

Report on the
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Cognitive Technology, like Digital Creativity, is an expression that bridges two worlds. Cognition and creativity are essentially human characteristics, whilst digital technology is the province of the computing machine. Both Cognitive Technology and Digital Creativity are elusive concepts whose interpretation demands a deep understanding of the relation between the human and the machine. Throughout this fascinating conference, the question *What is Cognitive Technology?* ran in counterpoint with two related questions: *To what extent is a human being like a machine?* and *To what extent can a machine be like a human being?* What was distinctive in the treatment of these themes was the vision that I felt had inspired Barbara Gorayska, Jonathon Marsh and Jacob Mey in establishing the conference: that the marriage of human and machine could be more than the sum of its parts - for richer, for poorer, for better, for worse.

It was most apt that CT97 should put so much emphasis on the importance of situated activity and context. There can be no better place than Japan to contemplate intelligence and mechanism in relation to people and technology - the strength of its social conventions, the reliability of its technological infrastructure, the complexity and subtlety of its language all illuminate this relationship. There can be few more appropriate contexts at present than higher education, where escalating class sizes and costs promote pressure for more efficient but more impersonal teaching methods that threaten to subvert the search for personal fulfillment for ourselves, our families, our friends and our students. There is no research issue more congenial to me than seeking a framework for modern computer science within which to interpret the emergent culture of human-machine interaction of unprecedented complexity, intensity and subtlety.

A formulaic prescription for writing a conference report is to give a brief, and as far as possible objective and impersonal, synopsis of the proceedings. Despite the excellent thematic organisation of the conference programme, the contributions were so eclectic that it would be hard to write a coherent report of that nature, and what I have been able to reconstruct has more the character of a personal testimony. My own agenda for CT97 was the exposition of our research on the Empirical Modelling (EM) Project (as advertised on <http://www.dcs.warwick.ac.uk/pub/research/modelling>) as a potential foundation for the emerging discipline of Cognitive Technology. This report will focus on philosophical themes arising from the relationship to EM.

As a prologue to the conference, Marsh, Gorayska and Mey framed the ideas that were central to Cognitive Technology as they first conceived it. These included emphasis upon:

- a. the process rather than the product;
- b. technological enhancement as opposed to technological constraint;
- c. how technology affects our conception of the world, and effects adaptation
- d. understanding the relation between the world as experienced and the world as conceived.

These concerns resonate strongly with EM:

- a. Our primary preoccupation is also with process, not product, and it is hard in practice to convince our reviewers that a model can have significance beyond the scope of a particular functionality. There is an ambiguity about whether process refers to how the designer conceives and constructs the product, or to a holistic perspective on user-computer interaction. In EM, a similar ambiguity arises from our definition-based spreadsheet-like representation of state, where it is possible to conflate design activity with use.
- b. Mey spoke of technological constraints as operating as closures, defined from the

outside-in, and of technological enhancement as associated with wholeness, defined from the inside-out. EM is centrally concerned with using technology to liberate model building from a closed-world culture. It conceives model-construction as an essentially situated process that relies upon the open and transcendent character of experience.

- c. EM views computing technology as a means to generate experiences. It promotes a holistic perspective that embraces the computer as an artefact, as a prosthesis and as an instrument.
- d. Mey referred to the dominant philosophical emphasis, originating from the renaissance, on the world as shaped by concepts within our minds rather than by experience. EM is much concerned with understanding the limitations of formal language, and with redressing the balance between the experiential and the conceptual as represented in particular in theoretical computer science. A major topic of concern for this research is a common phenomenon of computer science referred to by Masoud Yazdani in his account of CAL as "successful application through the subversion of theoretical concept".

Human and/or machine?

