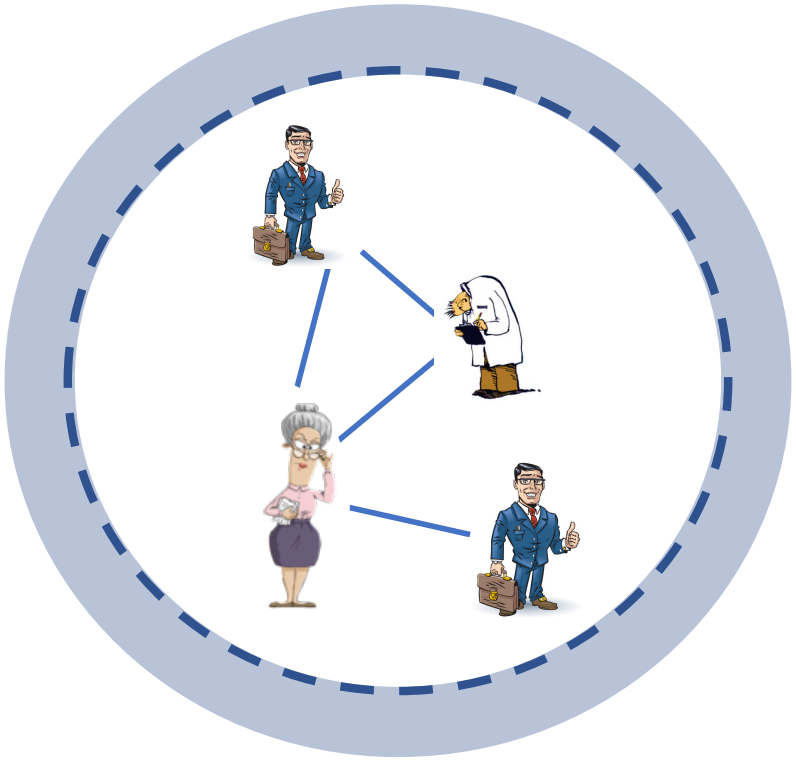
Systems of innovation and university-industry interaction



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Agenda

- Systems perspectives on innovation
  - System structure and functions
  - Technological systems of innovation
  - An example from marine energy
- University-industry interaction
  - Forms and principles for interaction
  - Relational conditions
  - An example from nanotechnology catalysis

Why should I care?

Helps you to understand your context and factors conditioning your future work

- Strategic analysis of the context of the firm
- Evaluating potential collaborative efforts and partners
- Identify obstacles for innovation, development and diffusion, and points of action

System perspectives on innovation

I wish innovation was like this…

"complex, uncertain, somewhat disorderly, and subject to changes of many sorts"

Kline and Rosenberg, 1986

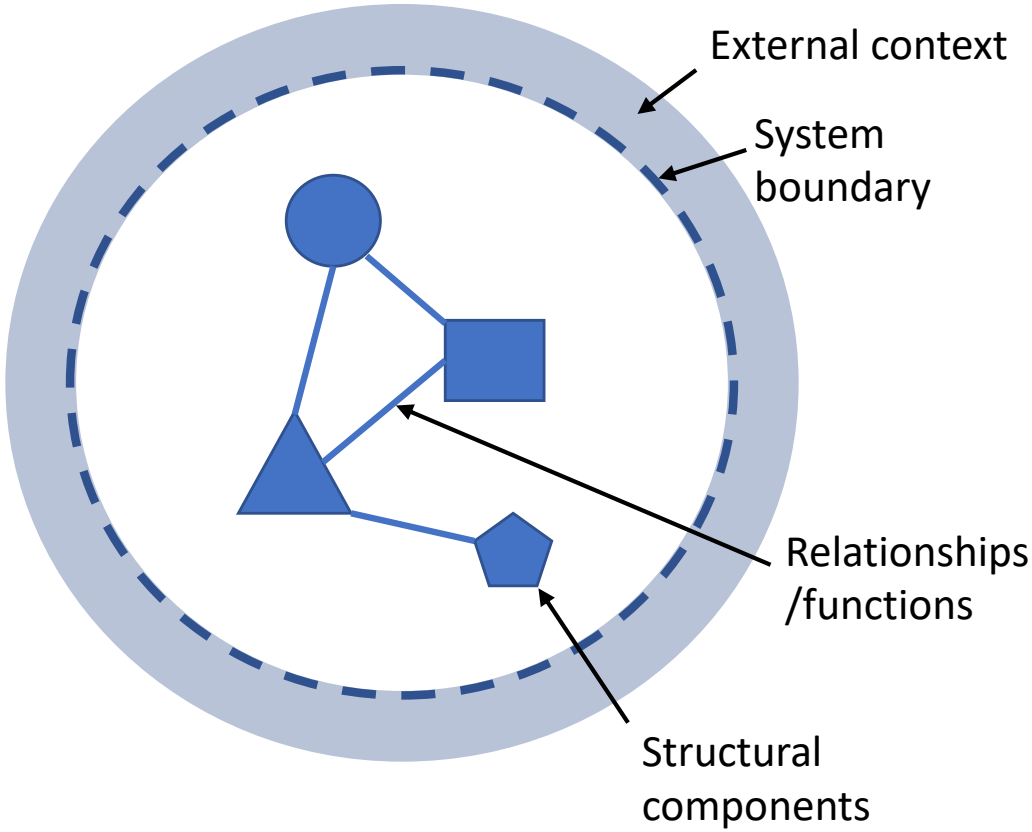
Systems perspectives to innovation – a useful approach to understand complex phenomena

What is a systems perspective?

