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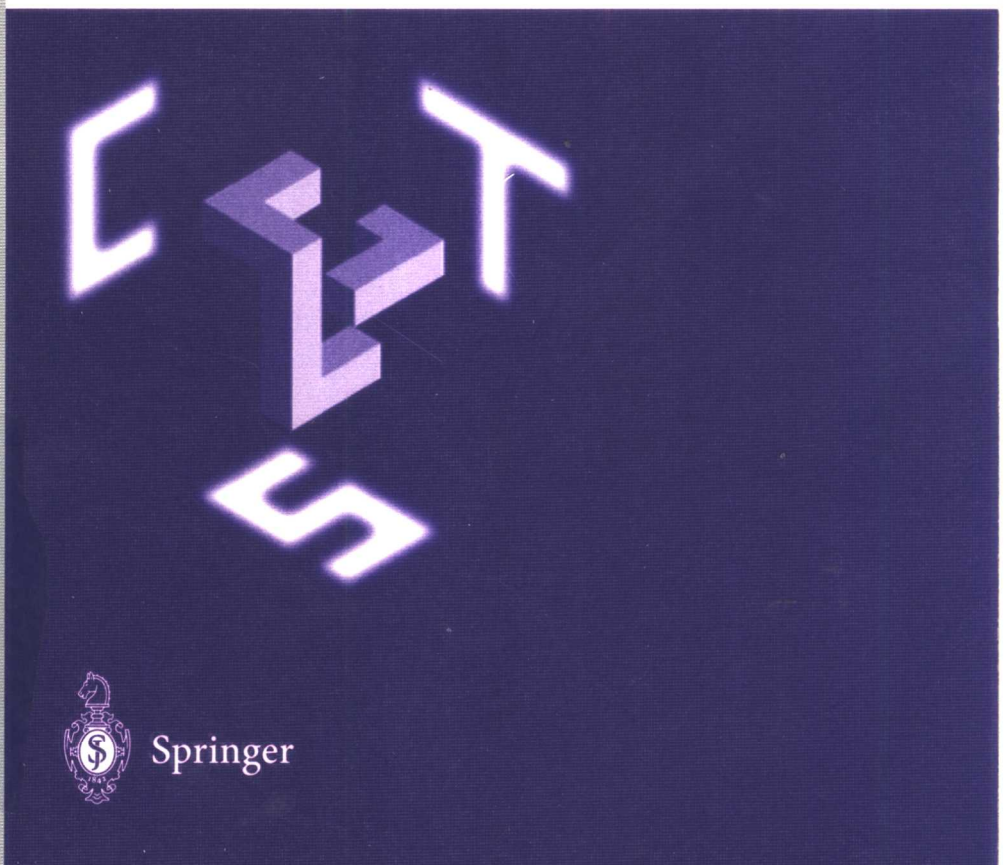
Cognitive Technology: Instruments of Mind

4th International Conference, CT 2001
Coventry, UK, August 2001
Proceedings



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Preface
Cognitive Technology: Instruments of Mind

Cognitive Technology is the study of the impact of technology on human cognition, the externalization of technology from the human mind, and the pragmatics of tools. It promotes the view that human beings should develop methods to predict, analyse, and optimize aspects of human-tool relationship in a manner that respects human wholeness. In particular the development of new tools such as virtual environments, new computer devices, and software tools has been too little concerned with the impacts these technologies will have on human cognitive and social capacities. Our tools change what we are and how we relate to the world around us. They need to be developed in a manner that both extends human capabilities while ensuring an appropriate cognitive fit between organism and instrument. The principal theme of the CT 2001 conference and volume is declared in its title: Instruments of Mind.

Cognitive Technology is concerned with the interaction between two worlds: that of the mind and that of the machine. In science and engineering, this interaction is often explored by posing the question: how can technology be best tailored to human cognition? But as the history of technological developments has consistently shown, cognition is also fashioned by technology. Technologies as diverse as writing, electricity generation, and the silicon chip all illustrate the profound and dynamic impact of technology upon ourselves and our conceptions of the world. The instruments afforded by these technologies continue to evolve and to shape the minds that first conceived them.

