Scientific Theory in Informatics A1N

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Lecture 15

Digital Innovation

(innovation concepts and theories, software innovation, digital innovation)

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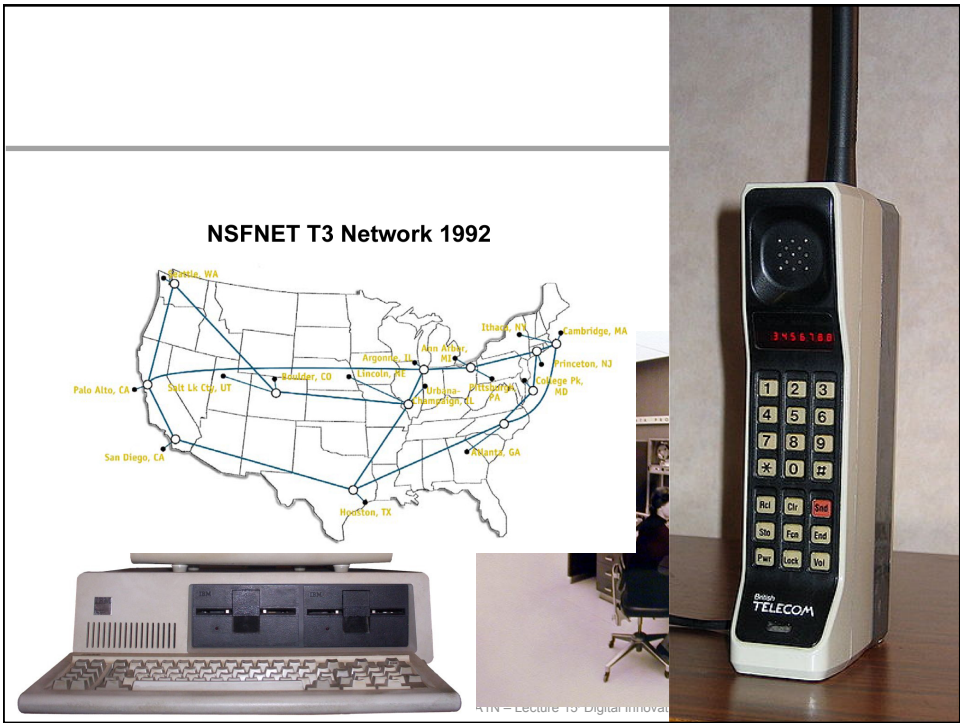
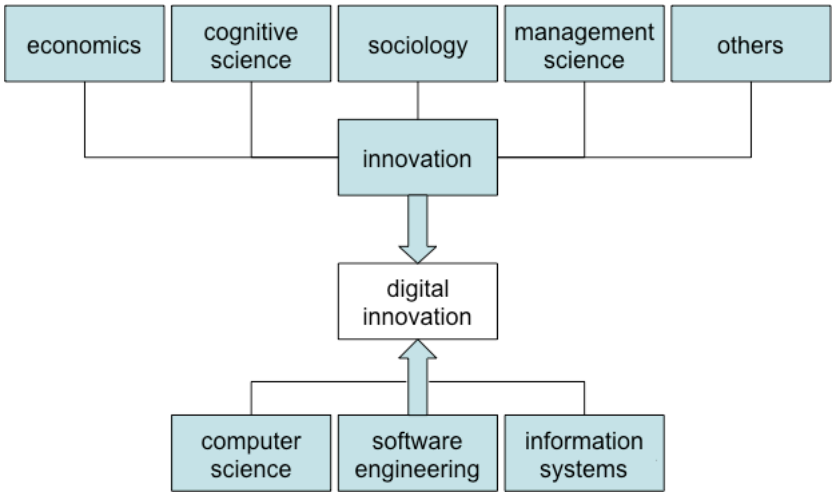