Understanding a phenomenon in terms of its components or structure (*what is it made up of*) and its processes or functions (*what does it do*)

Offers two (structure and processes) complementary insights into understanding a complex phenomenon

Key concepts in systems theory



Key aspects in Innovation systems perspectives

- Innovation is an **interactive** process (between different actors)
  - "No firm is an island"
  - Suppliers and customers (value chains), Universities and other knowledge institutions, Competitors, NGOs, Governmental agencies, Trade organisations ect.
- **Knowledge** perspective
- **Institutions** matters (norms, rules, trust, attitudes ect.)
- **Context** matters (infrastructure, technology, culture, history etc.)

Implications for practitioners on various levels

- Micro (firm) perspective- Inform management strategies, collaboration with whom, when and why? (Outsourcing, insourcing, national, global)
- Macro perspective - Policy implications

Two traditions of system perspective on innovation

Innovation Systems (Lundvall, Bergek, Malerba)

- **Knowledge-intensive:** Focus on the process of developing and diffusing innovation
- Aimed at strengthening the **innovative capacity** of a (broader) system
- Predominantly for **wider technology/innovation development and diffusion** purposes

Business/innovation Ecosystems (Moore, Jacobides, Adner)

- **Value creation:** Focus on the relationship between actors in the value-chain and their role in creating value
- Aimed at creating **customer value**
- Predominantly used for **business strategy** development

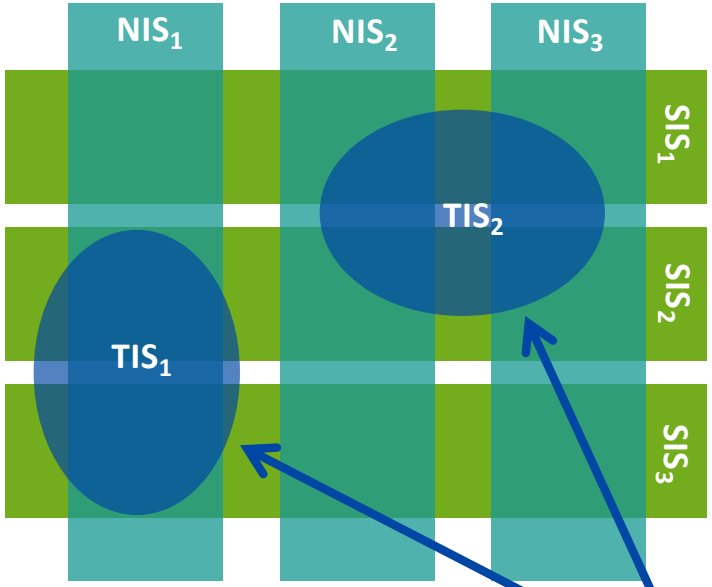
Different ecosystem approaches

Pilinkienė and Mačiulis (2014) and Oh et al (2016)

Ecosystem analogies	Industrial ecosystem	Innovation ecosystem	Digital business ecosystem	Entrepreneurship ecosystem
Environment	Local; industrial environment	From local to global; inter-organizational, political, economic and technological environment	From local to global; digital environment	Local; specific location
Actors	Manufactures and consumers	Entrepreneur; large and small enterprises; educational institutions; research institutions and laboratories; venture capital firms; financial markets; government institutions	Research and education organizations; innovation centres; small and large enterprises with their associations; local government and public administration	Financial capital; educational institutions; culture; support measures; human capital; markets; government institutions; nongovernment institutions; entrepreneur; large and small enterprises
Key determinants affecting ecosystem performance	Industry - environment interaction; ecosystem actors interaction	Resources, governance, strategy and leadership, organizational culture, technology. Interaction between ecosystem actors	Services and technological solutions, business and knowledge; interaction between ecosystem actors	Opportunities, skilled people and resources; interaction between ecosystem actors

System perspectives on innovation (Innovation systems)

National innovation system (macro level) – Lundvall (1992)



Sectoral innovation system (Breschi and Malerba 1997)

An analytical tool for understanding how innovation is developed and diffused that focus on identifying obstacles for action

