The changing conditions for the accumulation and transmission of knowledge in the age of multimedia networks make it inevitable that old philosophical problems become formulated in a new light. Above all, the problem of the unity of knowledge is once again a topical issue. The situation-dependent acquisition of knowledge that is made possible by mobile learning transcends the boundaries of traditional disciplines, linking the domains of text, diagram, and picture. Database integration and multimedia search become central problems in the epistemology of the 21st century, while handheld devices are emerging as vital technologies for supporting collaborative learning.

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MOBILE LEARNING

PASSAGEN VERLAG

Communications in the 21st Century

Edited by
Kristóf Nyíri

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Mobile Learning

Essays on Philosophy, Psychology and Education

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Kristóf Nyíri

Preface

The papers in this volume emerged from the conference *Philosophy, Psychology, Education*, held on November 29-30, 2002 in Budapest. The conference was organized within the framework of the interdisciplinary research program "Communications in the 21st Century". This program, which was launched in January 2001, is conducted in collaboration with Westel Mobile Telecommunications (Hungary) by the Institute for Philosophical Research of the Hungarian Academy of Sciences.[1] The results of our work so far have been published in three Hungarian volumes,[2] as well as one German[3] and one English volume.[4] The present volume is the second in the English-language series.

The changing conditions for the accumulation and transmission of knowledge in the age of multimedia networks make it inevitable that old philosophical problems become formulated in a new light. Above all, the problem of the unity of knowledge becomes once again a topical issue. The situation-dependent acquisition of knowledge that is made possible by mobile learning transcends the boundaries of traditional disciplines, linking the domains of text, diagram, and picture. Database integration and multimedia search become central problems in the epistemology of the twentyfirst century, while handheld devices are emerging as vital technologies for supporting collaborative learning.

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[1] For a regularly updated overview of the project see the website http://21st.century.phil-inst.hu.

[2] Kristóf Nyíri (ed.), *Mobil információs társadalom: Tanulmányok* [The Mobile Information Society: Essays], Budapest: MTA Filozófiai Kutatóintézete, 2001; Kristóf Nyíri (ed.), *A 21. századi kommunikáció új útjai: Tanulmányok* [New Perspectives on 21st-Century Communications: Essays], Budapest: MTA Filozófiai Kutatóintézete, 2001; and Kristóf Nyíri (ed.), *Mobilközösség – mobilmegismerés: Tanulmányok* [Mobile Communities – Mobile Cognition: Essays], Budapest: MTA Filozófiai Kutatóintézete, 2002.

[3] Kristóf Nyíri (ed.), *Allzeit zuhanden: Gemeinschaft und Erkenntnis im Mobilzeitalter*, Vienna: Passagen Verlag, 2002.

[4] Kristóf Nyíri (ed.), *Mobile Communication: Essays on Cognition and Community*, Vienna: Passagen Verlag, 2003.

