage capacity, energy efficiency, download speed, sensor capabilities, rate of pixels per dollar etcetera
- **Advances in computer science and software design** (e.g., artificial intelligence, programming etc.)
- **Increasing capabilities to digitize and analyze a rising body of information and data** (→ Big Data)
- **Transformative impact of information technology has already grown due to its grown technical capabilities**

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High Transformative Capacity (2): Cumulative Effects

- **Growing amount of automotive software, increasing proportion of value added**
- **Complexity of automotive IT infrastructure has grown significantly**
  ➔ Automobile manufacturers increasingly depend on IT expertise
- **Product differentiation via software**
  ➔ More and more functions are (re-)programmable
- **More and more data-based functions**
  ➔ Opens creative leeways for new product concepts and new players
- **Cumulative effects / network effects on established sectoral structures and value chains**

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High Transformative Capacity (3): Technology Pull and Push

- **Automotive technology pull: new IT-based features / functions, <u>product differentiation by software</u>**
- **IT Technology push:**
  - **Co-development: IT companies try to create demand for new IT products / technologies in the automotive industry** (e.g. Big Data)
  - **IT companies (e.g., Google, Apple) try to extend their business models to automotive sector**
    - ➔ to tie the car and its owner to their ecosystem
    - ➔ to access growing amount of data in the car
- **Automotive sector: increasing pressure to adapt, impending loss of technological leadership**

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High Transformative Capacity (4): High Transformative Impact

Techn. progress – cumulative effects – techn. pull & push

These factors are changing

- **technological profile of the sector**
  - → pressure to adapt
- **requirements in research and development**
- **market conditions**
  - → new players appear on the scene
- **legal adjustments are discussed**
  - (e.g.: driverless cars, electric vehicles, big data, etc.)

Transformative impact of IT technologies seems to have grown significantly

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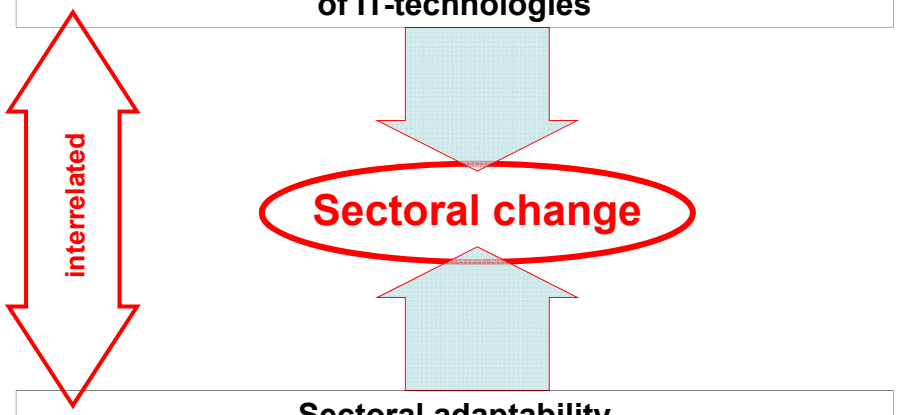
Concept of Technology-based Sectoral Change



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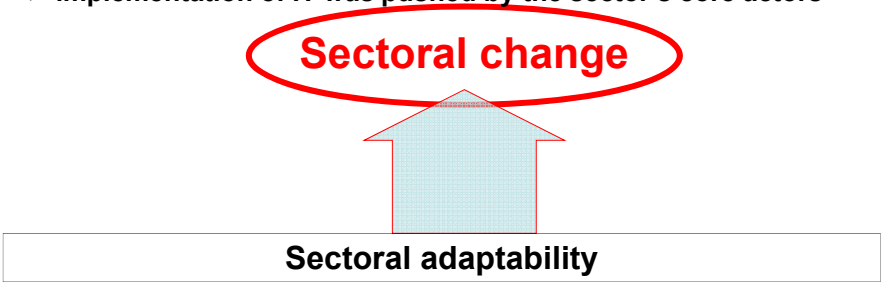
Concept: Sectoral adaptability

Automotive industry in the 2000s: very adaptable

Three reasons:

- **high pressure to innovate → openness and receptiveness**
- **IT technologies were not fundamentally changing the sector's products and markets**
- **implementation of IT was pushed by the sector's core actors**



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Limits of Sectoral Adaptability: Product Architecture (1)

Sectoral adaptability: openness and receptiveness

i.e. function of sectoral institutions and structures

Automotive product architecture

(product architecture = core institution of the sector)

- ➔ **Electro-mechanical product architecture, grown over a 100 years, consisting of great number of different modules and components around the different electro-mechanical functions**
- ➔ **Automotive IT architecture evolved within electro-mechanical product architecture (➔ similarly fragmented)**
- ➔ **Corresponding with product architecture ("Conway's Law"):**
  - ➢ **organizational and economic structures**
  - ➢ **organization of technological knowledge & experience**

➔IT product innovations affect automotive product architecture

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Limits of Sectoral Adaptability: Product Architecture (2)

Increasing importance of software for product performance and quality

- ➔ **Increasing efforts and expenditures to develop automotive IT**
- ➔ **Growing pressure for cross-company standard products provided by IT-companies**
- ➔ **Turning the car into new hardware?** (= following the PC-story?)

