

# Making Connections: Construals and Causality

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# Causality as problematic ...

On the notion of causality:

*“Though it is basic to human thought, causality is a notion shrouded in mystery, controversy, and caution, because scientists and philosophers have had difficulties defining when one event truly causes another.”*

*Patrick Shroul "The Art and Science of Cause and Effect"*

# Shrout's two riddles of causality

1. What patterns of experience would justify calling a connection causal?
2. What patterns of experience convince people that a connection is causal?

# Shrout's two riddles of causality

1. What patterns of experience would justify calling a connection causal?
  - **causality as a summary of behaviour under intervention**
2. What patterns of experience convince people that a connection is causal?
  - **using equations and graphs as a mathematical language within which causal thoughts can be represented and manipulated**

# Making bridges ...

Shrout alludes to a statistical technique underlying Judea Pearl's *Causal Inference* theory

... extending the range of mathematical and computational approaches that can be applied to contemporary research questions in the social sciences

# So: is causality **still** problematic ... ?

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*Patrick Shroul "The Art and Science of Cause and Effect"*

A closer look at Shroul's  
account of causality ...

# Shrout: Galileo

- Galileo: *description first, explanation second*
- Galilean ‘equations’:
  - Snell’s Law, Ohm’s Law, Joule’s Law ....
  - “... used long before they were explained by fundamental principles”

*Not really simply equations ...*



# Shrout: Hume

- Hume: causal connections are the product of observation: e.g. flame (cause) / heat (effect)  
“constant conjunction in all past instances”

But how to exclude specious correlation?

As when: *The rooster crows / the dawn breaks*

*Motivating intervention ...*

# Shrout: Russell and Suppes

- Bertrand Russell: causality does not feature in advanced science (cf. invoking an agent in explanation is seen as a point of weakness: “a relic of a bygone age”)
- Patrick Suppes: “There is scarcely an issue of ‘Physical Review’ that does not contain at least one article using either ‘cause’ or ‘causality’ in its title.”

# Shroud on science

**“... physicists talk, write, and think one way and formulate physics in another ...”**

- causality as a summary of behaviour under intervention
- using equations and graphs as a mathematical language within which causal thoughts can be represented and manipulated
- treating interventions as a surgery over equations

Reconciling the two  
perspectives on science ... ?

# Bridging the two aspects of science

David Gooding (1947-2009) historian / philosopher of science ...

*Experiment and the Making of Meaning (1990)*

“How do observers move from the concrete, practical context of individual experience of particulars to the realm of discourse about shared experience in which generalisation, argument and criticism are possible?” (p.xiii)

# David Gooding on Michael Faraday

Michael Faraday (1791-1867)

- Fundamental experiments on electromagnetism ...
  - laying the basis for Clerk Maxwell's equations
- Developed the electric motor
- Had no mathematical training

*How was Faraday able to achieve such results?*

# Gooding on Faraday's methods ...

*...to capture, express and communicate what has not been described before ... [Faraday] resorted to sketches of images, objects and actions and procedural explanations and instructions. Most effective were the mini-motors that he could mail to scientists around Europe with simple instructions to produce the anomalous electromagnetic rotations. These images and devices express ideas that are asserted through the performances aimed at communicating them.*

# Gooding's notion of a **construal** ...

*... To capture Faraday's methods I developed a notion of **construals** as **asserted, quasi-representations** that act both as heuristics (guiding an emerging interpretation of phenomena) and as a basis for communicating and negotiating an emerging understanding.*

The [Faraday and the computer](#) construal



# How Gooding viewed construals

David Gooding. Thinking Through Computing, Warwick Nov 2-3, 2007

Two responses to the mismatch between  
**phenomena** and **prevailing formalism**:

- Constrain the phenomena being studied
  - (cf. Ampere)
- ‘Embrace the monsters’ and explore alternative approaches to representation
  - (cf. Faraday)

# Possible orientations ...

- Making construals as a pragmatic approach to formalism ...