The studies included here move from the general to the particular, beginning with issues in philosophy and the history of philosophy, then turning to educational theory and cognitive science, and concluding with the description of a number of experimental projects in the realm of mobile learning. The first chapter, by Barry Smith, discusses the perspectives of an epistemology attuned to the realities of our new world of ubiquitous networks. In the studies by Dániel Schmal and Gábor Forrai epistemology is seen in the historical context of scholarly and scientific publishing, of the printed journals and books which served as the medium in which our modern thinking about knowledge and knowledge processes emerged. Kristóf Nyíri analyzes certain effects which the transition from a predominantly text-based culture to an increasingly multimedia culture can have upon epistemology. Zsuzsanna Kondor describes some basic tendencies in the history of metaphysics from the vantage point of media history. The chapters by Ahti-Veikko Pietarinen and Roberto Frega, on Peirce and Dewey, are re-evaluations of two late-nineteenth and early-twentieth century philosophers whose thinking enjoys a hitherto unanticipated contemporary relevance. Donald Peterson's analysis of the "e-condition" felicitously sets the stage for the subsequent philosophical and pedagogical discussions on knowledge and learning in a network society. Viktor Bedő addresses the problem of orientation in the virtual space of the network. Pithamber R. Polsani provides a profound elucidation of the notion of n-learning (network learning); Marcelo Milrad offers a masterly survey of the issues surrounding m-learning. Louise Mifsud explores the specific resistances m-learning is bound to provoke in schools; Andrea Kárpáti conducts a survey of the Hungarian e-learning and m-learning scene from the point of view of educational theory. The study by Andy Stone, Graham Alsop and Chris Tompsett describe a specific methodology that seems to be especially promising for analyzing mobile learning systems. Attila Krajcsi contrasts the glory of computer technology with the misery of cognitive science when it comes to the design of truly intelligent learning software. The volume closes with descriptions of four pilot projects. Hanne Turunen, Antti Syvanän and Mikko Ahonen present, and draw conclusions from, a primary school experiment; Anju Relan and Susan Baillie describe a system employing PDAs in medical education at UCLA; Eleni Malliou et al. introduce the AD-HOC Project, a venture that aims at m-teaching a foreign language on-site; Karin Drda-Kühn describes a German internet portal, now in its first experimental phase and with plans to serve also mobile devices, a portal designed to help build up a flexible employment market in the field of cultural work.

Mobile communications have already transformed, and will go on profoundly transforming, the world of knowledge production and knowledge acquisition. Philosophy and educational theory face a paramount challenge in attempting to understand, and indeed to influence, such changes. The present volume is designed to contribute to the meeting of that challenge. I would like to thank the authors for their commitment and for their most interesting contributions. Also, let me here express on behalf of all participants in the ongoing interdisciplinary research program “Communications in the 21st Century” our indebtedness to András Sugár, CEO of Westel Mobile Telecommunications, for his unfailing interest and indispensable support.

Barry Smith

The Ecological Approach to Information Processing

The World as Database

In the beginning was the mainframe computer: a large and somewhat ramshackle collection of boxes joined by wires. Then came the personal computer: a single, small box, which you could fit on your desk. At about the same time came functionalist conceptions of minds as "black boxes". And much fascination with the idea that the mind is a computer (and even, contrariwise, that the computer is a mind).

Now, however, the box conception of computers and minds is slowly losing its grip. Computers are connected together in gigantic networks; they move around; and, through Global Positioning Systems (GPS), they always know where they are. They are attached to digital video cameras and to meteorological and chemical and biological and medical and gamma ray sensors.[1] There are cognitive prostheses; wearable computers; computers you can hold in your hand; computers you can talk through; computers that can display the seismographic features of the terrain they are pointed at; computers that can display the vital signs of a patient you are examining who is a thousand miles away.

The European Media Lab in Heidelberg is testing tourism information services built into camera-sized computers which are at one and the same time ever-attentive tour guides, map displays, and cameras. You can point your computer/camera to the castle on the hill and ask it to read out the history of the castle; or display a map showing all non-smoking restaurants within walking distance; or inform you where in the vicinity of the castle you can buy cornflakes after 10 p.m. Computer/camera/sensor devices with even more powerful features are transforming the ways wars are fought and emergencies responded to. They are transforming com-

[1] O. Wolfson, "Moving Objects Information Management: The Database Challenge", *Proceedings of the 5th Workshop on Next Generation Information Technologies and Systems* (NGITS 2002), Caesarea, Israel, June 25–26, 2002.

puters themselves into entities that are, like human beings and other organisms, sensitive in different ways to their surroundings.

