

Human Computing

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A Vision

The hope is that, in not too many years human brains and computing machines will be coupled together very tightly and that the resulting partnership will think as no human brain has ever thought

JCR Licklider *Man-Computer Symbiosis* 1960

What went wrong?

The machine view of computing took over – and has been very successful for a large number of people in the IT industry (financially). Also shaped modern societies.

A technological, and commercial, continuing, triumph ... (including – for mere users - endless frustration, annoyance, expense, assaults on self-esteem, etc etc.)

Not so good for Licklider's vision ... or for human thinking, or culturally, or socially, or educationally,

There are other ways of thinking about computing ...

What might have been better?

Not so much the machine view 'took over' it simply persisted even when computers became 'personal' (1980's).

Wish to outline here a different view of computing that puts the personal into the forefront of personal computing. It comes about because of the presence of the computer and our experience of it, throughout the – joint – computation.

[*Aside: sometimes good things get 'lost' in history.*]

Two questions

What can be automated? (Denning 1985)

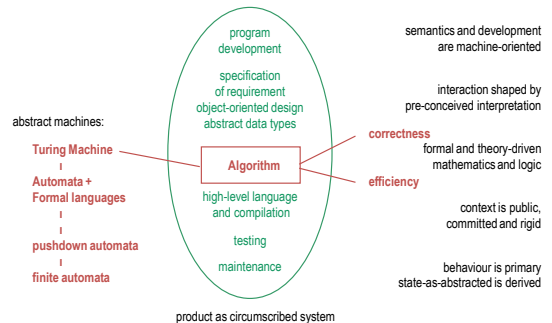
Reflecting a conventional (machine) view of computing

How best can we integrate automated processing with human thinking and acting? (Licklider 1960)

Reflecting a 'human computing' outlook

Focus of conventional Computer Science

computation = execution of algorithm (cf. mechanism + automation)



Empirical Modelling (EM)

EM is the name of our research group and project at Warwick (www.dcs.warwick.ac.uk/modelling)

Empirical: because the way of thinking about, and using, computers is based on observation and experiment.

Modelling: because the key idea of EM is to think of, and to use, the computer as a modelling medium rather than only a programming machine. Modelling begins with making sense. Such human modelling may be accompanied by all kinds of artefacts : visualisations, lego structures, films, writing, PDE's etc.

Human Computing

EM is primarily concerned with human, personal, modelling.

Human Computing is a perspective that highlights the way computing can support sense-making and human modelling.

Such modelling *begins* with sense-making.

The ways in which humans make sense of experience are similar to those which form the conceptual framework for computer modelling in EM. (*Construal, ODA, etc.*)

Human knowing also *begins* with sense-making. Thus computing for sense-making links modelling and knowing.

Why human computing?

Humans do not carry about well-formed, detached, representations of the world in themselves, neither can computers (with all respect to GOFAI and the Cyc project, Cf Hubert Dreyfus, *What Computers Still Cannot Do*, 1992).

Humans do make sense (make *construals*) by identifying relevant *observables, dependencies* and *agencies* in their experience. These are fundamental concepts in the principles and tools of computing with EM.

Charles Taylor

“ ... it is becoming a new orthodoxy that the whole enterprise [of epistemology] from Descartes, through Locke and Kant, ... was a mistake.

The heart of the old epistemology was the belief in a *foundational* enterprise..... [but more widely] belief in knowledge as accurate representation of an independent reality. (p.2 of *Overcoming Epistemology*)

Richard Rorty

“Wittgenstein, Heidegger and Dewey are in agreement that the notion of knowledge as accurate representation, ... needs to be abandoned. For all three, the notions of “foundations of knowledge” and of philosophy revolving around [removing skepticism] are set aside.” (1979, p.6)

Peter Naur

“ ... what is lacking in expert systems and knowledge-based systems is the ability of people to experience complex mental objects, to conceive their sameness, and to make associations ... Lacking these abilities the computer programs fail to model human knowing activity in any significant sense.”

(1995, p.226)

George Edelman

“We are not detached observers of the world, operating through “representations” in our mind. Instead we are agents embedded in the world, gaining our knowledge through action in the world.” (2006, p.46)

Broadening the view

Many thinkers in recent decades are advocating broader views of knowledge and knowing in many disciplines.

Some (few) are also calling for a broader view of computing: Winograd, Naur, McCarty, Cantwell-Smith, Jackson, etc ...

Empirical Modelling is setting out a plausible way forward for a broader approach to computing (theoretical and practical).

Making sense

Sometimes we are facing a new phenomenon which we do not understand. For example:

- we are very young
- we are just ignorant or lazy
- it has not occurred to us before
- it's another human being
- no-one understands it

There is a human urge to ‘make sense’ of things. Often we make up our own ‘story’ to do this.

Sense and Construal

Making a ‘story’ to make sense of something - in everyday life, in science, or in the arts or in our imagination, is a ‘construal’.

It is a personal, provisional idea expressed in words and images – even physical material, or computer displays. It will need revising.

Things we now understand well began as a construal and *may* later be modelled by equations, logical forms, or programs.

Is sense-making computing?

Thomas Hobbes (around 1660) claimed that reasoning was a form of calculation.

A key idea of human computing is to broaden the conception of computing to include understanding and sense-making. It thus opens the way to a closer integration of human processing with machine processing.

Human Computing as complementary

Conventional computing relies on specification and design in formal and abstracted ways, when logic, language and mathematics are used for description and implementation and exploited in reasoning and modelling.

