Research through Design
- design through research -

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Thinker versus Tinker

"There is nothing so practical as a good theory."

Ludwig Boltzmann (1884-1906)

"Don't worry about what anybody else is going to do... The best way to predict the future is to invent it. Really smart people with reasonable funding can do just about anything that doesn't violate too many of Newton's Laws!"

(1971)

Alan C. Kay (1940-)

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How do we get theories?

positivism:
{theory, model} \not\in \text{reality}
reality (t_1) \approx reality (t_2)

constructionism:
{theory, model} \in \text{reality}
reality (t_1) \neq reality (t_2)

What kind of knowledge?

Model-T

Theory

Test

Design

Model-D

Design

Theory

Test
Paradigm and novelty

*Paradigm* is an unchallenged theory or set of beliefs, existing worldview (concept introduced by Thomas Kuhn in 1962).

Novel results outside the present paradigm are mainly rejected by the scientific community.
Three paradigms and major barriers

Science

Design

Engineering

Explaining the world

Changing the world

Subjective

Objective

Human Oriented

Technology Oriented

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These persons really changed our world…

Christopher Columbus (1451-1506)

Leonardo Da Vinci (1452-1519)

Nikolaus Kopernikus (1473-1543)

Galileo Galilei (1564-1642)

René Descartes (1596-1650)
“The task is not so much to see what no one yet has seen, but to think what nobody yet has thought about that which everybody sees…

But life is short, and truth works far and lives long: let us speak the truth.”
(1818)

Arthur Schopenhauer [1788 – 1860]
1492 – Conquest of paradise – the new world
What did Columbus see and thought differently…
So, what is TRUTH?

The meaning of the word **truth** extends from honesty, good faith, and sincerity in general, to agreement with fact or reality in particular.

The term has no single definition about which a majority of professional philosophers and scholars agree, and various theories of truth continue to be debated.

There are differing claims on such questions as what constitutes truth; how to define and identify truth; the roles that revealed and acquired knowledge play; and whether truth is subjective, relative, objective, or absolute.

From Wikipedia, the free encyclopedia

La Vérité ("Truth")
Jules Joseph Lefebvre, 1870
“But life is short, and truth works far and lives long…”  Schopenhauer

“Time Saving Truth from Falsehood and Envy”  
François Lemoyne, 1737

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Analysis & Synthesis, Deduction & Induction

**Analysis** (reduction): Separating of any material or abstract entity into its constituent elements.

**Synthesis**: Combining of the constituent elements or separate material or abstract entities into a single or unified entity.

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**Deduction**: A form of inference; if the premises are true, the conclusion must be true, i.e., deduction preserves the truth (equivalent to analysis).

**Scientific induction**: a form of inference in which the conclusion, though supported by the premises, does not follow from them necessarily, i.e., induction does not necessarily preserve the truth (equivalent to synthesis).
Bloom's Taxonomy


Bloom's Revised Taxonomy

Causation, science and common sense

• We have a somewhat problem free handle on talk about causes, effects and causal explanations.

• Example: The beer got me so drunk that I fell down the stairs causing a fracture in my leg.

  That explains why I am moving around using these crutches.

• In science, acknowledging causes and effects is central!
What are causes and effects?

A

B

C
Are there causes and effects?

- We would normally not question that there are causes and effects.

- There seems to be an apparent necessity in causal relationships.

- Causation reduces to spatiotemporal contiguity, succession and constant conjunction.

- Regularities are just things or processes that we see repeated in nature.

- We have no epistemic justification for saying that they are necessary.
Similarity between worlds and causation

• We evaluate worlds with regard to matters of fact and laws.

• Some of these matters of fact will be causal.

• Laws of nature are sometimes considered to be causal.
  – Whether objects fall to the ground will depend on whether they are supported.
  – How far you can jump will depend on whether the laws of gravitation hold.

• So, when we determine the truth conditions for certain counterfactuals we already have to assume that certain causal facts either obtain or do not obtain in the worlds we evaluate with regard to their similarity.
To explain the world, we need to know...

- The cause(s) -- effect(s) relationship(s)
- Factors altering functional relationships
- Systematic context for that information
The basic idea in explaining the world...

X causes Y

Z (hidden variable)

X correlates with Y
Positivistic sciences

• An assumption of linear causality; there are no effects without causes and no causes without effects.  
  \[[\text{Causality}]\]

• A single, tangible reality "out there" that can be broken apart into pieces capable of being studied independently.  
  \[[\text{Reductionism}]\]

• The separation of the observer from the observed.  
  \[[\text{Objectivity}]\]
  – So that the results of an inquiry are essentially free from beliefs, interpretations, etc.

• What is true at one time and place will also be true at another time and place.  
  \[[\text{Universality}]\]
Principle of the minimum

“Ockham’s razor”:

• Elimination of superfluous concepts
  *(pluralitas non est podenda sine necessitate)*

• Scepticism

• Omnipotence principle

William of Ockham
(c.1280 - c.1348)
Criteria for scientific theories

Agreement with data
• Falsifiability (hypothetico-deductive method)
• Repeatability and reproducibility

Coherence or unity
• Internal and external coherence
  (deductive structure)

Generality
• Parsimony or economy
  (Occam’s razor to find the simplest theory)

Fertility
• New implied discoveries
A scientific method is…

“a method of research, in which a problem is identified, relevant data are gathered, a hypothesis is formulated [= discovery], and the hypothesis is empirically tested [= verification]” [Random House 1999]

• *Problem* is a question proposed for solution or discussion.

• *Hypothesis* is a provisional theory suggested as a solution to the problem: either a causal or a non-causal correlation between variables.
Scientific methods

Nomothetic research (in natural sciences and engineering): the aim is to find general causal laws to explain phenomena, theories are usually axiomatic (deductive) systems or sets of models.

Constructive research (in engineering and design): the solution of the problem is not only shown to exist but it is also constructed.

Idiographic (ideographic) research trying to provide all possible explanations of a particular case, for example in history.
Scientific methods (cont’d)

**Action research** (in design sciences): the problem is solved by certain actions whose consequences are evaluated and new actions are specified (iterative improvement, trial and error).

**Case study** (in design sciences): an in-depth, longitudinal examination of a single instance or event, which is called a case.

**Questionnaire study** (in social sciences): a series of questions are used for the purpose of gathering information, which is usually analyzed statistically.
Thank you for your attention…

“Traditional scientific method has always been at the very best 20-20 hindsight. It’s good for seeing where you’ve been. It’s good for testing the truth of what you think you know, but it can’t tell you where you ought to go.”

Robert Pirsig, 1974
“Zen and the art of motorcycle maintenance”
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