Knowledge Down a Wire

In the age of computers as boxes there arose the doctrine of methodological solipsism – also sometimes called "cognitivism" or "representationalism" (the differences do not matter here) – a doctrine that is commonly associated with the name of Fodor.[2] In order to understand a mind, on this doctrine – that is, in order to establish in scientific fashion the laws governing mental processes – you need to abstract away from all relations to any real-world objects toward which these mental processes might be directed. One should for methodological purposes assume, in other words, that solipsism is true, that the mind is a windowless monad. The parallel doctrine as applied to computers runs: computers are purely syntactic devices. Your computer deals, after all, not with *things* (castles, cornflakes), but with *strings* (with 1's and 0's); with what can be transmitted in the form of electrical impulses down a wire (or nerve). It is lacking all semantics.

Harry M. Collins tells the following story.[3] Imagine a 5-stone weakling whose brain has been loaded with all the knowledge of a champion tennis player. He goes to serve in his first match – Wham! – His arm falls off. The 5-stone weakling just doesn't have the bone structure or muscular development to serve that hard.

There are, clearly, different types of knowledge/ability/skill, only some of which are a matter of what can be transferred simply by passing signals down a wire from one brain (or computer) to another. Sometimes it is the *body* (the hardware) which knows. Sometimes it is the *world* (the environment) which knows. Your GPS device knows its location, not because of the impulses running through its wiring, and not because of the state of its hardware – but because it is at any given moment receiving quite specific signals from satellites and because these signals contain information to which it is sensitive in virtue of the precise location which it occupies in that moment. Human beings are sensitive to the information contained in other human beings' faces. Homing pigeons are sensitive to highly nuanced features of the earth's magnetic field. Hu-

[2] See especially J. A. Fodor, "Methodological Solipsism Considered as a Research Strategy in Cognitive Psychology, *Behavioral and Brain Sciences* 3 (1980), pp. 63–109.

[3] "Humans, Machines, and the Structure of Knowledge", *SEHR*, vol. 4, no. 2: *Constructions of the Mind* (1995).

man beings who can read are sensitive to the astonishingly variable types of information contained in printed texts.

Information in the Light

As Andy Clark argues in his book *Being There: Putting Brain, Body and World Together Again*,[4] we know more than is contained in the hardware and software of our minds because we are able to engage in what Clark calls *epistemic action*. We manipulate Scrabble tiles in order to be able to use the re-arranged pieces as a basis for the activation of the brain's preconscious pattern-recognition abilities. We write one number above another in order to be able to carry out complex calculations using pen on paper by allowing our hands to perform manipulations with these numbers on a sort of automatic pilot. We act so as to simplify cognitive tasks *by leaning on the structures in our environment*. We rely on the external scaffolding of maps and models, of diagrams and traffic signs. Just as not all calculations are done inside the head, so not all thinking is done inside the head – because much of it involves an interaction with the world outside in ways which depend on the types of sensitivity the cognitive agent show to his surroundings of the moment, which depend in turn on his goals, on what he is trying to achieve as an organism active in this world.

From Fodor to Gibson

From the perspective of Fodor's methodological solipsism the way to understand human cognition is to study the mind/brain in abstraction from its real-world environment (as if it were a hermetically sealed Cartesian ego). From the perspective of J. J. Gibson, Fodor's nemesis (for Gibson's time will come), the way to understand human cognition is to study the moving, acting human person as it exists in its real-world environment.[5] This means: taking account of how the human organism has evolved to fit into this real-world environment in such a way as to be sensitive to the information it contains (above all to those types of information which are relevant to survival).

[4] Cambridge, MA: MIT Press, 1997.

[5] Barry Smith, "Truth and the Visual Field", in J. Petitot, F. J. Varela, B. Pachoud and J. M. Roy (eds.), *Naturalizing Phenomenology: Issues in Contemporary Phenomenology and Cognitive Science*, Stanford: Stanford University Press, 2000, pp. 317–329.