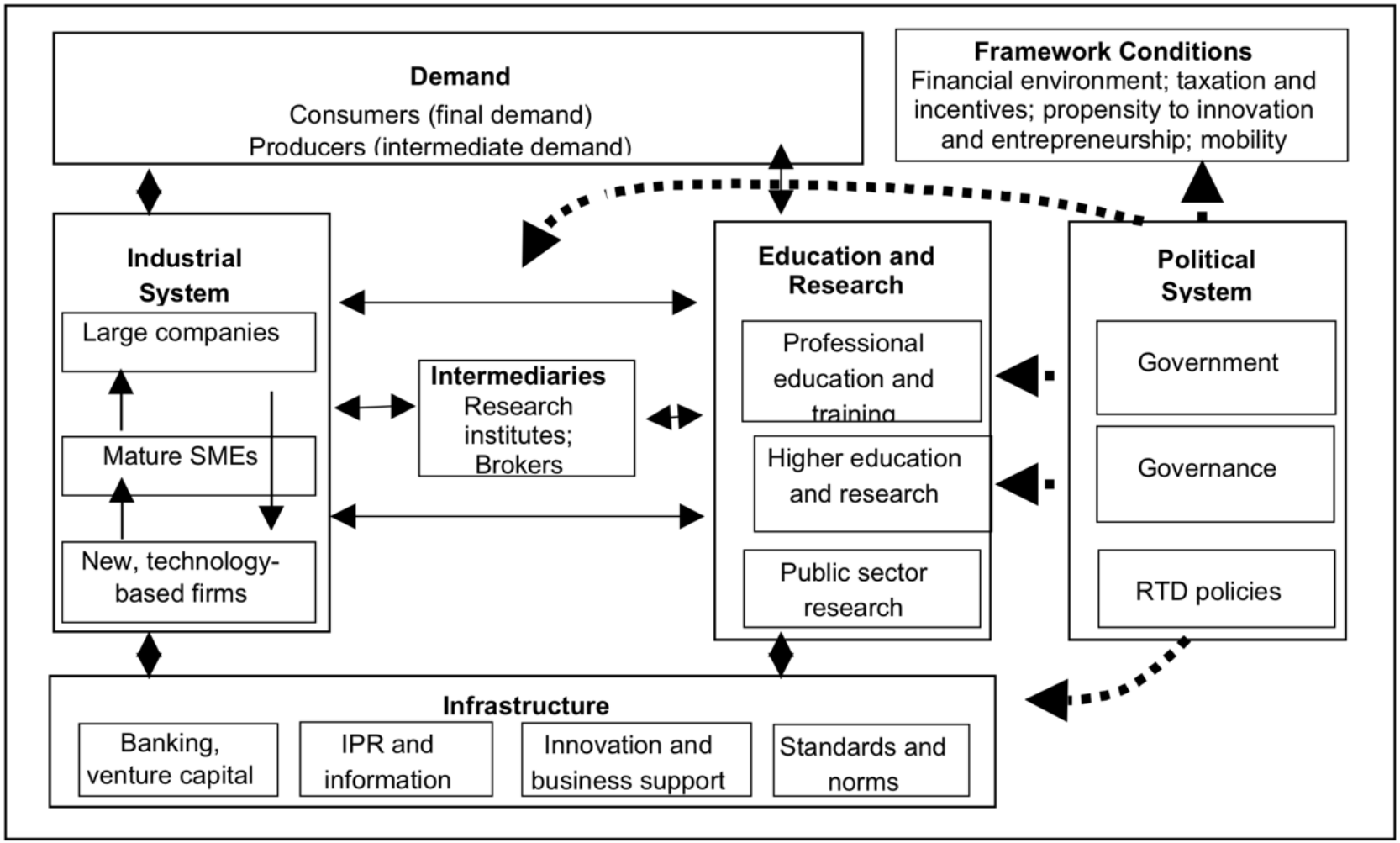
Technological innovation systems (meso level) Carlsson and Jacobsson (1994)

Other IS-related perspectives with geographical focus

- Regional systems of innovation (Cooke et al. 1997)
- Industrial clusters (Porter 1990)

