Understanding technology and its "(self)-healing" character

Symposium in honor of
Prof. B. Dankbaar
Radboud Universiteit Nijmegen
June 21, 2013
K. Debackere

Contents - 1

- Taking a start with technology: Friend or Foe?

Technology, old stories & beliefs

- **Technological utopianism** derived from the belief in technology -- conceived as more than tools and machines alone -- as the means of achieving a 'perfect' society in the near future. Such a society, moreover, would not only be the culmination of the introduction of new tools and machines; it would also be modelled on those tools and machines in its institutions, values and culture...More clearly, more methodically and more intensely than any other group, the technological utopians espoused positions that a growing number (even a majority) of Americans during these 50 years were coming to take for granted, or wanted to: the belief in the inevitability of progress and the belief that progress was precisely technological progress....The utopians were not oblivious to the problems technological advance might cause, such as unemployment or boredom. They simply were confident that advancing technology held the solution to those problems and to other, chronic problems, including scarcity, hunger, disease and war. In addition, they assumed that technology would solve the psychological problems that were increasingly worrisome, such as aggression, crowding, rudeness, and social disorder...

- **Source:** Howard P. Segal, "The Technological Utopians", in Joseph J. Corn (Ed.), *Imagining Tomorrow: History, Technology and The American Future (Cambridge: MIT Press, 1986). Representative Works:*

- *Chauncey Thomas, The Crystal Button: Or, Adventures of Paul Prognosis in the Forty-Ninth Century (1891)*

- *Edward Bellamy, Looking Backward, 2000-1895 (1895)*

- *Albert A. Merrill, The Great Awakening: The Story of the Twenty-Second Century (1899)*

- *Paul Devinne, The Day of Prosperity: A Vision of the Century to Come (1902)*

- *Charles W. Wooldridge, Perfecting the Earth: A Piece of Possible History (1902)*

- *Edward Chambless, Roadtown (1910)*

- *Herman H. Brinsmade, Utopia Achieved: A Novel of the Future (1912)*

- *Harold Loeb, Life in a Technocracy: What It Would Be Like (1933)`*

3

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Technology, critical stories & beliefs

- **Luddism** …
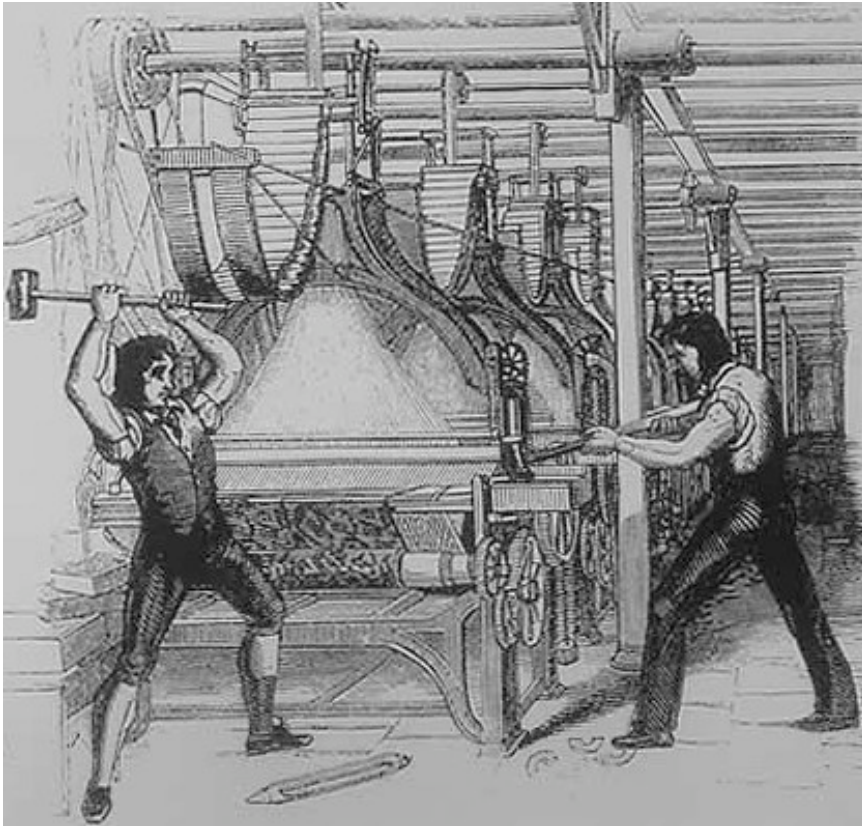
- **Smithsonian Magazine:**