We are, from this perspective, like highly complex tuning forks – tuned through our batteries of sensors to the environment which surrounds us in highly specific ways. Gibson himself was a psychologist of perception. His most important work – which should be read in conjunction with the writings of Barker and Schoggen[6] – is entitled *The Ecological Approach to Visual Perception*.[7] The Fodorian holds that in order to understand information systems we should turn aside from the hardware and from the surrounding world in which this hardware is embedded, and study instead manipulations of syntactic strings. The Gibsonian holds that in order to understand information systems we should turn our attentions precisely to this hardware and taking account of the environment for which it was designed and built. We then discover that information systems, too (with their GPSs and their biological sensors), are like highly complex tuning forks – they have evolved (or better: were designed) to resonate in tune with certain highly specific surrounding environments, and their functioning is intelligible only to the degree that we take account of the ways in which they are embedded within such environments.

Computerized Agents

The world of computerized agents – of robots, avatars, webbots – is a world of computers situated in environments and capable of flexible, autonomous action within such environments, including interactions – such as communicating, negotiating, coordinating – with other agents, both human and non-human. The orthodox methodology for dealing with such computerized agents has been described by Rodney Brooks,[8] Director of the MIT Artificial Intelligence Laboratory, as the "SMPA view" – for Sense Model Plan Act as follows:

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[6] P. Schoggen, *Behavior Settings: A Review and Extension of Roger G. Barker's Ecological Psychology*, Stanford, CA: Stanford University Press, 1989; H. Heft, *Ecological Psychology in Context: James Gibson, Roger Baker, and the Legacy of William James's Radical Empiricism*, Mahwah, NJ: Lawrence Erlbaum Associates, 2001.

[7] James J. Gibson, *The Ecological Approach to Visual Perception*, Boston: Houghton-Mifflin, 1979.

[8] See his papers "Intelligence Without Representation", *Artificial Intelligence Journal* 47 (1991), pp. 139–159, and "Intelligence Without Reason", *Proceedings of the 12th International Joint Conference on Artificial Intelligence*, Sydney, Australia, August 1991, pp. 569–595.

S: the agent first *senses* its environment through sensors
M: it then uses this data to build a *model* of the world
P: it then produces a *plan* to achieve goals
A: it then *acts* on this plan.

We are clearly once more inside a Fodorian perspective. Instead of relying on its surrounding environment, on the SMPA conception the agent builds an internal *model* of the world – an internal representation or copy – and it is to the latter that the agent's cognitive processes are directed.

In his own "Engineering Approach" to the problem of understanding and constructing computerized agents, in contrast, Brooks (like Gibson) lends very little weight to the role of representations or models. Rather, he takes his inspiration from evolutionary biology. In order to produce systems that interact directly with the world we should take as our starting-point simple organisms who have solved the problems of interacting with their surrounding physical environment in ways conducive to survival.

The Life (and Mind) of E. Coli

Consider for example the movement of the E. coli bacterium, which can best be described as a biased random walk.[9] In the default environment, which is marked by the absence of any survival-relevant stimulus, the cell simply wanders around, smoothly swimming by rotating its flagella counterclockwise. Such runs are terminated by chaotic events, called tumbles, when flagella rotate clockwise. Following a tumble, the cell begins a new run, picking a direction more or less at random. Sometimes however the cell encounters sugar – more precisely it encounters an increase in the density of a chemical attractant – to which its sensors have been attuned by natural selection. Those runs that happen to carry it up such a density gradient are then extended; those that happen to carry it down the gradient are not. Over time, therefore, the cell drifts in a favorable direction. Its life, if you like, is a life of *falling down sugar wells*.

[9] H. C. Berg, "A Physicist Looks at Bacterial Chemotaxis", *Cold Spring Harbor Symposia on Quantitative Biology* 53 (1988), pp. 1–9; Frederik Stjernfelt, "Biosemiotics and Formal Ontology", *Semiotica* 127 (1999), pp. 537–66; Bruce Alberts et al., *Molecular Biology of the Cell*, 4th edition, New York: Garland Science, 2002.