Internet- / Information technologies used for major product innovations (➔ increasing connectivity)

(e.g., infotainment and interface to smart phones, connected cars, big data-applications and cloud technologies)

- ➔ **Fragmented automotive IT architecture: complex and interconnected functions very costly to integrate**

➔ Competence for complex integrated IT systems: IT industry

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Limits of Sectoral Adaptability: Product Architecture (3)

Trend to autonomous driving is replacing driver as operator / controller of the car

- ➔ **Autonomous driving requires a central controller and a central operating system**
- ➔ **Fragmented automotive IT architecture: no OS today, comprehensive functions only inadequately supported**
- ➔ **Competence for operating systems:**
  - **Google (Android in the Car, now: Projected Mode)**
  - **Apple (iOS in the Car, now: Carplay)**
  - **Microsoft (Windows for Cars) etc.**

Limits of Sectoral Adaptability: Product Architecture (3)

Digitization opens up new technological possibilities

but cognition of new technological concepts may be constrained by sectoral development path

(i.e. routines, practices, policies, ways of thinking etc. around electro-mechanical paradigm)

- ➔ **e.g., security and 'drive by wire' vs. 'fly by wire'**
- ➔ **e.g., update-ability of cars over life-cycle:**

  automotive OEM: "too complex task" because of fragmented automotive IT architecture

  Tesla: Model S regularly receives over-the-air software updates that add new features and new functionality

  ➔ **new technological concept seen as impossible at OEM**

  ➔ **OEM vs. Tesla: technological / architectural / organizational differences**

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Limits of Sectoral Adaptability: Competitive Differences

Differences between sectoral innovation systems:

- ➔ **innovation cycles** (e.g. product time to market → how to keep up with IT industry?)
- ➔ **development methods** (e.g. consecutive vs. agile methods),
- ➔ **development approach** (e.g. self-driving cars: data-driven vs. hardware-oriented approach: what can be done in software?)
- ➔ **development strategy** (e.g. self-driving cars: radical vs. stepwise development)

Different business strategies (e.g., self-driving cars):

- ➔ **Automobile industry: focus on traditional customer ("joy of driving") → driver assistance; incremental approach: development of new product features, increasing car automation**
- ➔ **Internet / IT companies as new entrants in the market: need full car autonomy to sell content to former car drivers**

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Conclusion (1): Transformative Pressure

- ➢ **Automotive industry facing growing transformative pressure from information technologies**
- ➢ **Information technologies / digitization open up new technological opportunities**
  - ➔ **Product differentiation by software instead of hardware** (e.g., programmed engine performance → Renault Twizy)
  - ➔ **All automotive companies develop new IT-based products and services**
  - ➔ **Increasing complexity of automotive IT**
  - ➔ **Mastery of complex automotive software becomes important competitive factor**

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Conclusion (2): Limited Adaptability

Automotive industry tries to adapt to IT-based pressure …

… but sectoral structures and institutions threaten to limit the industry's adaptability

High time pressure / innovation pressure to speed up product development

- ➔ **many reason to cooperate with IT companies**
  But: "Sometimes it's already difficult to correspond on eye level." (Automotive manager)
- ➔ **at the same time IT companies squeeze into the market**

Limited sectoral adaptability opens up leeway for IT companies to expand their business strategies to the automotive sector

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Conclusion (3): Automotive Business Models

Open questions:
What are the business models of the future?

- Increasing product differentiation by software:
  large portion of profits will come from software
  ➔ **Who develops / controls / owns the software?**
- Increasing dependence on software
  ➔ **Will the car become exchangeable hardware?**
- Increasing data availability will enable new services
  ➔ **Who owns and who will monetize the data? And how?**
  ➔ **Who controls the car / the driver / the customer?**

➔ **Will the automotive OEMs be selling cars or will they be selling mobility services?**

➔ **OEMs may have to change their business models**

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Conclusion (4): IT Business Models

The IT companies' future automotive business models are not clear today

- ➔ **depends also on IT strategies of automotive companies**

Google is selling internet services and not cars (today)
Google's interests: the driver as a user, the data available in and from the car etcetera.

➔ So: still different business interests – no problem?

The point to make: Google's and Tesla's cars are not just cars, but software products

Google, Tesla et al. are acting as IT companies with much higher flexibility and without the electro-mechanical heritage of the automotive industry

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