AHRC ICT Methods Network Workshop and Network

THINKING THROUGH COMPUTING

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Report by Steve Russ and Meurig Beynon

Background

Empirical Modelling (EM) is a long-term research project in Computer Science at Warwick that is principled, practical, and yet has strong, explicit, philosophical roots. It involves regarding the computer as primarily offering a *modelling* medium: one that can be used by, or with, people to carry out a multitude of tasks, and even, characteristically, no specific task at all. (By the latter we have in mind the imaginative activity of exploring, experimenting or designing in which we formulate, in a new domain and perhaps for the first time, provisional worthwhile tasks – soon to be reformulated in the light of better understanding.)

This outlook subsumes, without replacing, the more familiar roles of the computer in implementing algorithms, processing information, being a communication medium and so on. Far from being a mere change in perspective on computing however, the approach challenges many conventional assumptions about computing and has some radical theoretical and practical implications. Many others, though travelling different paths in different territory, have also found the need to seek a broader perspective on the nature of computing. It was with a view to exploring and articulating these issues, and to joining forces in their understanding, that this meeting and network was conceived. Because of the emphasis on modelling (and therefore semantics), the perceived need to include human aspects within the computational framework, and our interest in a more phenomenological outlook on computing, it was natural to invite experts from humanities computing (Willard McCarty, King's College London) and philosophy of technology (Don Ihde, SUNY, Stony Brook) to be major contributors.

Contributions

For participation in the workshop we invited people known, through personal contact, or publications, to be dissatisfied with the conventional story and status of computing (that is, with computers viewed as essentially Turing machines, grounded and governed by mathematical and logical theory). Involvement with the associated network was, and remains, open to anyone interested. On the first day of the event there were substantial talks from Meurig Beynon, Willard McCarty and Don Ihde. Participants had all been asked to provide some indication of their own 'perspective on the nature of computing'. Many participants responded with something especially for the occasion and their contributions are on the webpage (together with our own 'model answer'(!)) - see the link from www.dcs.warwick.ac.uk/modelling/. We had short talks on the Saturday grouped as follows:

Modelling:

Willard McCarty (King's College London)
David Gooding (University of Bath)
Charles Care (University of Warwick)
Susan Stepney (University of York)
Adzhiev/Pasko (Bournemouth University)

Interaction/Information:

Peter Wegner (Brown University)
Neil McBride (De Montfort University)
David Clark (UCL)
Carsten Sørensen (LSE)

Thinking and Philosophy:

Don Ihde (SUNY, Stony Brook)
Annamaria Carusi (University of Oxford)
Hans-Joachim Petsche (Potsdam University)
Petra Ilyes (University of Frankfurt)

Three ingredients that served as reference points in most of the contributions were: the classical theory of computation; the contemporary practice of computing in the wild; philosophical stances that are more varied and broad than the 'analytical' emphasis on logic and language that has dominated much of traditional computer science, albeit implicitly. In spite of many differences in the focus of contributions they overlapped in addressing in various ways the question, 'Is there a coherent alternative to the classical view of computing?'

Peter Wegner's notion of 'interactive computing' and the research into non-standard models of computation associated with the GC7 Grand Challenge, as represented by Susan Stepney, aim at supplying broader foundations for computing by extending the concept of computation and/or promoting alternative approaches to software/systems development (as e.g. in Woodcock's *Dependable Systems Evolution*). The talks by Carusi, Ilyes and Care all offered some form of implicit critique of the classical story of computing. Carusi expressed deep scepticism about the naive way in which topics such as realism in visualization are being addressed by conventional computer science. "By what criteria" she asked. " should we judge what is a *good* account of realism in visualization?". Ilyes likewise challenged the meaning of 'representation' that is taken for granted in computer science but used in different senses within the social sciences. Both Carusi and Ilyes highlighted the difficulty of connecting the accepted fundamental science of computing with an experiential perspective on computers. Care gave strong further motivation for thinking of computers in physical terms by drawing attention to analogue computing as a vital ingredient in the history of computing. His talk also provided evidence of ambitious and successful applications of computers that demand a broader view of the underlying science.