Modern Luddites do indeed invent "machines"—in the form of computer viruses, cyber worms and other malware—to disrupt the technologies that trouble them. (Recent targets of suspected sabotage include the London Stock Exchange and a nuclear power plant in Iran.) Even off-the-grid extremists find technology irresistible. The Unabomber, Ted Kaczynski, attacked what he called the "industrial-technological system" with increasingly sophisticated mail bombs. Likewise, the cave-dwelling terrorist sometimes derided as "Osama bin Luddite" hijacked aviation technology to bring down skyscrapers.

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Technology, current stories & realities

How Digital Technology Found Utopian Ideology: Lessons From the First Hackers' Conference

Fred Turner

Department of Communication

Stanford University

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The pervasive nature of technology?

- ## What is "technology"? What do we know today?

  - o Detailed studies on the genesis and the history of specific technologies, e.g. MIT series "Inside Technology" --- MIT Press 1990 etc.

  - o Detailed studies on the design process of new technologies

  - o Detailed studies on the economic & market impact of technology, e.g. Technology & Market Structure, MIT Press --- cfr. infra

  - o Detailed studies on the multiple & multilayered interactions between technology and society, e.g. MIT Technology & Society Programme Publications

  - o Detailed studies on adoption and diffusion of new technologies, e.g. Markets for Technology, MIT Press

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In need of a theory of technology