*Begging the question re limits of formalism*

- Making construals as a broader approach to representation that complements formalism

*Relating to the vexing notion of **construction***

*integrating the sociological and scientific*

# Problematic issues

Making construals as a broader approach to representation that complements formalism:

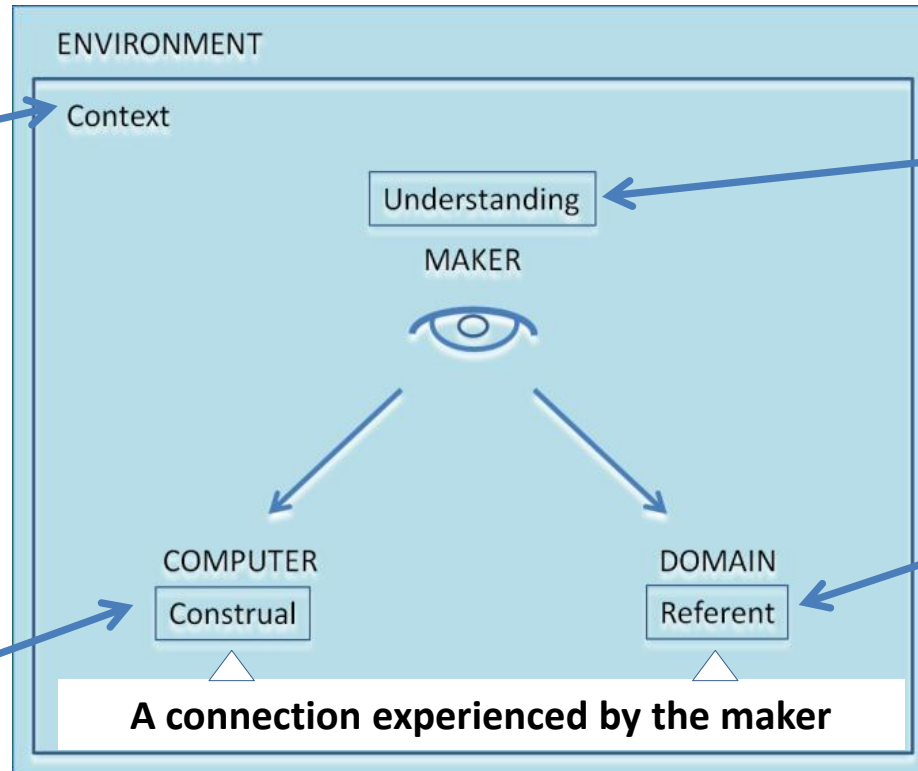
- Bret Victor – “Kill Math”?
- Exploratory Explanations? [The Evolution of Trust](#)
- Bruno Latour – “construction”?
- What basis for *informal* semantics?

Making digital construals ...

# Making a (“digital”) Construal

From which perspective is the maker making the construal e.g. Agents? Constraints?

**Script** of definitions of *observables* with associated **network** of *dependencies*



What interactions and interpretations is the maker familiar with? Convinced of? puzzled about?

What external subject does the maker have in mind when interacting with the construal?

# An illustrative example

The key concepts in making construals are

- observables
  - whose current values shape agent interaction
- dependencies
  - which connect changes to observable values
- agents
  - to which changes to observables are attributed

For a simple example, see [the purse construal](#)