The bacterium is a single cell. Thus it does not have a multicelled nervous system. But it has receptor molecules acting as sensors and these influence the behavior of its highly complex machinery of movable flagella via a signal transduction system. Different receptors react to different stimuli, some to single oxygen molecules, some to much larger carbohydrate molecules (or to molecules – perhaps produced in the laboratory as anti-bacterial agents – which have an external structure which can *fool* the bacterium into thinking that it is dealing with carbohydrate molecules). E. coli bacteria react to differences in concentrations of sugar molecules with a behavior shift – as a dog reacts to the smelt trace of another animal.

The attribution of intentionality, as we can see, does not depend upon the existence of a nervous system. There is a difference between a purely chemical system, and a system that is at once chemical and biological. We can ascribe simple biological intentionality to a single, movable cell; all that is required is the existence of sensors, information mediation (automatic interpretation, if you like) and motor responses resulting in adaptable behavior.

Intelligence as Situatedness

Let us return now to Brooks' Engineering Approach to the construction of computerized agents. Where the bacterium has one single layer of activity, intelligent systems such as ourselves embody a number of distinct such layers, including our various batteries of sensors (perceptual systems), as well as systems for proprioception, and so on. From Brooks' perspective, now, we should conceive such layers (a) as operating independently of each other, (b) as connecting directly to the environment outside the system.

Each layer operates as a complete system that copes in real time with a changing environment. Each layer is a biological system that has evolved through interaction with the world outside, and it is this world outside which serves to unify the different layers together in such a way as to ensure that they become adjusted to each other mutually over time. For Brooks therefore, *an artificial system that mimics some of the features of biological intelligence must be a situated system.*

Humans (and other organisms) fix their beliefs as they attune themselves differently to different parts of the world in light of their successive experiences. As Brooks points out in his "Intelligence without Representation", organisms sometimes mark the world by placing traces which change what they will be confronted with in the future. Thus they do not have to carry all their memories around with them, because again: they can lean on the structures in the external environment; they can use *the marked-up world as crutch.*

The Ecological Approach to External Symbolic Memory Devices

For human organisms the marked-up world includes libraries, maps, price lists, traffic signs, science texts, border posts, restaurant menus, fences. We can now rephrase our formulation of the views developed by Gibson in his *Ecological Approach to Visual Perception* as follows. We are like multi-layered tuning forks – tuned to the environment which surrounds us. We have evolved in such a way as to be attuned to our environment on multiple levels, in part because we ourselves have created this world via what Lewontin calls "ecosystem engineering".[10] This means that we have evolved to resonate automatically and directly, not only to those features of our environment which are relevant for survival, but also to new features – of language, culture, of externalized memory – which we ourselves have put there.

In his *Origins of the Modern Mind*[11] Merlin Donald refers to a radical transition in the emergence of modern human culture, which occurred when humans began to construct elaborate symbolic systems ranging from cuneiforms, hieroglyphics, and ideograms to alphabetic languages and mathematics. From this point on, Donald argues, human biological memory becomes an inadequate vehicle for storing and processing our collective knowledge. Thus Donald sees the modern mind as being itself a hybrid structure built from vestiges of earlier biological stages together with new external symbolic memory devices.

Gibson's ecological approach can now be reformulated yet again in order to take account of Donald's insight. To understand cognition we should study the moving, acting organism as it exists in its real-world environment, but now taking account of the fact that for human organisms this is a social environment which includes records and traces of prior actions in the form of communication systems (languages), storage systems (libraries), transport systems (roads), as well as legal and financial and political systems of a range of different sorts. The attunement of dif-

[10] Richard C. Lewontin, *The Triple Helix: Gene, Organism, and Environment*, Cambridge, MA: Harvard University Press, 2000.