- What is "technology"?
  - o In need of a definition of "technology"
  - o In need of a theory on the evolution of technology
- Santa Fe Institute: "Missing is a set of overall principles that would give the subject a logical structure. Missing, in other words, is a theory of technology --- an "-ology" of technology" (B. Arthur, 2009)
- In other words, can we come up with a theory of technology very much alike to what we have in biology (definition, evolution, …)
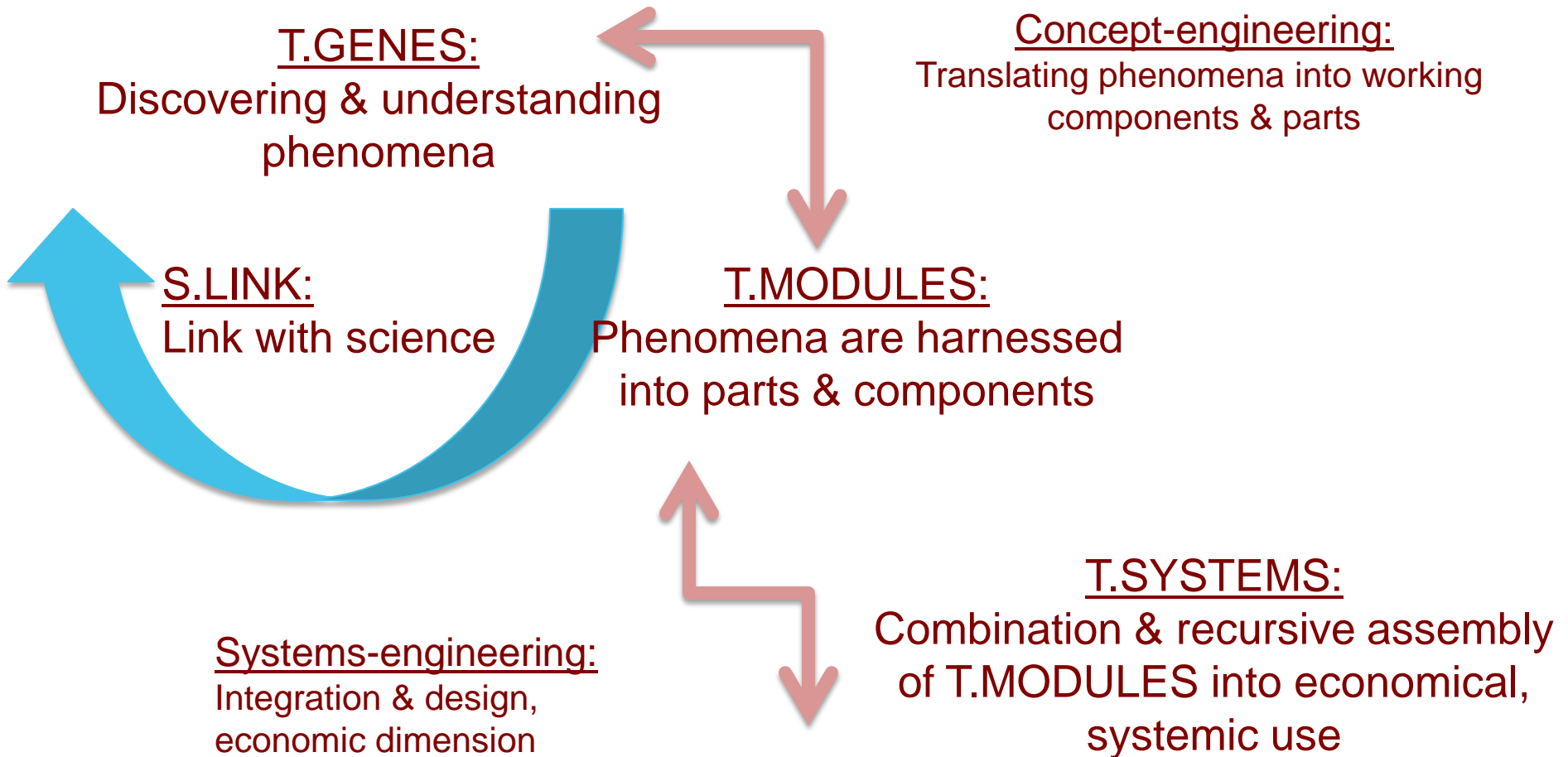
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In need of a theory of technology

- TECHNOLOGY:
  - It all starts with the discovery of natural (and one might add social) laws (or "phenomena") … those phenomena are hidden till they are discovered and unravelled (e.g. optical, electrical, chemical, biochemical, mechanical). Discovery of phenomena happens stepwise, gradually, and is often driven by serendipity ("Leaps in the dark", Oxford University Press, 2004);
  - "A technology is a phenomenon captured and put to use. Or more accurately, I should say it is a collection of phenomena captured and put to use" (B. Arthur, 2009)

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In need of a theory of technology

- TECHNOLOGY:

  "A powerplant is just a device that provides thrust. If we look deeper into it, as say when its coiling is removed for maintenance, we can see it as a collection of parts --- a tangle of pipes and systems and wiring and blades. The engine now visibly is a combination of executables. But look deeper again, this time beneath what is visible. The powerplant is really a collection of phenomena "programmed" to work together, an orchestration of phenomena working together. None of these phenomena is particularly esoteric; most are fairly basic physical effects. (…) All these phenomena --- scores of them --- are captured, encapsulated in a myriad of devices, and replicated, some many thousands of times in as many thousands of identical components. (…) Seen this way, a technology in operation ceases to be a mere object at work. It becomes a metabolism. (…) Phenomena are the "genes" of technology." (B. Arthur, The Nature of Technology, 2009: 50-53)

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In need of a theory of technology

T.GENES:
Discovering & understanding phenomena

Concept-engineering:
Translating phenomena into working components & parts

S.LINK:
Link with science

T.MODULES:
Phenomena are harnessed into parts & components

Systems-engineering:
Integration & design, economic dimension

T.SYSTEMS:
Combination & recursive assembly of T.MODULES into economical, systemic use