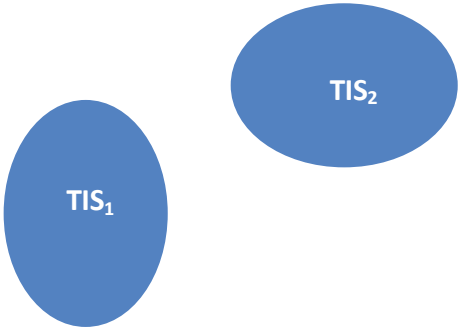
A National Innovation System Model

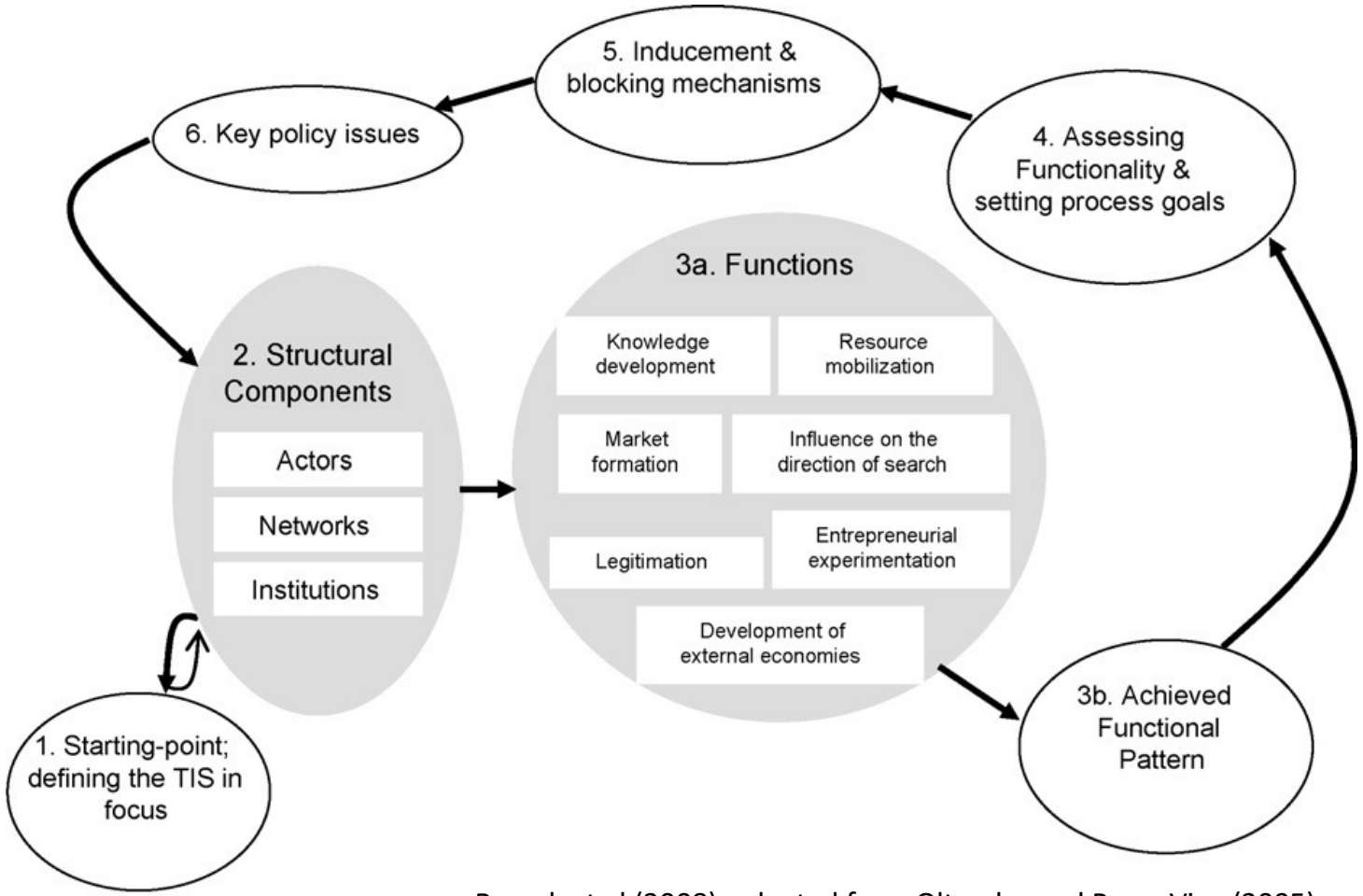
One example of a NIS operationalisation



Kuhlmann and Arnold (2001)

Steps in analysing a technological innovation system (TIS)





Bergek et al (2008), adapted from Oltander and Perez Vico (2005)

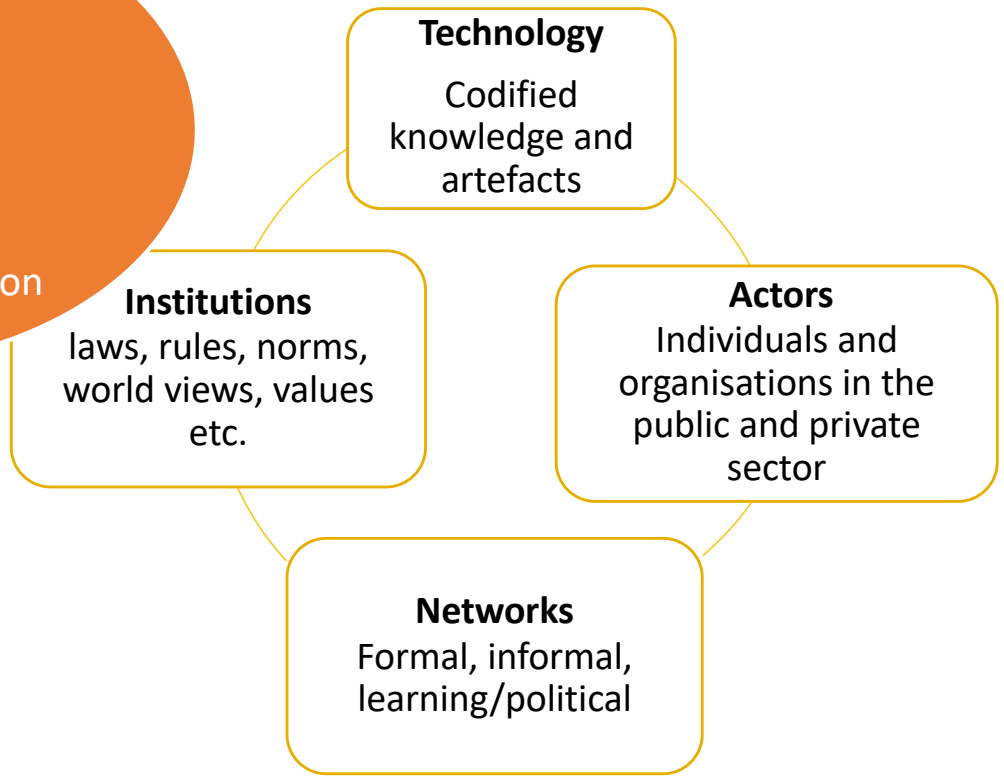
Defining and delineating a TIS

A **network** of **actors** who, under the influence of **institutions**, develop, diffuse and use a **technology**.

