

Invitation to Research

KEY INSIGHTS FROM THE PHILOSOPHY OF SCIENCE

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Philosophy of Science Agenda

- Aspects of Epistemology and Ontology
 - Data, Information, Knowledge, Wisdom
- Theory, Scientific Theory, Paradigms
- Systems and Models
- The Nature and Process of Science
- Alternative Research Approaches and Traditions
- Research Concepts and Terminology

Ontology

- The study of what exists
- The opposing views are:
 - '**Materialism**', which holds that anything that exists can be detected through the senses
 - '**Idealism**', which says that everything exists in the mind, and that the 'real world' that we think we see is only a shared idea
- The conventional compromise is to recognise :
 - external realities (the secular or **Real World**)
 - internal 'mind-stuff' (the **Abstract World**)

Epistemology

- The study of knowledge, its sources, varieties, limits
- Competing Views:
 - '**Empiricism**' holds that knowledge is derived from experience. The **extreme form** is referred to as '**positivism**' or '**logical positivism**', and holds that nothing is innate, and that only that which can be measured is worth worrying about
 - '**Apriorism**' considers that knowledge is innate. The extreme form denies the very idea of knowledge existing outside the individual mind

The Conventional Ontological and Epistemological Positions

- Things around me exist
- Knowledge that a person has of a thing is not the thing itself, but rather an internal model of the thing
- That is not inconsistent with the empirical view: we learn about things by sensing or measuring them
- It is also not inconsistent with the apriori view: each person's perceptual and cognitive apparatus (eyes and ears, optic and auditory nerves, sensory nervous system, brain, etc.) mediate their experience of the external things

Knowledge – The Mechanistic Definition

- The body of facts and principles accumulated by mankind over the course of time
- Goods that can be stored in a warehouse
 - Wisdom
 - Knowledge
 - Information
 - Data

Knowledge – Some Dictionary Definitions

- To know about, at a superficial level:
 - relating to one entity: to be acquainted with a thing, place or person
 - relating to more than one entity: to be able to distinguish one from another
- To know about, at a deeper level:
 - relating to a single fact: to apprehend with clearness or certainty
 - relating to a subject as a whole: to have theoretical or practical or spiritual understanding of that subject
- To know how:
 - to understand from experience or attainment, as in to know how to do or to make something

Data

- Any symbol, sign or measure that is in a form that can be directly processed by a person or a machine
- **Real-world data** is data that represents or purports to represent a fact in the real world. It has been in some sense 'captured'
- **Synthetic data** is data that is not intended to correspond to something in the real-world

Information

- Data that has value
- Informational value depends upon context
- Until it is placed in an appropriate context data is not information, and once it ceases to be in that context it ceases to be information
- A frequently-occurring context is a decision

Knowledge

The matrix of impressions within which an individual situates newly acquired information

Wisdom

- Judgement exercised by applying decision criteria to knowledge combined with new information
- The decision criteria might be:
 - specifiable or imprecise
 - authoritative or the subject of debate
 - mechanistic or values-based

Tacit Knowledge

informal and intangible

exists only in the mind of a particular person

'knowing that' cf. 'knowing how to'

not readily communicated to others

Codified Knowledge (cf. Information)

expressed and recorded, in a more or less formal language
(text, formulae, blueprints, procedure descriptions)

disembodied from individuals

communicable information

Codified Knowledge

An omelette recipe
A combination of structured and unstructured text

Tacit Knowledge

The expertise to interpret the recipe,
to apply known techniques and tools to the activity,
to recognise omissions and exceptions,
to deliver a superb omelette every time,
to sense which variants will work and which won't,
and to deliver with style