[11] *Origins of the Modern Mind: Three Stages in the Evolution of Culture and Cognition*, Cambridge, MA: Harvard University Press, 1991.

ferent groups of specialists to these externalized symbolic memory devices then allows a range of different, new sorts of activities on the part of humankind, via a vast division of cognitive-ecological labour. Gibson talks of the environment as an array of affordances, where: "The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or evil." The environment of a commercial organism includes those affordance which we call prices. The environment of a lawyer includes those affordances which we call torts and malfeasances. The environment of a physician includes those affordances which we call symptoms and diseases on the part of his patients. The environment of a computer-aided geologist investigating viscoelastic flow includes those affordances which we call foreshock sequences and processes of earthquake nucleation. The realm of affordances, and thereby the world itself as a domain accessible to our direct cognition and action, becomes hereby expanded – not only because of the addition of ever new layers of external memory devices, but also because of the addition of ever new types of prosthetic sensors, which enable us to become attuned to ever new sorts of features in the environments by which we are engaged.[12]

[12] Work on this paper was supported by the Wolfgang Paul Programme of the Alexander von Humboldt Foundation. Thanks are due also to Claus Emmeche, Paul Penner, Luc Schneider and Frederik Stjernfeldt for helpful comments.

Dániel Schmal

Epistemology and the Printing Press

Journals and the New Pattern of Philosophical Debates in the Late Seventeenth Century

In this age of mobile communication, all of us witness the progressive disappearance of the material obstacles which hitherto have blocked the current of information exchange. Communication is less and less confined to fixed places, and the structure of our everyday conception of time is also changing. At the same time, the new modes of telecommunication have led to thoroughgoing changes in scientific research as well. In this presentation I will restrict the scope of my considerations to scientific communication, focusing on the case of a journal in the early modern period to show what kind of changes can result in the self-understanding of a community of scholars through the adoption of a new method in the field of communication. As in our present age the progressive development of the internet and mobile communication seems to have reshaped even the system of scientific work,[1] in the early modern age it was the appearance of learned journals which left their mark on the outlook of classical science. Though the journals in question belong to a paradigm whose decline is becoming more and more obvious today, I think it is worth turning back to the origin of this paradigm, to have a look at the way it emerged, in order to get a better insight into what is changing now, and how.

In what follows, I have selected a scientific journal from among the periodicals of the second half of the seventeenth century to use as an example, in a historical case study as it were, to call our attention to some important points about the interaction between new forms of communication and ideas expressing the self-representation of a scientific community. My essential point will be that, though the ideas in question were very traditional ones, the old notions, meant to explain the nature of scientific research, were sensibly reshaped by a radical shift in the field of communication.

[1] Cf. esp. János Laki and Gábor Palló, "New Communication Media and Scientific Change", in Kristóf Nyíri (ed.), *Mobile Communication: Essays on Cognition and Community*, Vienna: Passagen Verlag, 2003, pp. 185–209.

It is a well-known historical and sociological fact that very few philosophers involved in the birth of the modern sciences belonged to professional university circles.[2] With the exception of some minor Cartesians in the Low Countries, none of the leading figures of the new philosophy obtained a professorship at any university. Leibniz gave up his promising university career to enter the service of different German aristocrats, Spinoza refused the university post offered to him by the Academy of Heidelberg, and Pierre Bayle, the person who will be the focus of our considerations, also declined to accept the professorship of philosophy at Franeker in 1684. The universities, even those founded in the late sixteenth or early seventeenth century, mostly remained the strongholds of late scholasticism. The organisation of the new science took place outside the walls of the traditional system of scholarship. New means of communication had to be forged. This shift in the system of communication meant at the same time the rejection of some traditional forms of the exchange of ideas, most notably the medieval system of university disputations. Despite the more and more extended use of printed texts in higher education, up to the late seventeenth and early eighteenth centuries it was the disputation, a basically oral form of interaction, which remained the core of the university curriculum. By contrast, the new network of scientific communications totally ignored the medieval tradition of verbal skirmishes. Though for different reasons, both the Baconian and the Cartesian program of philosophy rejected verbal disputations, and the new method of acquiring scientific knowledge called for new ways of displaying information, especially in written and printed texts. The proliferation of diagrams, illustrations and tabulations presents just a few examples of the new forms envisaged to meet the requirements of a science based on observation. Among these new forms of communication an outstanding place must be assigned to the learned journals emerging in the second half of the seventeenth century.