Digital innovation: discipline background



Digital innovation: lecture structure

- Historical foundations of IS: organisation, management
- Contemporary theme and good bet for the future: innovation
  - No unified framework or commonly agreed research agenda
- Part 1: innovation: concepts and theories
  - Various sources (mostly explained in the book see below)
- Part 2: software innovation (how to produce innovative software)
  - Rose, J. (2010) *Software Innovation: eight work-style heuristics for creative software developers*. Software Innovation, Dept. of Computer Science, Aalborg University, Aalborg.
  - Rose, J., Jones, M. & Furneaux, B. (accepted) An Integrated Model of Innovation Drivers for Smaller Software Firms. *Information & Management*.
- Party 3: digital innovation (how software innovations help to change organizations and society)
  - Various sources

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Part 1: innovation: concepts and theories

Basic terms

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- invention – the creation of something new (such as a new algorithm, program or software development technique)
- creativity – a state of mind which leads to innovative thinking
- innovation - creative act and invention carried into wider use, leading to substantial kinds of change; thus the successful exploitation of new idea

Innovation overview

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- (digital) innovation = invention + exploitation + diffusion
  - invention: the creative act or process and its result (e.g. a software program)
  - exploitation: commercial development and adaptation to practical situations
  - diffusion: adoption by a wider audience

(digital) innovation: consequences

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- installed base = starting point
- result of digital innovation is experienced as change in
  - the way people work
  - the way business is carried out
  - people's choice of entertainment
  - communication habits and interaction
  - governance of communities
- types of (digital) innovation
  - radical
  - incremental
- innovation is not simply a good
- all change involves winners and losers
- may provoke resistance

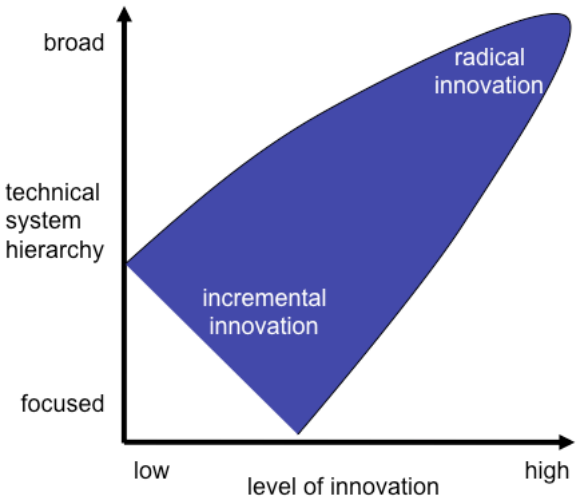
(high-tech) innovation: the motor of the economy (Schumpeter)

- new products
- new methods of production
- new sources of supply
- the exploitation of new markets
- new ways to organise business
- meets resistance (inertia) from established players
- driven by the entrepreneurial function

Innovation: product and process

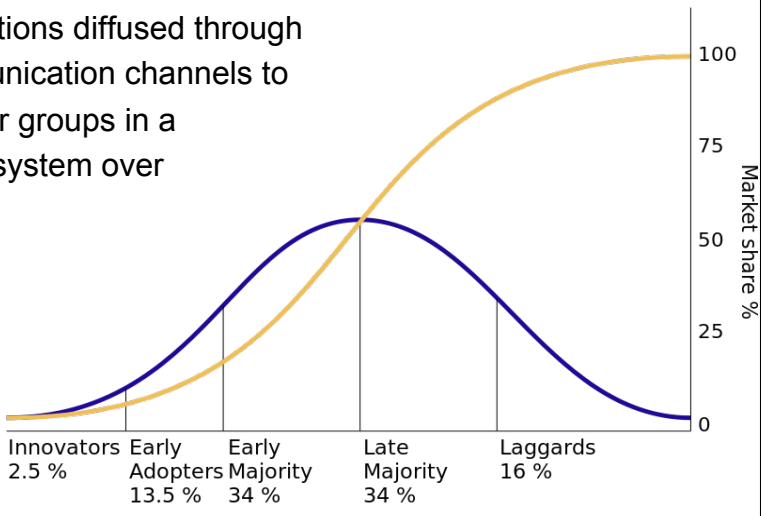
- (software/digital) product innovation – (the creation of novel and useful software programs)
- (software/digital) process innovation – (the introduction of novel and useful ways of developing software)

Radical and incremental innovation (after Altshuller)



Diffusion of innovation (Rogers)

- Innovations diffused through
- communication channels to
- adopter groups in a
- social system over
- time