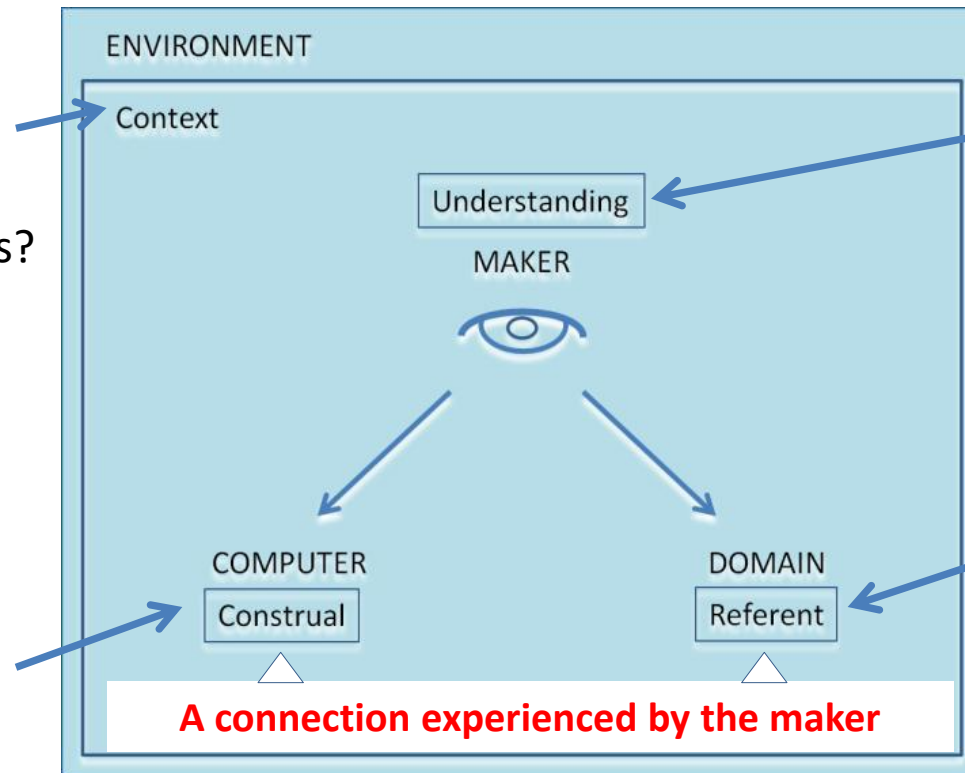
# Connections with Shrout

- Conjunction in experience with intervention as a critical component: cf. Hume
- Live editing of observables (“what if?”) as in Galilean laws
- Families of definitions of observables: cf. equations and graphs as a mathematical language within which causal thoughts can be represented and manipulated
- Open ended interaction with scripts: cf. surgery

# “Human Computing”

From which **perspective** is the maker making the construal e.g. Agents? Constraints?

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Making construals as an *essentially personal* experience



# David Lagadno's experiment

- Causal Cognition Lab: UCL



Studying the circumstances under which an observer will attribute the motion of one object to that of another whether or not there is observational evidence to support such attribution.

# The 'MISTER PRESIDENT' Crossword

*... The remarkable feature of the puzzle is that 39-Across could be answered either CLINTON or BOB DOLE, and all the Down clues and answers that crossed it would work either way (e.g., "Black Halloween animal" could be either BAT or CAT depending on which answer you filled in at 39-Across; similarly "French 101 word" could equal LUI or OUI, etc.)*

*Jeremiah Farrell's Crossword of Nov 5, 1996*

# Roles for making construals

- Objects-to-think-with / ... -to-converse-with  
an explanatory role for making construals
- Commonsense everyday informal reasoning
  - [Adventures in a lift](#)
- Support for design activities
  - [The room construal](#)
- Empirical software development activities
  - [Construing the moment](#)