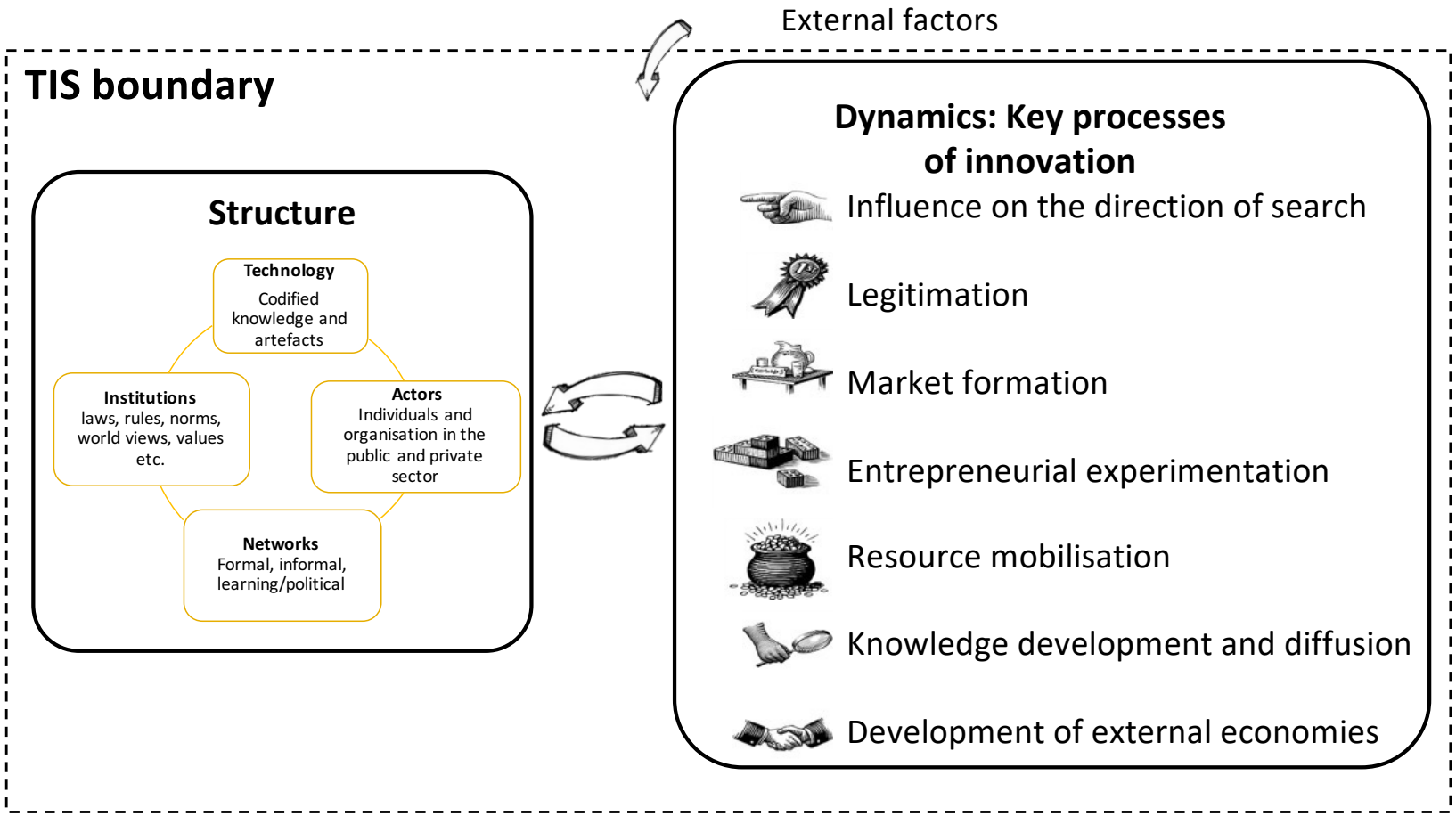
Examples of TISs:
IT in home care
Organic milk
Electric cars

… often includes a geographic delimitation

The structural components

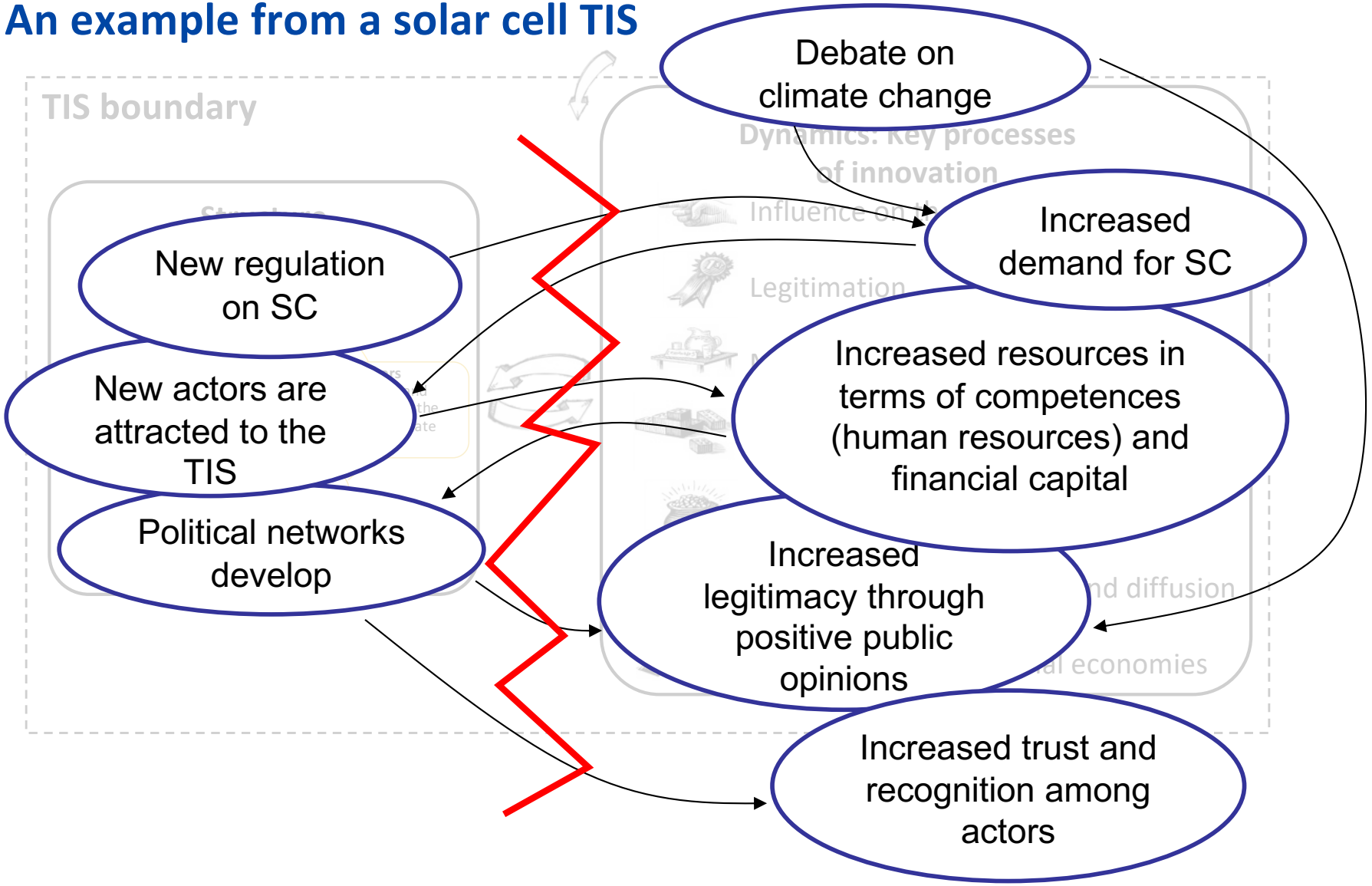


Structure and dynamics of a TIS



Structure and dynamics of a TIS

An example from a solar cell TIS



State of structural components in marine energy TIS

The technology

- **Formative** phase, immature and highly dependent on public support
- **No dominant design**, no commercial plants, mainly small-scale sea trials
- Sea-based and **decentralized** infrastructure