Sociology of science: actor-network theory (Callon, Latour)

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- Descriptive theory of (innovation in) science
- Actant, actor-network, assemblage, inscription, black box, irreversibility
- Translation (Callon):
  - Problematisation: defines the problem or opportunity with which an actor proposes a solution. Defining the proposed solution acts as the obligatory passage point;
  - Interessement: attracts other actors in the proposed solution to favour a new opportunity which confirms the problematisation phase.
  - Enrolment: a negotiation process to exhibits how the interessement meets the actors' interests and needs and persuades them to accept the new actor-network.
  - Mobilisation: an important process which ensures that actors represent other actors' interests.
- Example: Latour's description of the development of the diesel engine in Science in Action

Disruptive innovation (Christensen)

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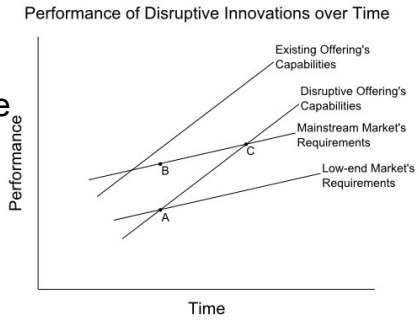
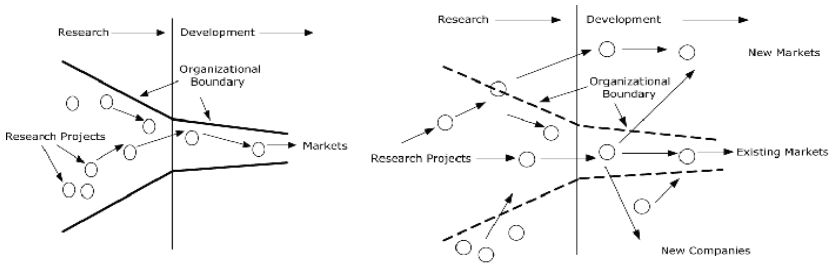
- Sustaining v. disruptive innovations
- Well-managed companies produce sustaining innovations but new entrants capitalise on disruptive ones
- Disruptive technologies locate components with low end performance in new value networks to create new markets
- Established companies ignore disruptive innovations because the markets are small – can't compete with the first movers
- Disk drive example



Open Innovation (Chesbrough)

- not all the smart people work for us; work with smart people inside and outside our company
- external R&D can create significant value; internal R&D is needed to claim some portion of that value
- we don't have to originate the research to profit from it
- building a better business model is better than getting to market first
- if we make the best use of internal and external ideas, we will win
- profit from others' use of our intellectual properties, buy others' intellectual properties whenever it advances our own business model



Closed Innovation | Open Innovation

Concepts and theories summary

- Invention, creativity, innovation
- Invention + exploitation + diffusion
- Digital innovation as change in social systems
- Economic theories of innovation
- Product and process
- Radical and incremental innovation
- Diffusion of innovation
- ANT: sociology of science
- Disruptive innovation
- Open innovation

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Part 2: software innovation

(how to produce innovative software)

Software innovation

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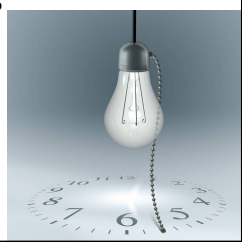
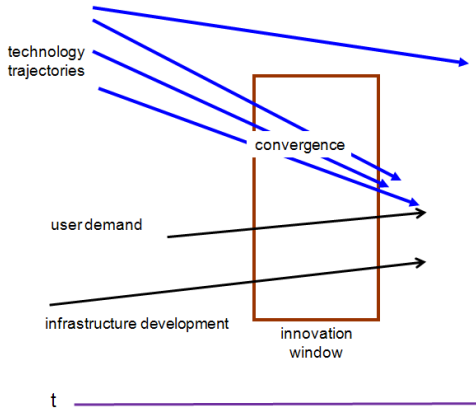
- Software trajectories and innovation windows
- Knowledge communities and innovation
- The innovative software product
- Innovative software processes
- Creativity in the software developer
- The innovative software team
- Innovation toolboxes: tools and techniques
- Innovation assessment and evaluation