Many contributors were keenly aware of the tension between the constrained way in which computing is conceived within classical computer science and the diversity of computing practice. Typically practitioners sensitive to such issues do not directly question the status of classical computer science. They seek instead to introduce a meta-story that can overcome its limitations: arguing that there is something in addition to computation that is being interpreted in practice. This is consistent, for instance, with the way in which Willard McCarty - developing a theme introduced by Mike Mahoney – sets out to demonstrate that plurality of computing of which humanities computing is a part. It is also represented in Carsten Sørensen and Lars Mathiassen's account of the roles played by the computer in information science. In McCarty's account, humanities computing is linked to a meta-activity that exploits modelling as a mode of problematization. In Sørensen and Mathiassen's account of business activities, classical computer science is directly associated with just one of four kinds of human-computer interaction, where the emphasis is on computation, rather than networking, collaboration or adaptation. Valery Adzhiev and Alexander Pasko's discussion of the applications of computing in areas such as art and the preservation of cultural heritage likewise drew attention to the need for a "higher-level" alternative to traditional computational techniques for representing geometry. In all three application areas, significant points of connection with Empirical Modelling can be identified.

Other contributors spoke about the way in which their own experience and understanding of computing practice suggested a reading that was quite at odds with the interpretation offered by classical computer science. David Clark explained how his experience of programming and his research into the history of computing pointed to a view of 'programming as rhetoric'. Petra Ilyes outlined how her experiences of working on software requirements highlighted the constructive nature of computer-based representations. Neil McBride stressed the discrepancy between creative interactive use of computers and the practices that are endorsed by viewing computing from an orthodox computer science perspective. To a greater or lesser extent, these three contributors called into question the relevance of classical computer science to contemporary computing practice, and envisaged a future scenario in which academic computer science would have very little connection with computing in the wild.

Many of the contributions to the workshop were implicitly associated with a philosophical reorientation. For Wegner, the notion of interactive computing highlighted the importance of an empiricist perspective. A significant question relating to the scope of 'interactive computing' is what kind of interaction is envisaged. McCarty, in an informal discussion relating to this point, cited the distinction between interacting with a car as a mechanic or as a driver. Such a distinction points to two very different kinds of interpretative framework - one in which the type of interaction is relatively closed and within the scope of a manual, whilst the other is more open-ended. Wegner's account of interactive computing seems to aim at extending the concept of Turing computation in a way that retains the qualities of a formal semantic framework, but - in the process - also inherits the limitations. A similar stance towards semantics is perhaps characteristic of the non-standard models of computation, even when (as in evolutionary models of system development) the method of generating the semantic relation is unusual.

What is problematic from the formal perspective is that the interpretations of interactions with computers are in no sense constrained to formality, and - in some contexts - the ways in which the effects of computational processes engage with wider experience of the world are arguably not merely informal and unsystematic but wholly mysterious. It is precisely because McCarty does *not* know why something in Ovid's *Metamorphoses* is personified that he constructs his Onomasticon. This accounts for the need to use the computer in a way that stresses the hermeneutic aspects, making models not on the basis of absolute knowledge of a theory, but as a means to constructive problematization. The notion of courting an explanatory formalization with no expectation of ultimate absolute success is at the heart of McCarty's vision for humanities computing. The difficulty for classical computer science is to explain what possible role the computer can play in conducting this courtship with integrity. At the workshop, this issue was brought sharply into focus by Wegner's reaction to McCarty's talk: 'But you haven't told us what is *bad* modelling'.

The contributions mentioned so far were all explicitly connected with computing. They were complemented by three further contributions by Ihde, Gooding and Petsche, that can be seen as pointing the way to a more radical rethinking of computing such as is conceived in Empirical Modelling. They are all associated with philosophical investigations that put key characteristics of the classical view of computing into a quite different perspective.