The technologies of the third millennium promise mind-machine interactions of unprecedented intimacy and subtlety. These interactions embrace radically new kinds of experience that force us to re-examine fundamental concepts of embodiment and consciousness which frame our understanding of the relationship between minds and machines. The implications of these interactions will hinge on the ways in which humans make meanings out of these new experiences. The conference and these proceedings address this issue using the diverse perspectives afforded by a wide range of disciplines, and evidence drawn from both contemporary developments and the history of technology. Its aim is to deepen our insight into the potential influence of current and future technologies over people and society.

1 The Making of Meaning

The CT 2001 conference focuses on the core question of how technology contributes to the making of meaning. 'The making of meaning' is to be broadly

interpreted as referring to all the activities by which significance is attached to the actions of people and machines engaging with a technology. For a new technology, meaning is in the first instance associated with intended and preconceived applications. The pioneers of the motor car were first preoccupied with refining the car engine, supplying the primary driver controls, building basic roads. As a technology matures, new meanings typically emerge, as skills are acquired, and unforeseen functionality is identified. Driving skills and protocols evolve, the car becomes a status symbol, the drivers are subject to road rage. A new technology typically establishes a pattern of usage, and an associated social organization. Driving regulations are introduced, and the organization of families, industries, and cities comes to reflect greater mobility and autonomy. This in turn spawns languages and conventions that are universally understood by proficient users of the technology. New features and classifications of road are created, and resources to provide services, information, and training about cars and driving are developed. Established technologies supply the metaphors that influence the ways in which we interpret and communicate our experience. Access to autonomous travel is perceived as a norm, neighbouring cities converge, metaphors such as "giving a proposal the green light" and "stepping on the gas" invade our language.

The contribution of technology to the making of meaning through these processes has been analyzed in many ways: in the design and creation of technologies and artifacts themselves; in the psychological, sociological, and historical analysis of their individual and corporate use; and in the philosophical implications for our modes of thought and ways of communicating. A proper understanding of the processes of mutual co-evolution and adaptation which shape our interaction with the technology of the computer age will ultimately require a holistic rather than a reductionist approach. Given our current understanding of these matters, an integrative and holistic account is inevitably a long term ambition, but it is an ambition which must not be forgotten. With this in mind, CT 2001 addresses the core question of how technology affects the making of meaning from the following perspectives taking both empirical and more analytical or philosophical approaches.

2 The Personal and Experiential

The impact of technology upon individuals is central to our understanding of the making of meaning. Technologies such as writing and number systems have provided us for a long time with the ability to extend our cognitive and conceptual operations, and various new technologies take this further by offering enhanced representational and perceptual capacities which change the nature of human experience as an embodied condition. This raises very difficult questions about the role of embodiment, affect, and consciousness in the making of meaning, as individuals begin to operate with altered or novel perceptual capacities in virtual or real environments which are seemingly unconstrained in the relationships

they permit between self and world, and self and other. It also has implications relating to ethics and aesthetics, and thus to psychological well-being.

3 The Social

The persons who are affected by a technology will not only change their role in the constitution of their social world, but are also affected by how that technology is embedded in and changes their social order. Consequently, any proper understanding of the conference theme must turn to macrosociological accounts of the impact of technology. We are already witnessing how new technology is rapidly changing the temporal and spatial dimensions of communication and decision making, and how this is having a differential impact on sections of society. It can isolate those who do not have access to it, but it can also bring together those who were previously separated by custom, prejudice, or geography. These changes are potentially of great significance for the structuring of society and the access to political power and economic resources of different persons and groups. This raises important questions concerning the access to and organization and regulation of these technologies.

4 The History of Technology

Whilst we live in times of great technological change, technologies which have a major impact are not novel. Studies of Cognitive Technology have, for the most part, been focused upon contemporary and emerging computer-based technology, but there is no reason why studies of earlier technologies cannot yield important lessons. Indeed it would be foolish to ignore what can be learned from an analysis, comparative or otherwise, of technologies which have gone the full cycle from invention and introduction, to acceptance and maturity, to the point where they become a seemingly natural part of the world for all. This analysis would necessarily focus on the co-evolution of technologies, societies, and persons as each adapts to the changing circumstances.