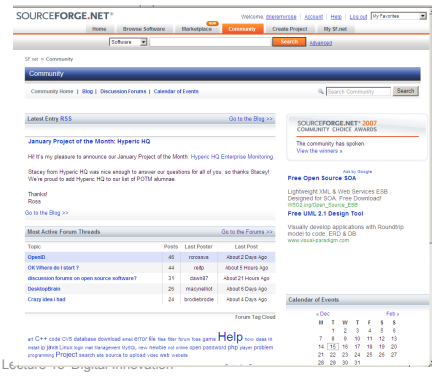
Software trajectories and innovation windows

- market and technology trajectories
- hardware and software convergence
- market (user demand)
- infrastructure development
- innovation windows



Knowledge communities and innovation

- knowledge production: absorptive capacity
- innovation networks: theory
- crowd-sourcing
- open innovation
- open source community



The innovative software product

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- invention v. innovation
- novelty and utility
- consequence = social change
- incremental v. radical
- utility forms
  - computing infrastructural
  - technology enabling
  - user service
  - business change enabling
  - interaction/communication
  - entertainment
- innovation profile

innovation profile:

- novelty
- utility
- user community
- social change
- market
- technical innovation
- infrastructure dependence

The innovative software process

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- agility: necessary, not sufficient
- market-led and technology-led software innovation
- blue ocean – innovating on industry standards
- improvisation, bricolage
- six innovation process strategies
  - creative requirements analysis
  - designed process framework
  - low-tech prototyping
  - user-driven innovation
  - community development
  - research prototype

The creative software developer

- the developer's mental process: recognising and exploiting discovery points
- a set of personal development competences concerned with both solving problems and recognising opportunities
- a style of thinking associated with different strengths in individual's development personalities
- meta-thinking: recognising predispositions and tendencies in one's own (and others') thinking and coming beyond them
- whole-brain thinking: beyond rationality
- a relationship between the individual developer and communities of people and ideas (domain, field)
- a state of mind: the way the developer's mind is disposed when being creative (flow)
- a universal mental skill to be enhanced

The innovative software team

- negative:
  - creativity barriers
  - group dysfunction
- positive:
  - innovation team roles
  - innovation team interaction
  - team learning
  - innovative social patterns
    - accommodation of divergent thinking
    - expertise integration
    - overview, vision, common purpose, shared learning
    - environmental scanning

Tools and techniques for innovative development

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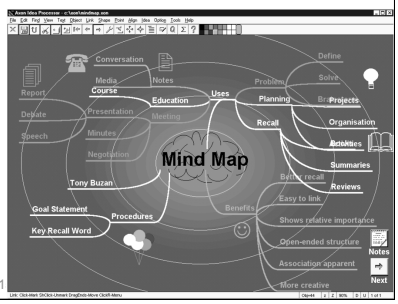
- creativity techniques
- tools for:
  - support for escaping routine work
  - sandbox tools
  - knowledge tools
  - collaboration tools
  - visualization and overview support
  - creativity technique support

- repertoire
- situational choice



Evaluating software innovation

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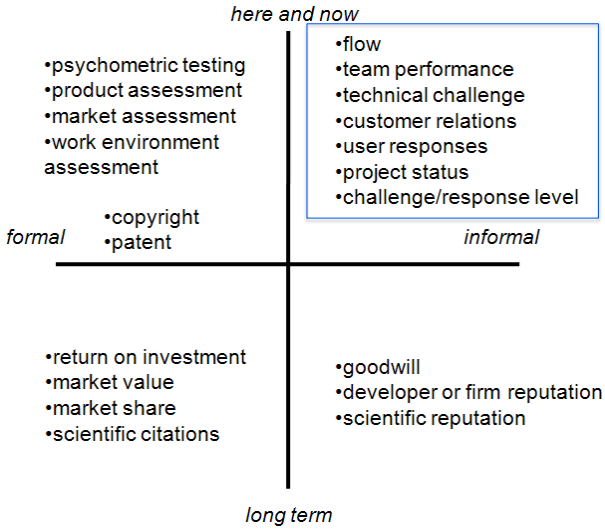