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Combining the previous insights

- What do we conclude about technology?
  - There is technological progress & differentiation
  - People take strong stances towards technology: they create it, they destroy it, they love it, they hate it, they exploit it, they change it, they grow it, they revolutionize it
  - "It" also has a life of its own as Arthur claims
  - What people do with & to "it" and what "it" does to people underpins the healing and self-healing character of technology; there is no status-quo in technology --- it drives humanity but is driven by humanity
  - Technology creation & destruction is therefore first and foremost a communal activity ("technological communities")

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Contents - 2

- Zooming in on the conference theme: Technology and the economy
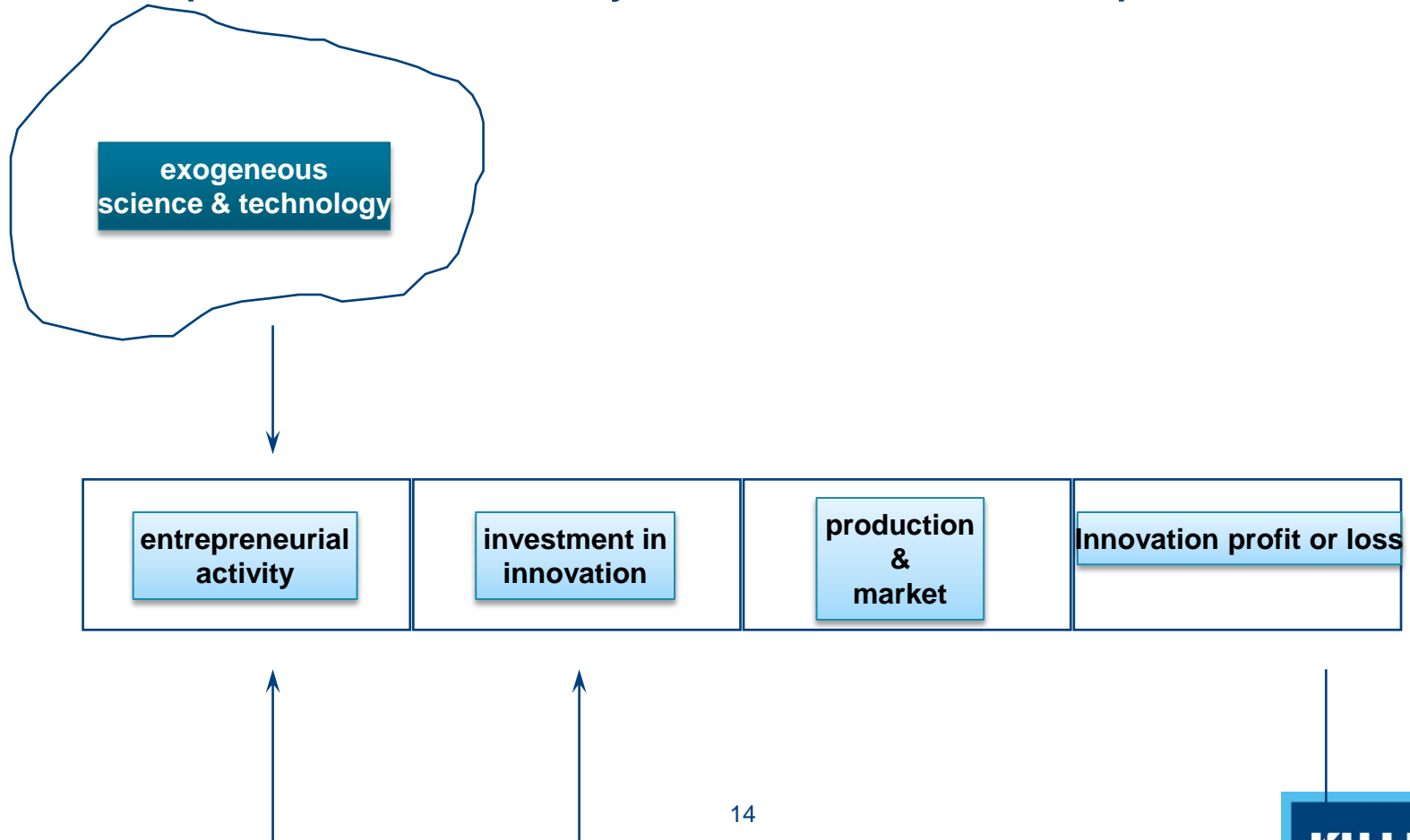
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Importance of technology