5 Education and Individual Development

Any newly born child faces the challenges provided by the technologies of the society into which he or she is born, and must develop in some appropriate fashion if he or she is to prosper. The sense and meaning which they find in a technology may differ from that which their parents found in it at an earlier stage of its introduction or development. This has consequences for both the individual and social perspectives mentioned above, and it is important to understand how each new generation comes to understand and respond to the meanings of a technology for itself. Technologies are also significant in individual development in the ways in which they offer differing kinds of educational engagement and experience. Constructivist approaches to learning highlight a potentially key role

for technology in education. Understanding the current role and future scope of educational technology is intimately bound up with understanding how it is implicated in the making of meaning. This motivates a re-evaluation of traditional theories of knowledge representation and of educational development in the light of, for example, new advances in web-based learning and mind-computer interfaces.

6 Creating, Designing, and Engineering

Ultimately, each of these perspectives is only of more than academic interest if it can be translated into understandings which can affect the processes of invention and design. Consequently, CT 2001 considers such translations in the light of particular engineering practices, both successful and unsuccessful. The contemporary context for design highlights the need for a more holistic approach to design such as Cognitive Technology commends. Key issues include: the need to take account of requirements that cannot be preconceived, but evolve through feedback and adaptation in use; the problems of devising abstract models of mind and machine to support the design of applications that use new technologies (such as virtual reality, robotics, and brain-mediated interaction); and the paradoxical way in which the social and technical infrastructures that enfranchize particular technologies can obstruct alternative creative developments.

June 2001

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Barbara Gorayska
Jacob Mey

Cognitive Technology: *Instruments of Mind*

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Cognitive Technology: Tool or Instrument?

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Motto:
"Toiling to live, that we may live to toil"
(*Wm. Morris, 19th century Utopian thinker,*
quoted in Ehn 1988:1, 371)

Abstract. This paper discusses the tool aspect of the cognitive artifacts often referred to as 'instruments of mind'. Having established the basic distinction between tool and instrument, the authors then go on to review the notion of artifact itself, and discuss the potential for mind change that is inherent in the use of 'mental' instruments such as the computer. It is pointed out that the relationship between the mind and its instruments is a dialectic one, and that the 'reflexivity' inherent in this relationship constitutes the very nature of our interaction with cognitive instruments, such as it is studied in Cognitive Technology.

1 Phenomenology of Terminology

Why, in our everyday use of language, do we make a distinction between the terms 'tool' and 'instrument'? Closely related, they don't seem to quite acquire the status of the synonymous. We talk about instruments for making music; we have surgical instruments; we are familiar with the instruments on the dashboard of a car or in the cockpit of a plane, and would never think to refer to them as tools. Alternately we talk of a tool box, carpenter's tools, bicycle tools, gardening tools, etc. and would become disoriented should someone speak of them as instruments. Clearly we make a distinction but upon what basis? It is possible that an examination of this distinction may lead to insights into the ways humans construct and orchestrate environmental interactions and events. This paper explores that possibility.

1.1 So What's the Real Difference?

One clear (but maybe superficial) example of how we differentiate between tools and instruments emerges when we compare their representation in a car: i.e. the instruments are found on the dashboard while the tools are in the trunk. Can we say

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then that distinction is simply a matter of relative location and importance of function? We think not (Is a cigarette lighter a tool? An instrument? Or a gadget?). However the example is useful in that is suggests that the distinctions we make between the various objects we purposefully use are in some critical sense socially constructed.

Take a hammer. A hammer as such is just a hammer; following Marx; we can say that it only becomes a *tool* by becoming 'socialized', that is, by entering the production process.[1] This socialization is critical to the determination of its status. What is interesting is that the determination process is governed by an emphasis on user need and user skill, not on the object as a physical entity. Consider that the same hammer, in the hands of a physician, becomes an *instrument* rather than a tool (e.g. when testing for reflexes).

1.2 Emphasis on the User

Pelle Ehn has remarked that "the tool perspective takes the labor process as its origin rather than data or information flow" (1988:375). The importance of this perspective becomes evident if we consider instruments to be a particular class of highly specialized tools, designed to help the worker perform an operation in a skilled manner, or vice versa, when instruments are 'created' out of tools by the skill of the operator (e.g. it is the skill of the surgeon that converts the humble kitchen knife into a surgical instrument).