# Objects-to-think-with

Seymour Papert (1993) Mindstorms

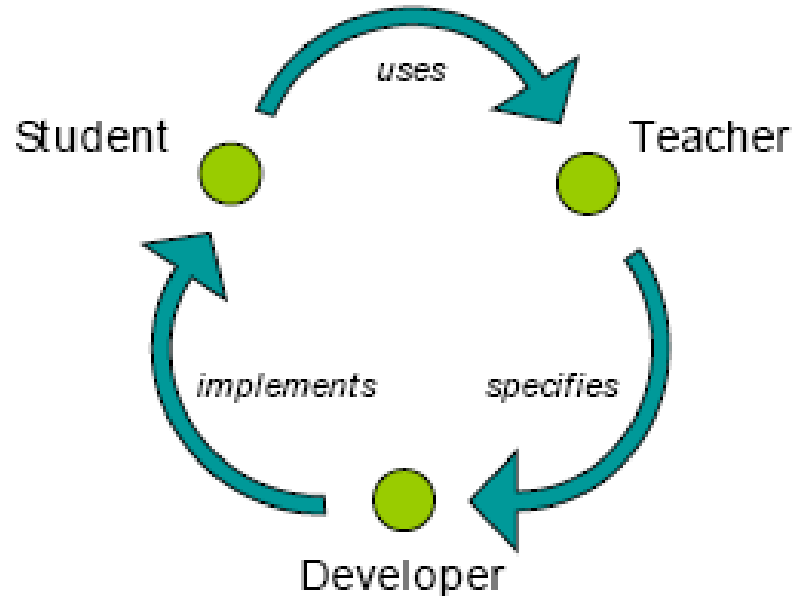
Papert saw programs as *objects-to-think-with*

- The gears of his childhood ...
- Constructionism ...
- Construction as integrating perspectives of designer/teacher, learner, developer

... cf. end-user programming

# Constructionism ...

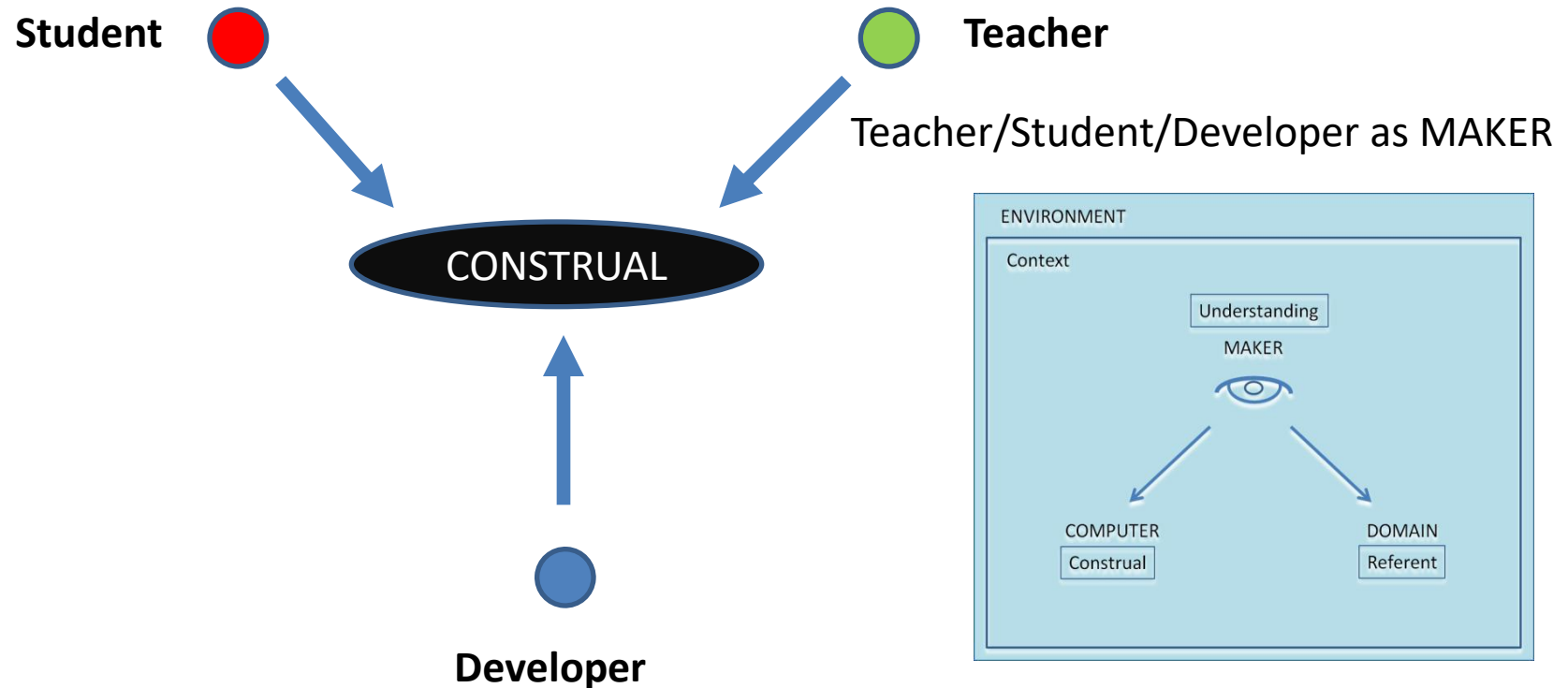
Learning through constructing an *object-to-think-with* ...