- Joseph Schumpeter (inspired by Kondratiev): technological progress as fundamental to economic progress, driving competition through product differentiation

- Schumpeter developed two models: he considered them to be "opposites" & mutually exclusive, though in reality they turned out to be highly complementary

"The eternal gale of creative destruction"

… pushing new firms and industries to the forefront and destroying old ones … e.g. Michael Porter…

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Model - I

- Schumpeter-**I**: the theory of the heroic entrepreneur

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exogeneous
science & technology
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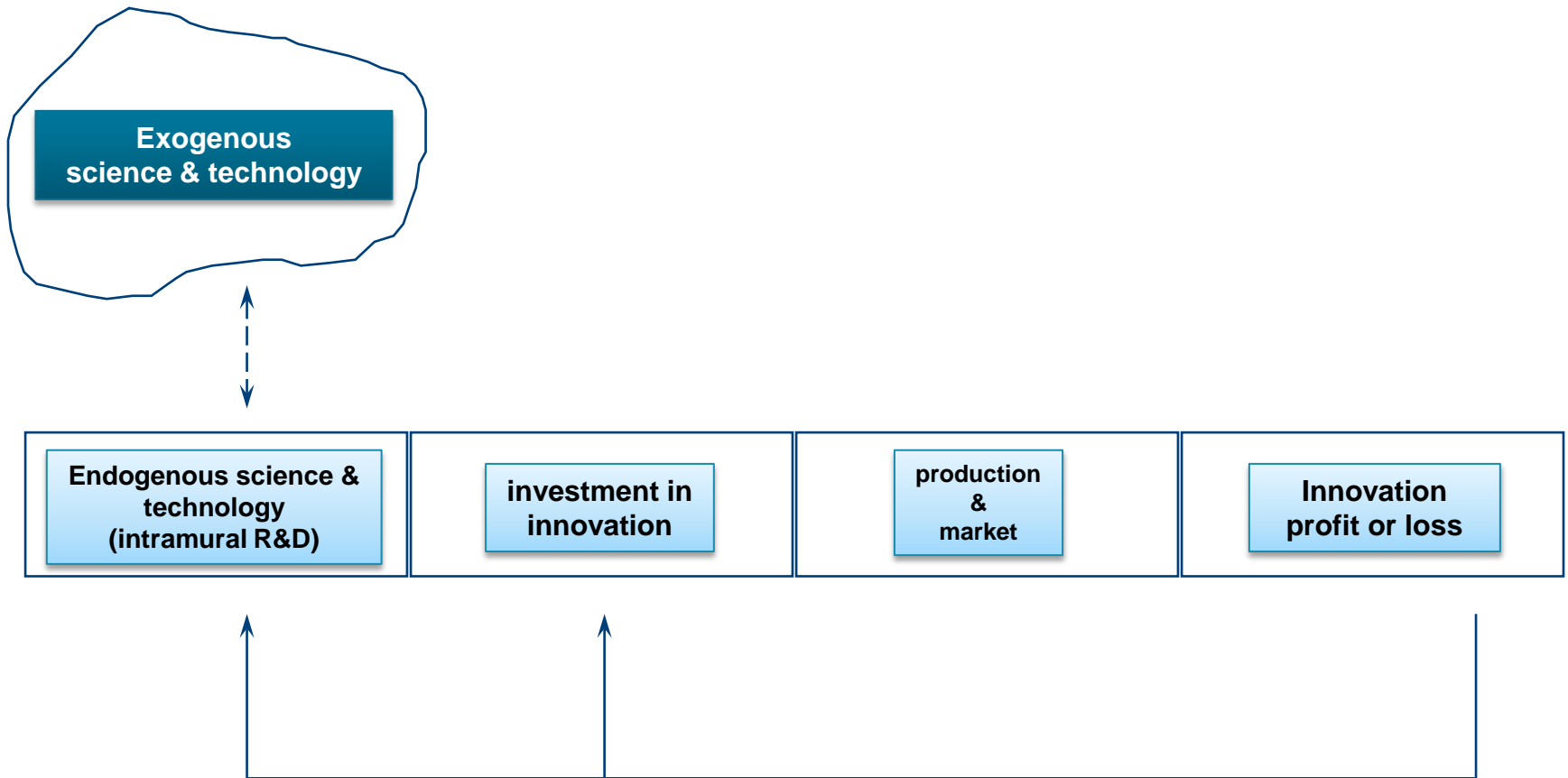| entrepreneurial activity | investment in innovation | production & market | Innovation profit or loss |