Software innovation summary

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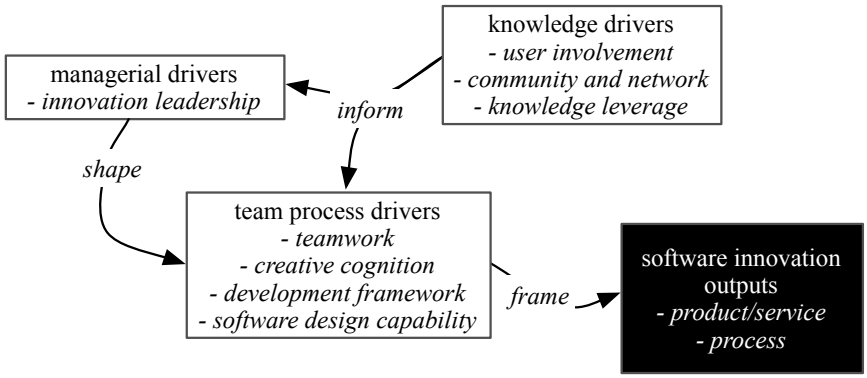


Part 3: digital innovation

(how software innovations help to change organizations and society)

Digital Innovation: some themes

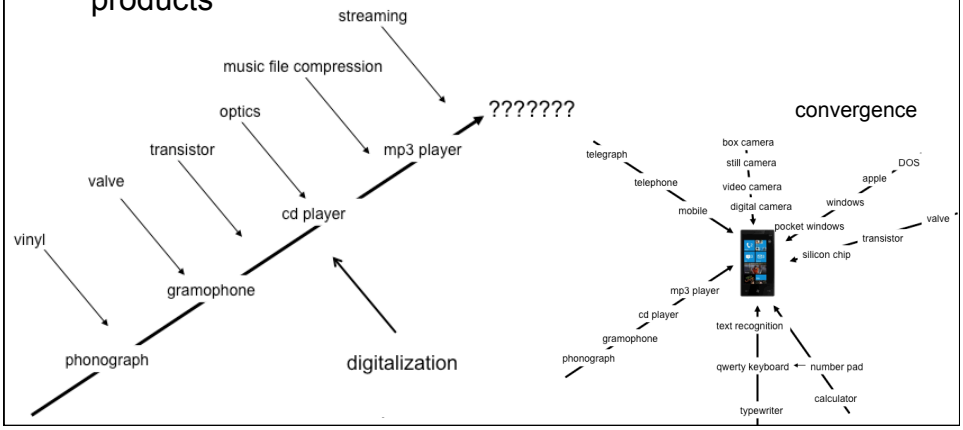
- Sociology of science: technological determinism, social shaping, mutually constitutive models
- Digitalisation as innovation
- Digital artifacts and their characteristics
- Digital artifact characteristics and openness
- Generative capability for digital innovation
- Digital ecosystems – the new innovation landscape
- Digital architectures for the digital ecosystem
- A transformational model of digital innovation

Sociology of science background (hugely simplified)

- Hypothesis - technological determinism: the structure and culture of society is decided by the technologies it develops
  - To paraphrase Marx ('the windmill gives you society with the feudal lord: the steam-mill, society with the industrial capitalist'): the spear makes a hunter gatherer society, the plough an agrarian society, the steam engine an industrial society and the computer a knowledge society
- Antithesis - social shaping (ANT, social construction of technology (Bijker)): the structures and culture of society are inscribed into the technologies it develops, technology is a reflection of society
- Synthesis - socio-materialism: the social and the material are entangled together and can't be separated, technology both shapes and is shaped by society
- Digital innovation: digital artefacts (see next slide) shape and are shaped by social groups (team, organisation, society) in complex ways (which can't completely be unravelled) to produce change – some change is significant enough to be called innovation

Digitalisation as innovation

- The conversion of a non-digital artefact to a digital one - possible with anything that can be represented as information – the inclusion of digital artefacts in physical products