Actors

- 10 rather **small developers**
- Hesitant/**passive suppliers** and utilities, limited collaboration
- **Government** and regional actors **support** RD&D and develop policy

Networks

- Strong network around one **dominant actor**
- Generally weak university-industry networks

Institutions

- **Positive** public attitudes, skeptical power sector
- Policies for promoting renewable energy technologies, but not specific
- Consenting process for sea installations – **conflict of interest** regarding space
- **Misalignment** with **energy paradigm**

State of TIS dynamics for ME

	Weak **direction of search** due to technical uncertainties and uncertainties regarding role in the future Swedish energy mix, good international potential, expectations in the light of a Swedish Maritime Strategy
	Strong public **legitimacy,** some political interest but in the shade of wind and nuclear, technical failures weakens legitimacy, strong international interest and proven concepts abroad
	Weak **market formation**, no commercial installations, uncertain Swedish market potential, public funding scheme for renewables include ME but is disadvantages v-a-v other sources
	Intense and wide **experimentation** and relevant infrastructure for experimentation, low experimentation among complementary industries, experimentation at sea is resource intensive
	Relatively strong financial **resource mobilisation**, hesitant investments from private actors and mainly on projects abroad, good access to human capital and complementary infrastructure
	Strong **knowledge** development and patent activity but centred on a dominant “closed” actor, relevant knowledge from complementary industries, week knowledge among public actors
	Strong networks around a dominant actor, signs of new relationships emerging, underdeveloped value chain, low general trust

Blocking factors in marine energy

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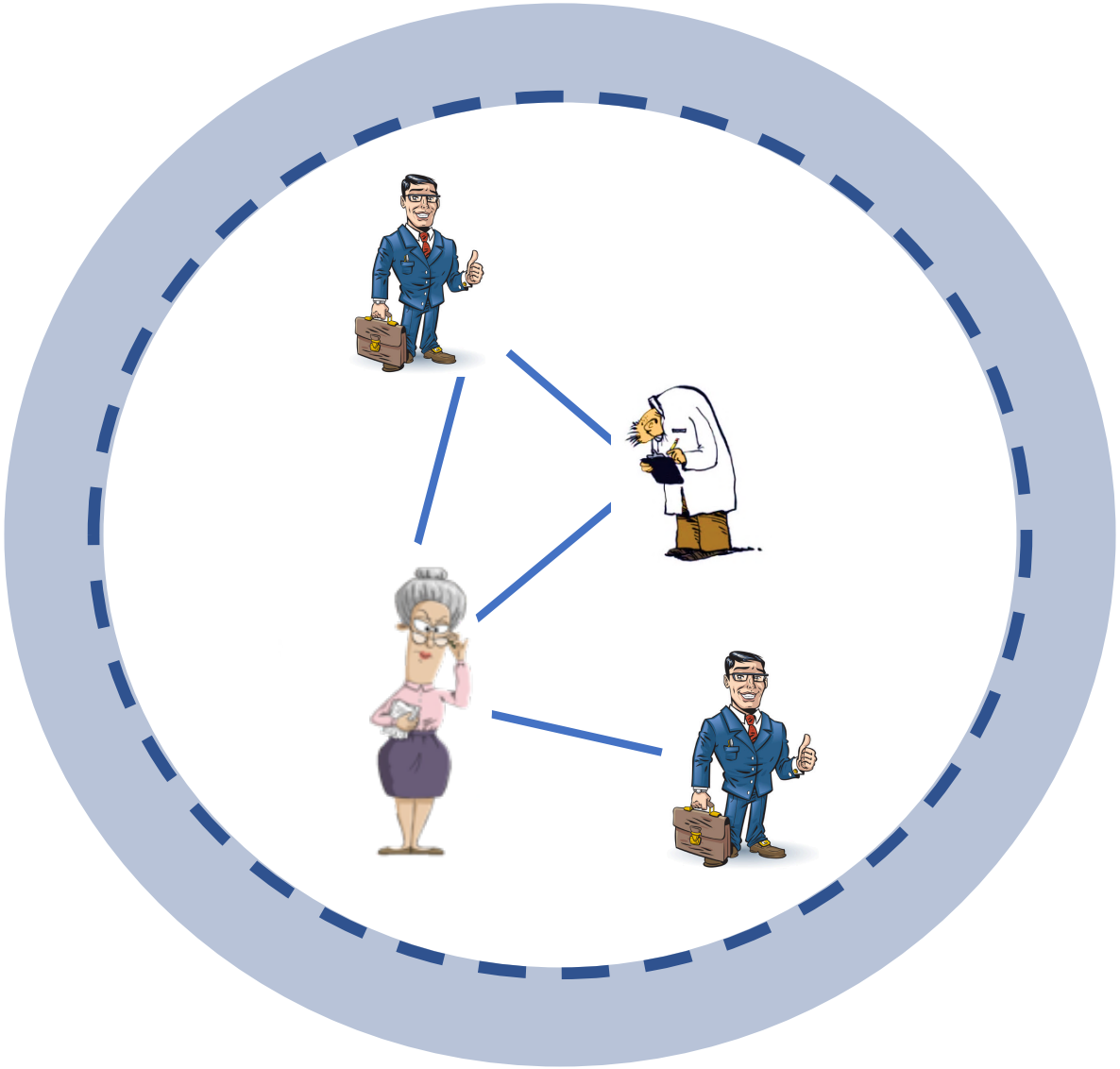
Blocking factor	*Main impacts*
B1. Limited test and demonstration activities	Persistent technical uncertainties, knowledge gaps, and skeptical attitudes among some actors
B2. Lack of knowledge and coordination among public actors	Unbalanced allocation of public funding, concentrated knowledge development, low levels of trust, and limited collaboration among actors
B3. Lack of collaboration among actors	Limited knowledge diffusion, few joint RD & D projects (which enable resource-pooling and risk sharing), and poor political lobbying
B4. Passivity of established actors	Lack of knowledge, capabilities, and financial capital
B5. Small and uncertain domestic market potential	Passive established actors, focus on foreign markets, and lack of political direction
B6. Lack of political direction	Lack of clear instructions to and coordination among public actors, passive established actors, and uncertainties regarding the domestic market potential
B7. Insufficient market incentives	Lack of market incentives for test and demonstration activities and passive established actors