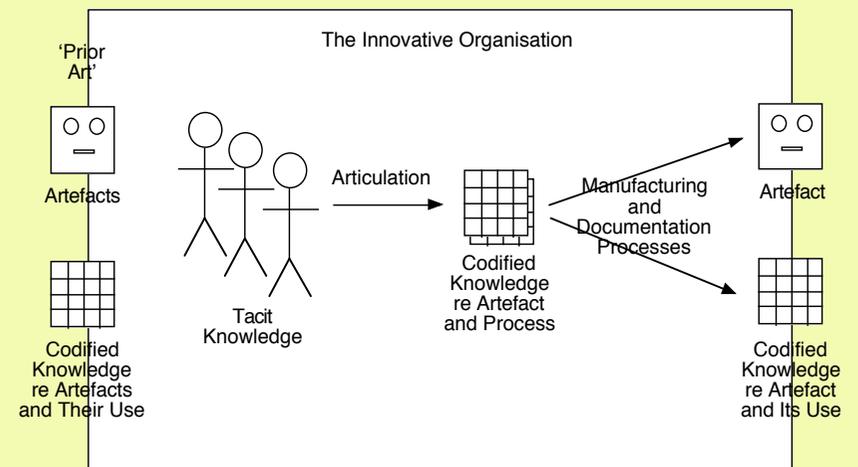
Technology

- A combination of:
 - **codified knowledge** about artefacts, artefact manufacture, and artefact usage
 - **tacit knowledge** of many individuals
 - **business processes** within multiple organisations, into which are integrated codified and tacit knowledge
 - **artefacts** designed, manufactured and used by means of that codified and tacit knowledge
 - **educational materials** relating to artefacts, artefact design, production, use, maintenance

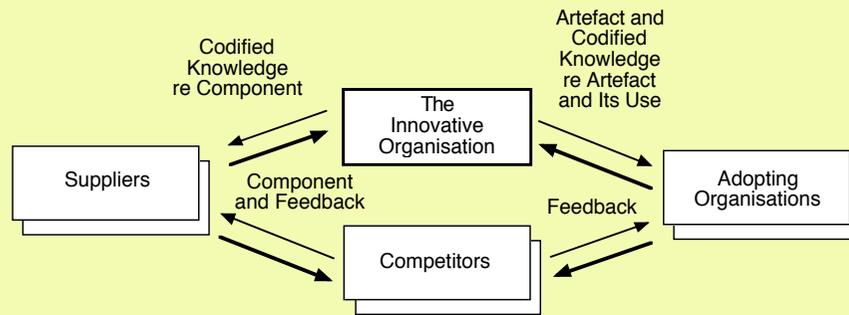
Big-Bang Innovation cf. Cumulative Innovation

- Genuine 'breakthroughs' do occur
- But most Innovation is progressive:
 - Process Innovation is often needed, in order to support Product Innovation
 - Step-wise Refinement results in Incremental Emergence or Conversion
 - Dependent on Interaction with others, and often on Contributions of others, incl.:
 - Users
 - Suppliers
 - Competitors

Info Flows Within the Innovative Organisation



Info Flows Within the Innovative Sector



Plus Consultants, Educational Institutions, Labour Mobility

Knowledge Processes

- **Knowledge Creation**
Always commences as Tacit Knowledge
- **Articulation**
Conversion of Tacit into Codified Knowledge
- **Knowledge Transfer**
Tacit Knowledge from one person to another:
 - directly
 - via Codified Knowledge

Communication

- Data and Information are not simply transferrable from one person to another, but are subject to constraints of:
 - the sender, e.g. effectors, motivations
 - the medium, e.g. capacity, noise
 - the receiver, e.g. perceptive and cognitive apparatus
- Data and Information are expressed in a Language, often a specialised Dialect, which is subject to lingual and cultural ambiguity

Semiotics

- The study of communications
- Distinguishes multiple levels, at least:
 - **Syntactics** relations among signs
 - **Semantics** relations between signs and real world objects
 - **Pragmatics** relations between signs and users of those signs

Recapitulation of the Conventional Assumptions

- There is a reality, outside the human mind
- Humans cannot directly capture those things
- Humans:
 - sense and measure those things
 - construct an internalised model of them
- The acts of sensing and measurement are enabled by, and constrained by, the human perceptual apparatus (anatomy and physiology) and mental processes
- Knowledge exists at two levels:
 - within individual humans
 - captured, expressed, and stored for recovery

Theory

- Formal Theory:
 - **A coherent group of general propositions that enable a systematic description of Phenomena within a particular Domain (and possibly explanation and even prediction)**
- As distinct from Ad Hoc Theory:
 - A conjectural, as-yet-untested description
- Nets to catch what we call 'the world', to rationalise, to explain, and to master it (Popper)

The Ideal Form of a Theory

- A Theory is founded on Axioms
- The Axioms are capable of being processed using formal Rules of Logic, to produce Inferences
- Those Rules, applied repetitively to Axioms and Intermediate Inferences, give rise to more specific Inferences, which are operationally defined, i.e. they can be related to the Real World