The human-machine duality pervaded the conference agenda. Recurring themes were the projection of mechanisms onto human behaviour, and the projection of human qualities onto machines. There was concern about associating simple mechanisms with complex humanity, and about attributing complex human qualities to simple machines. I had always subconsciously connected a logicist view of AI with an over-simplification of what-it-is-to-be-human that aims to reduce intelligence to the application of rules, and had often criticised logicism from the philosophical position that was most eloquently expressed at CT97 in the introduction to Christopher Lueg's paper on situated design. The cognitive approach to agent-oriented modelling, represented at CT97 by Hrushikesh Mohanty's paper on a strategy for goal adoption by Belief-Desire-Intention agents, strikes me as vulnerable to this criticism. In contrast, the situated treatment of agency presented by Kerstin Dautenhahn was sufficiently open-ended to accommodate behaviours that could defy such reduction, and seemed more in tune with the general spirit of CT97. But, for me, by far the most startling perspective on this debate was that presented by Rodney Brooks at the very end of the conference.

Brooks' work is solidly non-logicist in its philosophical stance. I find his approach to the analysis of agency, with its forceful emphasis on eschewing representation and reasoning, very congenial. Though our work on EM has involved nothing of the same nature as Brooks' ambitious construction of physical systems, there seems to be every prospect of relating his essentially empirical approach to our observation-oriented analysis of agency in EM. There are patent points of contact between EM and Brooks' interest in "making systems part of life", in experimentally grounded analysis and implementation of stimulus-response patterns, and in associating intelligence with primitive and pragmatic observations ("a sitting event occurs where people change their height"). In stark contrast, the philosophical position that Brooks presented at CT97 was quite dramatically different from that I had adopted in my paper: "We are just machines, even simple machines ...", "We keep anthropomorphising people too much ...". It was instructive to see reductionism and logicism as orthogonal viewpoints, and to recognise the concept of the BDI agent as potentially representative of a more flattering view of human agency, such as (to echo a concern of Gorayska) might distinguish the psychopath from the saint.

The theme of what it is to be human (I hesitate to say fully human for fear of anthropomorphising people too much) is implicit in our concept of education. Kevin Cox gave a chilling account of higher education as it might be when driven into web technology via economic exigency. Jennifer Glos heartened those of us in fear of redundancy by extolling the virtues of being educated at MIT rather than at a workstation in Ohio - the financial sacrifice notwithstanding. Yazdani's vision of education with web-technology ("do it better" vs. "do it cheaper") was the more reassuring: encompassing acquisition of knowledge, cultivation of criticism, training in skills, and affective and social developments. For the time being, at any rate, it also put a refreshing distance between human and machine.

For those who believe that anthropomorphising dignifies behaviour, the dangers of imputing too much intelligence to machine behaviour are readily acknowledged. As Richard Janney remarked: Against our will - contrary to our reason - we empathise with computers. Pathologies of human-computer interaction were much discussed in relation to the Tamagotchi phenomenon, and nowhere more dramatically illustrated than in the postscript to Janney's paper, which referred to

the case of a computer user who sought psychotherapy after physically abusing his family of PCs. The potential benefits of making machines imitate characteristics of human interaction were quite as much in evidence at CT97: notably in Frank Biocca's lucid account of the role of embodiment in VR, in Glos's work on using digitally augmented keepsake objects to assist children in "finding their voice", in Masuda's research into the role of head movements in communication, in Brooks' robot that entices people to talk to it because its eyes follow the sound of the speaker's voice. The implicit conflict between benign and malevolent influences of humanoid technology was eloquently exposed by Biocca in his keynote address: *The Cyborg's Dilemma*. A technology that imitates human behaviour closely can help us to interact with computers in a more direct and rewarding manner, but at the same time can seduce us into developing inappropriate and potentially dangerous expectations about the nature of the external world.

Worldless Words and Wordless Worlds

The status of language in communication, knowledge representation and modelling was a topic of particular interest to me throughout the conference. Many presentations at CT97 stimulated me to re-examine the assertion in my conference paper that EM aims to lay a principled foundation for pre-linguistic, pre-articulate representations beyond the scope of symbolic AI. On the one hand, several of the most prominent participants came from a linguistics background, and introduced me to theories of language beyond the range of formal languages studied in theoretical computer science. On the other hand, there were many fascinating papers demonstrating practical work on the analysis of processes and experiences. For me and for EM, these disparate sources suggest valuable new directions for scholarship, and potential case-studies for consideration in the longer-term. They also represent two completely different perspectives that both Cognitive Technology and EM have in some way to reconcile.