Andersson, Perez Vico et al (2017)

University- industry interaction



But first… what is a university and what do we do here?

The three missions of universities

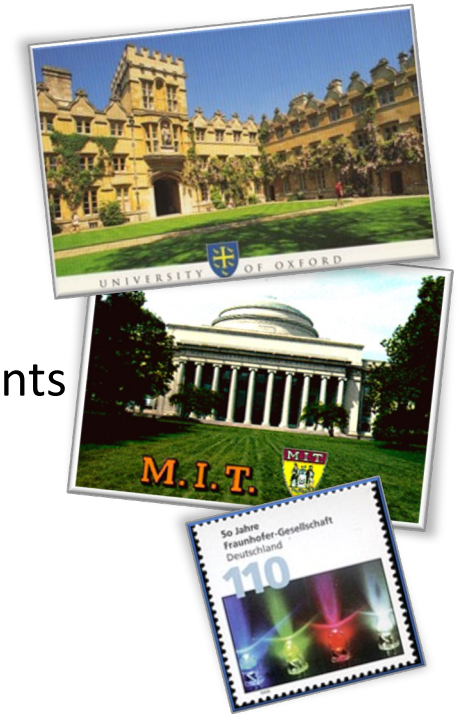
*Providing **quasi-public** goods (basic knowledge and human capital) as a **permeable** organisation – filling the gap of **market failures** related to **knowledge production***