Still, it is not simply the measure of technical sophistication which transforms a tool into an instrument; tools can be highly sophisticated, but still not qualify as instruments. For instance, if I upgrade the common goad-stick (a long rod with a nail attached to its end) to an electric or electronic device for goading on my cattle, it remains a tool, even though I am employing relatively complex technology. But if I govern the animals by remote control and am to finely steer their movements from a distance, in the fashion of a boy flying his miniature airplane, then I'm using an instrument. Here, it is my skills in manipulating the device to a purposeful end that constitutes the *instrument* as such.

1.3 Emphasis on the Nature of the Operation

We further differentiate between tools and instruments based on the operations they perform. Tools are essentially for constructing, repairing, or modifying. Instruments are for 'instructing' or 'guiding' a process[2]. When my car breaks down, I don't start banging on the instruments on the dashboard; I get out my wrench and jack and other tools and try to fix the problem.

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[1] In the capitalist mode of production, the tool furthermore becomes capital. Cf.: "A negro is a negro. Only under certain conditions [that is, in a slave economy] does he becomes a slave". (Marx 1971:155; quoted in Ehn 1988:97)

[2] (in accordance with the term's etymology: Latin *instruere* ("to guide") plus the suffix *-mentum*, as in *tegu-mentum* 'that by which I cover' (e.g. a blanket, a roof), *indu-mentum* 'that which I put on' (a garment)

Whereas a tool is for running or 'debugging' an operation, an instrument 'instructs', 'in-forms' it. While the tool directly extends and amplifies user skills, the instrument serves to govern and help manage those skills. Both tools and instruments have to do with the use of skills and the performing of an operation. However, in the case of the tool, emphasis is more on the operation and the kind of work being performed, while in the case of the instrument, emphasis is more on user skills and the way in which the work is being done.

Given this distinction, is it then possible to define any specific object as belonging exclusively to either class? Again we think not. Instead it may be reasonable to define a class of objects, which we will call artifacts, which may be functionally defined as having the characteristic of being able to be purposefully used by a conscious reasoning agent. Within this class there are a number of subclasses such as "tools", "utensils" "instruments", "gadgets", "machines", 'prosthetics", "organisms", et cetera. Each of these subclasses has determinant characteristics but are not mutually exclusive. Hence subclass membership of any particular artifact, on the occasion of its use, may be determined by the context and purpose of use as well as the measure of attention applied by the user. A smooth continuum between the cognitive characteristics of the user and the functional potential of the artifact is implied. Unpacking the parameters of that continuum may help us to better formulate more environmentally sensitive and humane instrument design principles.

1.4 On Artifacts, Cognitive, and Others

The notion of artifact was originally coined in physical anthropology and archaeology. It is used to indicate the presence of a human agent in a piece of nature, as for example a fetish or a tool. If we find such an 'artificial' object in nature, our first thought is that there has been somebody out there who made it, or put it there. By extension and extrapolation the artifact can be used in various other ways: e.g. to support a claim for the existence of God.[3] To further extend the notion of human agency as critically important to the defining of an artifact, one could consider finding to be an act by an agent that transforms the object or piece of nature into an artifact by the mere fact of its having been found. Such is the case of the so-called *objet trouvé*, the odd item (possibly itself already an artifact) that enters the artist's conception of nature, as expressed in the work of art.

As the name suggests, cognitive artifacts may be considered to be of a different, special kind: they have something to do with cognition, with the way humans 'cognizingly' enter and represent the world. A good example is the artifact commonly known as the book. Norman gives the following description.

"Cognitive artifacts are tools, cognitive tools. But how they interact with the mind and what results they deliver depend upon how they are used. A book is a cognitive tool only for those who know how to read, but even then, what kind of tool it is depends upon how the reader employs it." (1993:47)

[3] This is the first of the four 'canonical' proofs, often called 'the watch in the desert proof'; among the remaining three, the best known is the so-called 'ontological one', of dubious fame.