The papers that were particularly focused on sensory issues and perception were those by Lenay and David Good. Lenay's paper gave a most interesting account of experimental work that examined sensory substitution, in which optical inputs from a camera were converted into tactile stimuli. Lenay's research demonstrated that with training in the use of such technology, blind users could learn to identify objects, and apprehend new concepts such as parallax, shadows and superposition. A significant emphasis in this work was that the user had to be able to act on receptors as well as to receive tactile input. This association between 'primitive knowledge about our environment' and 'patterns of interaction we recognise in processes we conduct as active agents' is an important theme in EM. It would be most interesting to be able to formulate within EM such remarkable observations as Lenay's characterisation of position as a rule of anticipation that links action and sensation.

Good's paper dealt in a most enthralling way with a related theme: how best to provide auditory assistance for navigation to the blind. The theme of his talk was that the blind train their ears to listen to their environment in ways resembling the intelligent use that sighted people make of their eyes. Getting a sighted person to construct a binaural recording that is useful to a blind person is analogous to asking a blind person to make an intelligible video. Only by getting a blind person to make their own binaural recording of an environment is it possible to create a navigational aid in the form of an auditory map for other blind people. There were many intriguing aspects to Good's talk: the personal testimony of blind users ("I've heard many corners before, but I've never had a chance to listen to one", "this building sounds terrible"), the analogies between auditory and visual environments (noise = light, invariants of the auditory environment = visual objects), and the potential for computer simulation of environments from an auditory standpoint.

Dependency relations that link conceptual features of a situation to more primitive observables are common in EM. Brooks's characterisation of a chair as a sitting place, and thus as a place where people change their height, is in this spirit. As computer-related technology matures, there is more and more emphasis on ways of integrating abstract interpretations into models. A variety of different kinds of research on this general theme were represented at CT97. Thomas Stoffregen presented the results of experiments on the perception of affordances that were designed to give insight into how displays for control systems might best inform the user about constraints operating on the system. A key theme in this work is that monitoring the parts of the system alone was not sufficient. A more holistic way of representing the behaviour of the system than the conventional bank of dials monitoring every component is required. Herder's paper *Enhancing perspicuity of objects in a VR environment* provided an abstract context for related concerns, stressing the need to represent the features of an interface or model so as to reflect their meta-level

significance to the human interpreter. Zeiliger and Belisle's new web browser that serves as personal knowledge construction environment was a practical demonstration of what is involved in 'transforming an artefact into a tool'. Nehaniv's account of how sophisticated mathematical models can serve as generalised coordinate systems to give cognitive empowerment addressed a similar concern at a much higher-level of abstraction. The above review of research topics, from Lenay through to Nehaniv, has been set out to reflect a spectrum of research activities associated with Cognitive Technology. At one end of the spectrum are activities where the emphasis is on personal viewpoint, and on the intimate relationship between knowledge and situated processes of interaction in which familiarity identifies invariants, and generates expectation. At the other end are the powerful universally acknowledged abstractions that express refined knowledge of reliable and general relationships. In essence, this spectrum of activities is familiar to me as what appears in my conference paper as *An Empiricist Perspective on Learning*.

Reviewing these applications as a whole, I found it hard to imagine a linguistic perspective on such existing, nascent and potential developments in computer use that appear so essentially beyond and before words. Only at one extreme end of the spectrum, in Nehaniv's research, are we in the province of formal language. A sophisticated coordinate system is an excellent way to embody deep knowledge about the structure of a particular domain. Where we are without deep knowledge, as in Good's first forays into the auditory world of the blind, a sophisticated coordinate system is only as relevant as the Shinkansen to an Antarctic explorer. Be that as it may, the influential presence of linguists was what distinguished CT97 from previous conferences I have attended on computer-related topics. I much appreciated the literary element, as evidenced by what is (to a computer scientist) an unfamiliar tradition of presenting papers verbatim. On several occasions, I noted words that were new to me. I had a sense of language being used by virtuosos wrestling at the limits of the expressible.