Ihde's philosophical position can be characterised as 'post-phenomenology'. It represents an experience-based philosophy that is contra-Cartesian, and so dispenses with the Cartesian language of 'organism' and 'environment' used by Husserl and Dewey in their accounts of phenomenology. In a post-phenomenological treatment of computing, the technological object, the human and the environment are not to be separated - analysis must take all these into account together. The focus is upon the 'possibility structure of a phenomenon', where the possibilities in general exhibit multi-stability and admit several perceptual variations. In the search for such variations, the experimenter is not cast in the role of a passive receiver, as in early modern epistemology, but experiments through intervention and construction. In respect of such activity: "the smarter you are, the more you tinker, the more robust the result". Viewed from a post-phenomenological perspective, both the humanities and the sciences are seen as engaged in essentially the same kind of hermeneutic activity, where each is concerned with the construction of

instrumentally realistic images. The distinction lies in the emphasis placed in the humanities on the individualistic rather than the corporate nature of the investigation. And where the problems of the analytic tradition stem from the mind-body problem, those of post-phenomenology reflect the 'body-body' problem - the difficulty of relating the *mechanical* and the *organic*.

Where Ihde's presentation called the duality between the machine and the human agents interacting with the machine into question, Petsche's talk concerned philosophical writings that commend a view of the nature and role of mathematics in computing that differs from that afforded by classical computer science, and is better oriented towards a phenomenological stance. Drawing on the ideas of Whitehead and Poincare, it places the emphasis upon 'process' not 'substance', and stresses the essential role of the human interpreter in the effective application of mathematics. Of particular relevance to the movement away from the mechanical interpretation of formal language that is characteristic of traditional models of computation is the quotation with which Petsche concluded his talk:

'Modelling is a synthetic process whose combinational power cannot be handled with general descriptive knowledge but necessarily includes imagination, intuition and contingency.'

Modelling in this spirit is closer to McCarty's vision than to the routine application of mathematical models that is prevalent in scientific computing.

The philosophical reflections highlighted a reorientation, or a reconceptualization, that led McCarty to speak of "the new computer science". The presentation by David Gooding perhaps best clarified the potential nature and scope of such a reconceptualization. Gooding's work is directed at addressing problematic issues in the received philosophy of science. His rethinking derives added force from its close relationship to authentic historical scientific developments - specifically those that led from the experimental practical work of Faraday to the theory of electromagnetism as set out in Maxwell's equations. A central concept in Gooding's philosophy is the notion of a construal.

This does not refer merely to a mental construct (as in "this is how I construe it") but:
'Construals are practical, situational and often concrete. They belong to the pre-verbal context of ostensive practices [...] a construal cannot be grasped independently of the exploratory behaviour that produces it or the ostensive practices whereby an observer tries to convey it.'

(*Experiment and the Making of Meaning*, 1990, p.22,88)

Faraday's construals took the form of images to help him order his manipulation, some of which proved to be useful in taming phenomena. In this context, the relationship between the experimenter and his construal has quite different characteristics from the relationship between the human interpreter and the machine in classical computer science. As Gooding's description indicates, the construal is intrinsically bound up with how the human interpreter interacts with it. Because the development of the construal is associated with trial interpretations of unfamiliar experience, it is - in the first instance - neither 'modelling for' nor 'modelling of' in the sense of McCarty. In effect, it is an activity that typically takes place prior to the emergence of clear roles, referents, purposes and theories.

Gooding's account of Faraday's experimental work illustrates clearly the sense in which the interpretation of construals precedes the classification of experience associated with classical dualities: the mental and physical, subjective and objective. This is in keeping with the spirit of phenomenology. A close parallel can be drawn between the ways in which Faraday's construals were exploited and the ways in which computer-based artefacts are being used in some modern computing practice, and essentially in Empirical Modelling. Gooding contends that the notion of construal is necessary to do justice to how the practical artefacts and theory of electromagnetism came into being. Where *Thinking Through Computing* is concerned, a similar notion of construal is quite as relevant as a means of making sense of the relationship within classical

computer science between procedural accounts of functional objects such as computer programs and declarative accounts of the logical structures that purport to justify such programs.

Conclusions

There was a strong sense in the final session of the workshop that participants had appreciated both the substance and the style of the meeting. While many communities of practice were represented there was evidence of a common interest, and some confidence, in the emergence and shaping of a 'new computer science' that would not only be of special value to computing in the humanities but to computing in relation to all human endeavours. The meeting (and resulting network) was an exciting new venture for the Empirical Modelling group bringing us into many new communities. It also represents a pioneering venture on the part of the Methods Network into strategically important new ways of developing and using computing resources. We have interest from three journals in publishing articles arising from our Workshop and we are planning a follow-up meeting in April 2008.