Digital artefacts and their characteristics

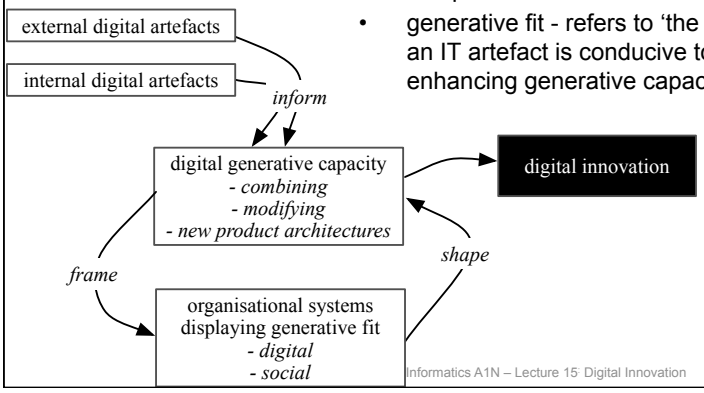
- Composed of bit-sequences
  - e.g: emails, blogs, picture, videos, apps, software, operating systems, digital platforms
- Characteristics which are different from those of physical products, including
  - *device versatility* – many different bearer machines (hardware) that can store and execute them
  - *deep homogeneity* – through common representation: 'bitstrings all the way down' (Yoo, Henfridsson et al. 2010)
  - *recombinability* (Quah 2003) - can be combined and modularised in different ways
  - *modifiability* (Kallinikos, Aaltonen et al. 2013) - can easily be changed or reprogrammed
  - *self-referentiality* (Yoo, Henfridsson et al. 2010) - created and modified by other digital objects
  - *non-rivalry* - can be used by many simultaneously without degrading their value
  - *expansibility* - can be reproduced infinitely many times with minimal cost
  - *non-excludability* - difficult for the creators of a digital object to prevent others using it (Quah 2003)
  - *spreadability* (Jenkins, Ford et al. 2013) - disseminate easily, leading to network effects (such as increase in value with wide use), and skewed outcomes (disproportionate returns for the minority of digital products that achieve a broad uptake).
- Tight or loose (but dependent) relationship with many varied kinds of hardware (bearer machines)

Digital artefact characteristics and openness

- Digital characteristics enable, facilitate openness, e.g:
- Open source and innovation
  - New innovation model: private collective model (von Hippel and von Krogh)
  - Virtual communities, incremental development models, code sharing
- Open source and proprietary software development now integrated (e.g. Google android)
- Variety of open source licenses
- New business models

Generative capability for digital innovation

- generative capacity and fit (Avital and Te'eni, 2008)
  - generative capacity refers to 'the ability to produce something ingenious, or at least new in a particular context'
  - generative fit - refers to 'the extent to which an IT artefact is conducive to evoking and enhancing generative capacity'



Digital ecosystems – the new innovation landscape

- 'a distributed, adaptive, open socio-technical system with properties of self-organisation, scalability and sustainability inspired by natural ecosystems´ Wikipedia
- Describes the multiple inter-connectedness of digital artefacts, bearer devices (hardware) and their producers and consumers
  - For example - blog, email, social network, app, software program, operating system, network, internet, software platform, multiple devices
- Example: digital platform (iOS, iStore), multiple apps from multiple independent developers, low entry costs, multiple incremental innovations, few winners ('killer' apps) – innovation dependent on crowding effects not single heroic innovator (Boudreau, 2012)

Digital architectures for the digital ecosystem

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- New product architectures, value networks
- Loosely coupled layers of devices, networks, services, and contents
- Serve as a platform in one layer, and a component in another
- Example: eBook (Kindle, Amazon, .epub standard, self-publishing (Lulu), iPad)

MODULAR ARCHITECTURE

- Fixed product boundary and meaning
- Loose coupling between components through standardized interfaces
- Components nested in a single design hierarchy
- Product-specific components
- Components designed and produced by firms sharing product-specific knowledge

Low ← Reprogrammability, Homogenization of data, Self-reference → High

LAYERED MODULAR ARCHITECTURE

- Fluid product boundary and meanings
- Loose coupling between components through standardized interfaces
- Heterogeneous layers following multiple design hierarchies
- Product-agnostic components
- Layer are coupled through standards and protocols shared by heterogeneous firms

Yoo, Henfridsson + Lyytinen, 2010

A transformational model of digital innovation