A 'Scientific' Theory, a la Popper

- A body of theory which enables **propositions** to be generated **which are in principle 'refutable' by comparison against observations of the real world**
- Matters of belief in religion and politics are not refutable, e.g. 'through grace, a believer's soul is saved', 'only a virtuous ruler can survive'
- A scientific theory cf. an a-scientific theory:
 - is not morally better (and is arguably 'a-moral')
 - is better in the senses that its primary orientation is toward explanatory and predictive content, and that discoveries can be cumulative

- The empirical basis of objective science has ... nothing 'absolute' about it. Science does not rest upon solid bedrock.
- The bold structure of a theory rises, as if it were above a swamp. It is like a building erected on piles. The piles are driven down from above into the swamp, but not down to any natural or 'given' based; and if we stop driving the piles deeper, it is [only] because we are satisfied that the piles are firm enough to carry the structure ... for the time being

Popper

A Scientific Paradigm, a la Kuhn

- A paradigm is a body of language, shared precepts, theory and methods
- A scientific paradigm involves a scientific theory with significant explanatory and predictive power
- Patterns of work arise, and assumptions become engrained, enabling efficient mass production of detailed research, in '**normal science**'
- A culture or '**program**' develops around the paradigm, and institutions emerge

Progress Within a Paradigm

- A paradigm remains in use for a considerable period of time
- A great deal of accumulation occurs, of specialised language, data, theory and methods
- Much progress is made in explaining natural phenomena and/or developing technologies based on the theories

Stultification Within a Paradigm

- As the culture or 'program' develops around the paradigm, institutions emerge, and gather political power
- Vested interests constrain thought and research within the paradigm
- People who try to work with other precepts are marginalised (e.g. holistic theories in medicine and biology; cf. Lakatos, Berlin)

Anomaly Accumulation

- Gradually, however, anomalies accumulate – instances which the theory fails to explain, or can only explain by postulating ever-more embellishments (e.g. Ptolemaic cosmology; contemporary nuclear physics)
- As anomalies accumulate, rebels are emboldened to propose counter-theories, or more general theories which explain the existing theory as a special case (e.g. Newtonian physics as a special case of Einsteinian physics)

Paradigm Shift

- Multiple new theories compete
- Gradually, one of the new theories gains acceptance, usually fairly slowly because of the vested interests that oppose it
- The emergence of a new paradigm is painful for the vested interests, and exciting for the rebels

Classical Paradigms

- **Celestial Mechanics:** Aristarchus / Copernicus / Kepler / Newton / Einstein (Subsumation and Generalisation)
- **Particle and Quantum Sub-Atomic Theories** Competition / Uncomfortable Co-habitation / (Massive Anomaly Accumulation)
- **Lamarckian and Darwinian Evolution** (Competition, A Winner Declared, Discomfort)

Organisations as Machines vs. Organisations as Bio-Organisms

- General Systems Theory (von Bertalanffy, Boulding)
- Cybernetics (Wiener)
- 'Sociotechnical Systems' (Emery & Trist 1960, Mumford 1983)
- Management Cybernetics (Beer 1972, 1975)
- 'Living Systems' (Miller, 1978)
- 'Soft Systems Methodology' (Checkland 1981, Checkland & Scholes 1990)
- The Multiview approach (Wood-Harper et al 1985)
- Cognitive Science (Winograd & Flores 1986)
- 'Designing-in-Action' and 'Bricolage' (Ciborra and Lanzara 1989, Ciborra 1991)

An Alternative 'Bio-Organic' or 'Organismic' Paradigm

- Winograd and Flores argue (1986, p.11):
 - for the "rejection of cognition as the manipulation of knowledge of an objective world"
 - for recognition of "the impossibility of completely articulating background assumptions"
 - for recognition of "the primacy of action and its central role in language"
- Such a paradigm need not involve the rejection of rationalism and science in favour of holism, vitalism or some other ascientific framework, but rather the re-direction of the rationalistic tradition

Recapitulation

- Data
- Information
- Knowledge
 - Tacit cf. Codified
- Theory
- Paradigm
- **Empiricism** as knowledge derived from the real world
- **Positivism** as outright denial of the worth of non-empirical knowledge
- **Science** as research based on theories that generate refutable inferences