Education

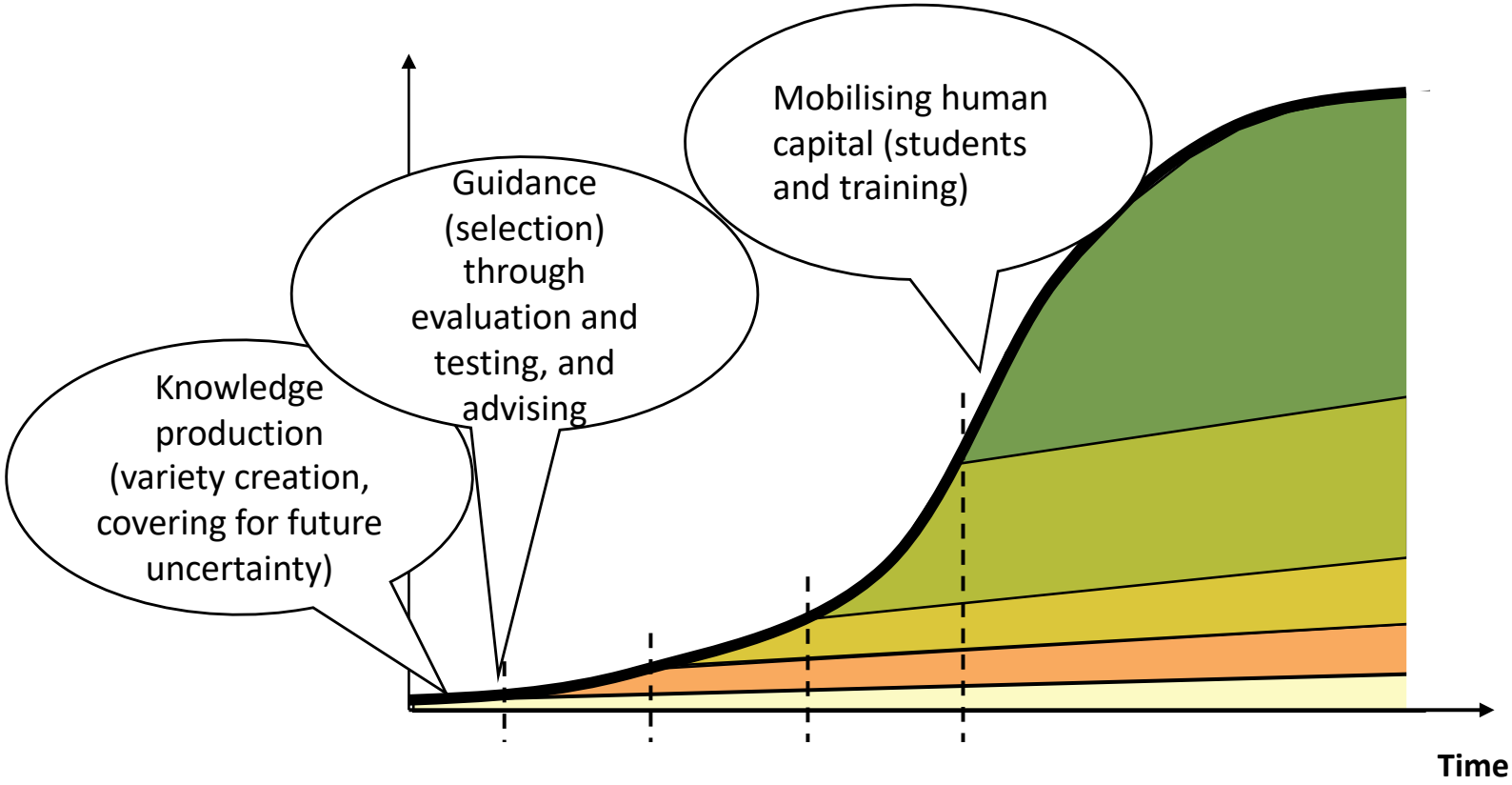
Research

Societal engagement
Third mission

The role of universities and research institutes/laboratories in innovation



- Conducting research (collaborative/contract/independent)
- Teaching and supervising graduate and undergraduate students
  - Contract/professional training
- (Independent) advice and evaluation
- Test and demo infrastructure
- Bridging organisations (basic research → innovation), particularly research institutes but nowadays also universities

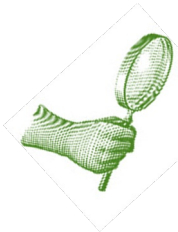


Why do university-industry (U-I) interaction take place?

Fundamental principles for knowledge production and interaction

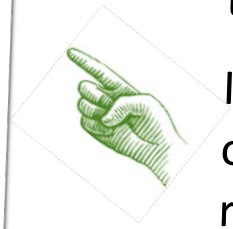
- Contemporary societal **knowledge production** is **distributed** due to **specialisation/division of labour** between different knowledge domains and types of knowledge (Hayek 1945)
- The distributed nature of knowledge production obliges **interaction** and **interactive learning** for innovation (new combinations of knowledge) (Lundvall and Johnson, 1994)

Benefits from U-I collaboration



Learning impact: Broadening and deepening the knowledge base through development of new knowledge /new combinations of existing knowledge, e.g. insights into practical perspectives, validation of theoretical models, build-up and movement of human capital

Impact on **tangible assets**: The build-up of and access to financial and physical assets, e.g. research funding, revenues from contract research/education, access to data, test environments, instruments and research objects, economies of scale



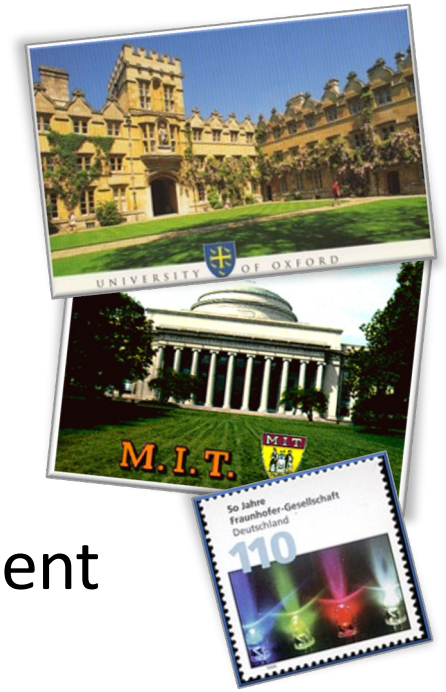
Impact on **guidance**: Influence on decisions about resource allocation and organisational focus, cognitive or behavioural changes, e.g. new venues for research and teaching, increased legitimacy/interest for specific research areas

Social impact: The development and maintenance of interpersonal relationships through the build-up of trust, sense of belonging and recognition, e.g. strengthening/establishing relationships with other sectors of society for future collaboration.

How collaborate?

Forms of interaction	*Examples of university-industry interactions*
Collaboration in research	Collaborative research, contract and action research, shared facilities and research infrastructure, mobility of persons and shared employments, engagement related to PhD education
Collaboration in education	Contract and professional education, societal alignment of educative programs, student placements and case studies, collaboration in teaching and supervision
Collaboration in tech transfer	Co-development and diffusion of innovations, venture creation (academic entrepreneurship)
Collaboration in outreach	Networking and arena development, providing advice and expertise, participation in public events and popularization of research

Trends in U-I interaction



Interaction is increasing due to

- Companies outsourcing knowledge development
- From a vertical strategy/model to a network strategy/model (remember the chain-linked-model of innovation?)
- Universities becoming Multiversities (task expansion)
- Larger public R&D sector with less guaranteed funds force universities to collaborate
- Increased focus on grand societal challenges demand collaboration

Conflicting or complementary logics in U-I collaboration?

An academic context:
Truth-seeking, understanding a phenomenon, problematizing, long term, driven by peer recognition, open disclosure (public good) and research freedom

A business context:
Practical problem solving, limited disclosure and private appropriation, driven by monetary incentives, management and control.

University-industry relations - a smooth relationship?

- Conflicting logics
  - E.g. exclusive licensing v.s. knowledge openness
- Diverging the role of academics (within-role conflicts)
- Competitors as universities are becoming more engaged in their own innovation and commercialisation of knowledge
  - Public RD&I funds
  - Highly skilled individuals
  - The knowledge war - Patents and paper races
  - IPR

An example of U-I interaction in the area of nanocatalysis

Academic activity: Education of PhDs

Resource mobilisation of human capital

Knowledge embedded in persons is **diffused**

New knowledge underpins **entrepreneurial experiments**

Influence on the direction of search as ex-students take on influential roles in industry

Market formation through industrial partners that act as leading customers

New individuals bring **social capital** with new relationships

1980 1990 2000