The learner plays many roles ... motivates environments in which the learner can be the developer (cf. Scratch)

# Alternative view of constructionism ...

Learning through constructing an *object-to-converse-with* ...



Diverse agents sharing observables and dependencies ...

... as illustrated in the [hex colouring](#) and [OXO laboratory](#) construals



The **Penny Rolling** puzzle (cited in Mindstorms p150)

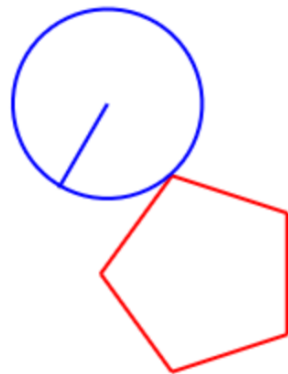
“If one penny rolls around another penny without slipping how many times will it rotate in making one revolution? ...”

“... One might guess the answer to be one, since the moving penny rolls along an edge equal to its own circumference, but a quick experiment shows that answer is two; apparently the complete revolution of the moving penny adds an extra revolution.”

Martin Gardner: *Mathematical Carnival*

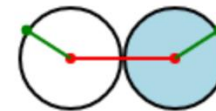
<http://jseden.dcs.warwick.ac.uk/construit/?load=27>

*Penny rolls around a regular polygon ...*

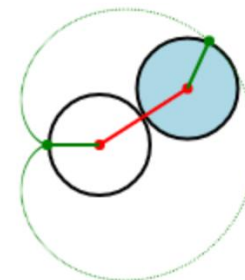


*Can change  $k$ , the number of sides of the regular polygon dynamically*

*Pennies rolling like gears ...  
... with both free to rotate*



*... and with one of them fixed*



<http://jseden.dcs.warwick.ac.uk/construit/?load=8>



# Roles for making construals

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Making connections in experience?

# Causality as connection

- Hume: “constant conjunction in all past instances”
- Have to introduce the idea of “intervention”
- Causality not about what we have always observed in the past but about what we expect *as of now* ...
- For this to make sense, we have to speak of direct live immediate experience ...

# Radical Empiricism

*William James (1910) Essays in Radical Empiricism*

Consult the [notes on radical empiricism](#)

- Conjunction in experience, John Dewey (p2)
- Stance on causality (p6-7)
- Objections (p8)

# Jamesian dictums

- ... subjectivity and objectivity are affairs not of what an experience is aboriginally made of, but of its classification.

*William James, Essays in Radical Empiricism, p141*

- In the empiricist view ... as reality is created temporally day by day, concepts ... can never fitly supersede perception.
- The truth is that neither elements of fact nor meanings of words are separable as our words are.

*William James, Some Problems of Philosophy*

# Resources

[go.warwick.ac.uk/em/construit/followup/bridgesseminar](http://go.warwick.ac.uk/em/construit/followup/bridgesseminar)

[wmb@dcs.warwick.ac.uk](mailto:wmb@dcs.warwick.ac.uk)

# The CONSTRUIT! project

*Making construals  
as a new digital skill  
for creating interactive  
open educational resources*

construit.org  
jseden.dcs.warwick.ac.uk/construit

WARWICK

Helix5



“The environment for making construals” – aka as “the MCE”



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Any questions?