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Issues with model - I

- Problems with Schumpeter-I:
  - Incomplete contracts & residual rights
  - Moral hazard issue
  - "Principal – agent" issue
  - Knowledge is a public good … hence issues of appropriability
  - Indivisibility of knowledge … hence small firms are at a disadvantage
- Hence Schumpeter-II --- stressing:
  - The importance to internalise & to endogenise R&D
  - The need for the "right" market conditions ("monopoly as conducive to innovation")
  - To be done by the "right" companies (large & resource-intensive)
- However … the theory of dynamic complementarity

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Model - II

- Schumpeter-II: the force of the monopolist & the large firm

Exogenous science & technology

| Endogenous science & technology (intramural R&D) | investment in innovation | production & market | Innovation profit or loss |

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Technology and the economy

- Robert Solow and the econometric proof of technology as the "3rd" production factor ➔ Solow-residual to explain economic growth beyond labor and capital (*The Review of Economics and Statistics, Vol. 39, No. 3. (1957), pp. 312-320)*:

  o Y=F(K,L) (i.e. Cobb-Douglas $Y = \alpha L^{\beta} K^{\gamma}$)

  o Y=F(K,L).X(T) with X(T) a parameter measuring technical progress (e.g. evolution in R&D expenditures)

  o R^2: $\pm20\%$ ==> $\pm80\%$

"Learning by doing and continuous innovation"

… enabling firms to reap enormous benefits from institutionalising and routinising their innovation production function… also: William Baumol …

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Contents - 3

- Technology, a prime foundation to sustainable capitalism?

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Capitalism

- William Baumol's 4 modes of capitalism (2007):
  - "State controlled" capitalism
  - "Oligarchic firm" capitalism
  - "Entrepreneurial" capitalism
  - "Large firm" capitalism
- "Bad habits" as to innovation & growth:
  - "State controlled" capitalism
  - "Oligarchic firm" capitalism
- Luckily something good as well:
  - "Entrepreneurial" capitalism (see Schumpeter-I)
  - "Large firm" capitalism (see Schumpeter-II)

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Capitalism & technology

- However, large firm capitalism and entrepreneurial capitalism are not independent but interdependent ➔ **the theory of dynamic complementarity** between large, incumbent firms and small entrepreneurial firms ("YICs") in fostering innovation …

- Leading to an ambidextrous innovation ecosystem … given that small entrepreneurial firms are often a better vehicle to bring a disruptive innovation to the market …

- As consequence, large incumbent firms adopt organizational solutions like "corporate venturing," "internal venturing," or "intrapreneurship," …in order to **internalize ambidextrous** solutions within the firm's boundaries …

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Contents - 4

- Technology, "a" driver of sustainable capitalism through the quadruple helix

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Technology and sustainable capitalism through the Quadruple Helix