Human computing is complementary and makes immediate, raw, experience fundamental: *it is the development of a construal with a computer.*

Not the *alternation* of human and computer interaction, but the *continuous engagement* and negotiation of the human with the computer.

What it's not and what it is

- Not something humans alone can do, nor is it computing for human affairs, nor 'soft' computing, nor HCI, nor human-centred computing
- Computing that proceeds with the essential and continuous engagement of human cognitive processes, a 'symbiosis' of the human and electronic
- Most computing has not been of this kind, some of it already is, and much of it will be in the future

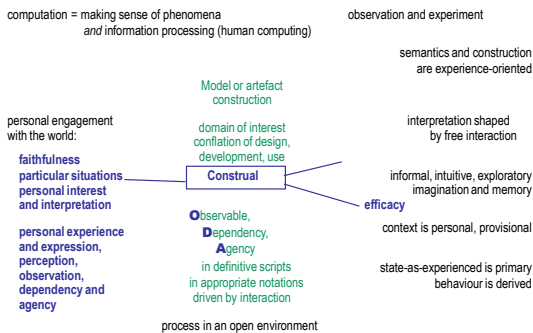
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Some examples

- Arithmetic with an abacus is an example of joint activity between a human and a very simple device.
- Construction and experimentation with spreadsheets for combining results from coursework and exam questions, or for elaborate financial analysis.
- Using EDEN or JSEDEN for modelling in which the introduction of observables, and (re-)definitions of dependencies, by a modeller is guided by comparing interactive experiences of model and referent.

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Empirical Modelling: a broader view of computing



EM: from informal to formal

EM is a framework for the movement between the less reliable to the more reliable:

- | | | |
|---------------|---|-------------|
| • state | | behaviour |
| • experience | → | abstraction |
| • modelling | | programming |
| • experiment | ← | procedure |
| • environment | | system |

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Experience in action

The artefacts we build with the computer are themselves a source of immediate experience which relates – through interaction – with experience of their referent.

This drives their incremental development and gives grounds for confidence in their reliability.

The computer becomes a medium with which to think and explore - prior to 'programming'. It allows us, "to make thinking visible" (Zdenek Kosopetsky). Cf written language

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What happened to 'experience'?

"The concept of experience went from being the most useful concept for philosophical purposes to being one of the most neglected or villified concepts over the course of the twentieth century."

Marianne Janack, *What We Mean by Experience* p.21

Software development?

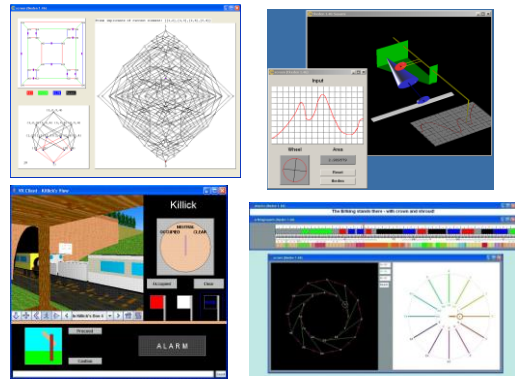
Realising Software Development as a Lived Experience, Meurig Beynon (See EM webpage -> Publications -> 2012)

Many of our models, and tools, are simple and crude, without any commercial level of development ...

Can do quite complicated things ...

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Sense-making in mathematics, in the physical world, social interactions and music ...



Cognition complements realism

But our strength currently lies in doing simple things with cognitive integrity (computerised 'back of an envelope'). Some models exhibit 'cognitive layering'.

Human computing (and EM) contrasts with conventional computing with regard both to computation and to knowledge.

E.g. knowing a city v. knowing how to use the underground, real personal knowledge v complete propositional knowledge (GOFAI) [NB not exclusive!]

Goal of EM modelling is to gain understanding - holding together multiple viewpoints – keeping interpretations open and allowing extraction of programs addressing many goals.

Foundations of Computing?

Cantwell-Smith (2002) begins from the gulf between computing practice and the 'theory of computing' (computing science).

Examines six major current construals of computing against his criteria and finds them 'wholly inadequate'.

Concludes with remarkable vision of computing not as needing foundations but as providing 'foundations'.

Another vision ...

"For sheer ambition, physics does not hold a candle to computer or cognitive—or rather, as we should now call it, in order to recognise that we are dealing with something on the scale of natural science—*epistemic or intentional science*.

Hawking (1988) is wrong. It is we, not the natural scientists, who must develop a theory of everything." *Cantwell-Smith (2002)*

Empirical Modelling in 2012

Human computing (or EM) is a step towards bridging the theory-practice gulf, and the machine-human gulf, through a radical re-thinking of computing in terms of experience and construal.

Principles of this approach are well-formed, the practical tools need more development.

Conclusion

Human computing (EM) gives conceptual and practical support to the imaginative and interpretive aspects of human experience.

It does so by taking seriously the interactive experience offered by modern computing and making this the basis of a semantics of modelling and programming.

EM offers a rich framework able to support modelling across many areas of knowledge.

Further reading

Meurig Beynon, *Radical Empiricism, Empirical Modelling and the nature of knowing* 2005

Meurig Beynon, Steve Russ, Willard McCarty, *Human Computing – Modelling with Meaning* 2006

Meurig Beynon, Steve Russ, *Experimenting with Computing* 2008

W.M.Beynon, R.C. Boyatt, S.B.Russ *Rethinking Programming* 2006

Can all be downloaded from:
www.dcs.warwick.ac.uk/modelling

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Brian Cantwell Smith, *The Foundations of Computing*, 2002
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Gerald Edelman, *Second Nature*, Yale, 2006
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