One concern is that the classical linguistic stance on user-computer interaction operates with an obsolete stereotype of communication: that of two agents taking turns. Audio-visual, tactile and kinesthetic processes involve analogue continuous input. Typical human-human interaction essentially involves simultaneous uncircumscribed interaction between several participants and their environment. It seemed to me significant that the papers of Haberland and Janney didn't address issues such as the use of spreadsheets: a paradigm that has much more in common with the internal processing associated with personal knowledge construction. The dangers that attend too narrow a view of language were underlined by William Martens' observation that dyslexics, unable to cope with grapheme to phoneme conversion, could demonstrate superior understanding of mathematical concepts through the use of manipulatives.

It was fitting that my impression of Western learned theories of language colliding with new frontiers should be complemented by the creative and subversive celebration of language that was associated with all things Japanese. Listening to Okuyama's vivid and eccentric review of billions of years of brain evolution, pondering the way in which he cheerfully challenged our comprehension with such mischievously obscure phrases as *The Tragedy of Gender*, it was no surprise to find - in a paper that blazes to its conclusion with the poetic typos: "to err is humane", and "Nowadays computers themselves communicate with each other. Will they whisper lovely words some day?" - this apt and powerful sentiment: Language thus helps one build a new world of one's own. No wonder that Zhang et al should explore communication that requires three modalities, and that the construction of a database for the retrieval of a single Japanese character should demand all of Lothar Schmitt's UNIX expertise, and more. All this found its echo in the environment of Aizu itself, with "I Love Street" at its commercial centre, the nearby Slut boutique, and the chain of Kiosk stores, to which are attached the eight epithets: Mart, Plaza, Gift, 24, Your, Tasty, Let's

Sadly, I never learnt how to kiosk, nor ever found a restaurant that served one. Even making allowance for the impact of Saki upon our collective consciousness, it seemed though that we were beginning to make contact with that distinctively Japanese concept *kansei*. Under the tutelage of an Swiss-Italian-French-Japanese alliance at Ibaraki and their spokesman Luc Berthouze, we learnt how to craft plain words, in all their semantic inadequacy and slipperiness, into metaphors for the transmission of complex subjective information. By way of practical demonstration, as Berthouze and his disciple Mey proposed, Cognitive Technology might be most aptly characterised as *mistake-ology*, *mis-technology*, *mysticology* ... but who can say? What was clear was that beneath a veneer of playfulness lay profound uneasiness about the very categories of our language. Was Lueg constructing "a model"? was Janney really talking about "interaction", and with whom - the

computer, or the program designer? was there really any distinction between "the natural" and "the artificial", as Haberland asked? and did Kari Kuutti's paper call into question whether words can express what we mean by using technology for "augmentation", "amplification" and "mediation"?

One of the highlights of the conference for me was Naomi Miyake's beautiful practical illustration that understanding is an iterative process of shifting from understanding to non-understanding. It seems that you can't say this in words, as attempts to eliminate the self-reference prove. A similar principle seems to apply not only to the transition from uncertain to certain knowledge but to the category shifts associated with personal to public knowledge, particular to general knowledge. I'm convinced that empirical activity centred on processes and artefacts is essential to conveying such semantic subtlety, and see this as an inevitable point of arrival for Janney's pragmatic linguistic stance: language is an embodied phenomenon. The key to developing this theme is implicit in a comment made in the context of Biocca's presentation that our simulation system is what distinguishes us from other animals, and it could be good to enhance it.

Epilogue

I do not look forward with enthusiasm to the day when there is technology to generate such a report as this automatically, but neither do I imagine for a moment that it ever will. I remain sceptical about Brooks' contention that, just as the work of Galileo displaced the earth from the centre of the universe, we in the next millennium will be compelled to view the human as merely a machine. My philosophical preference is for a pragmatic approach to determining viewpoint and ascribing agency in the spirit of William James' Radical Empiricism: for some practical purposes perhaps it is as well to regard the earth as the centre of the universe, and myself as more than a machine. All in all, this leads me with uncharacteristic immodesty - if it is possible to speak modestly of oneself in such terms - to commend Empirical Modelling for consideration as an appropriate framework within which to characterise and develop Cognitive Technology.

CT97 was a most memorable conference, for which we are indebted to its founder members, to the local organiser, Chrystopher Nehaniv, and to Toshiyasu Kunii, whose vision played such an important part in laying the foundation for this international, interdisciplinary meeting in a proud and ancient Japanese prefecture.