**The Triple Helix
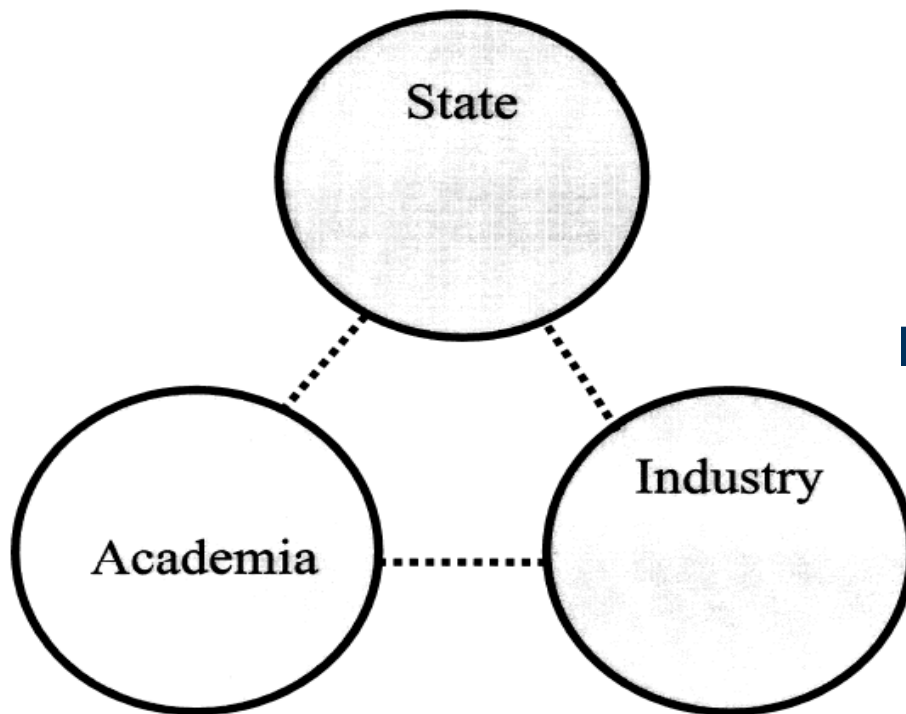(Etzkowitz & Leydesdorff, 2002)**

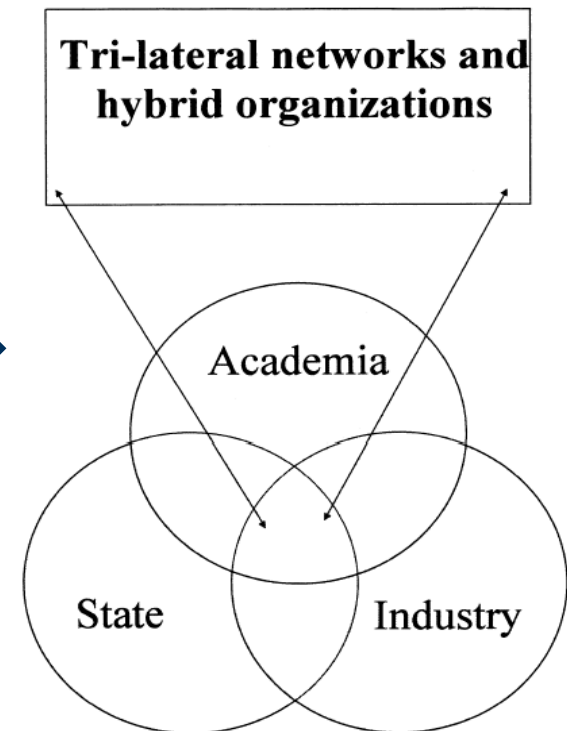Fig. 2. A ''laissez-faire'' model of university–industry–government relations.

Fig. 3. The Triple Helix Model of University–Industry–Government Relations.

Technology and sustainable capitalism through the Quadruple Helix

Academia

State

Community

Industry/Market

Taking into account the (self)healing character of technology via the communal dimension

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Thank you!

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