The particular journal I will discuss here is the *Nouvelles de la République des lettres*, a monthly review of books, edited by the outstanding French philosopher, Pierre Bayle, called the "father of Enlightenment" in the eighteenth century.[3] Exiled from his native country because of his Cal-

[2] On this question see Richard Tuck, "The Institutional Setting", in Daniel Garber and Michael Ayers (eds.), *The Cambridge Companion to Seventeenth-Century Philosophy*, Cambridge: Cambridge University Press, 1998, pp. 9–32. Cf. esp. p. 13: "It is notable how few major seventeenth-century philosophers managed to exist within the environment of a university."

[3] On the project of the journal and the circumstances of the publication see Elisabeth Labrousse, *Pierre Bayle: Du pays de foix à la cité d'Erasme*, The Hague: Martinus Nijhoff, 1963, pp. 189 ff.

vinism, Bayle found a refuge in Rotterdam some five years before the official revocation of the Edict of Nantes in France. Having accepted the offer of an Amsterdam publisher, Bayle launched his journal in 1684. The *Nouvelles*, mostly written by the editor himself, was an enormous success all over Europe.

The first and most important reason behind the establishment of the journal was the much complained-of shortage of books and the anomalies of the European book trade in the early modern period. As Bayle declared right at the beginning of his project, a good review of books was eagerly needed, since by the time the books arrived at the peripheries of the continent, they were likely to be outmoded in Paris.[4] So the *Nouvelles* was meant to make available the most up-to-date information to everyone interested in the arts and sciences. Accordingly, the editor made it clear, in a preface attached to one of the early issues, that the journal had two different aims, the instruction of the public and the satisfaction of their curiosity.[5] Thanks to its fast distribution the *Nouvelles* proved to be an effective means to communicate the latest results of the new mechanical science, theology and other branches of learning.

Two remarkable features of the journal deserve especial mention. The first one is the strikingly large scope of the subjects taken under review. The span of the articles covers classical philology, physical science, philosophy, theology, numismatics, history, and so on. What unites the extremely scattered pieces of information is not their internal coherence but the unity of critical reason which weighs and exposes them side by side on the pages of the same journal. Overcoming the contingency of the juxtaposition of the different subjects, this unity gives a kind of "transcendental" coherence to the elements gathered – a unity which helps the reader to recognize the outlines of the same scientific and philosophical project in the background.[6] The second feature to be noted is the huge number of debates and debated questions reviewed in the *Nouvelles*. It is important to keep in mind what a huge amount of literature was devoted to controversial issues in the 16th and 17th centuries. In an epoch when European societies were deeply divided on religious and political matters, the culture of books was intrinsically bound up with a sensitive environment of debate. At the same time the controver-

[4] Pierre Bayle, *Œuvres divèrses*, vol. I, ed. Elisabeth Labrousse, Hildesheim: Georg Olms, 1964, p. 3 (March 1684, *Préface*).

[5] *Ibid.*, p. 101a (August 1684, *Avertissement*).

[6] "On se veut étendre indifferémment sur tout sorte des choses" – Bayle says – without, so to speak, "une partialité déraisonnable", *ibid.*, p. 2 (March 1684, *Préface*).

sial literature always recalled the threat of political instability, religious struggles and even wars. This fact makes us understand Descartes's aversion to university disputations in particular and to philosophical or religious debates in general. Thus one gets the impression that an important, though undeclared, role of the journal was to substitute oral discussions of the university disputations with a new form of debate, and to regulate them partly by adopting, partly by creating new norms for the culture of argumentation. So the fact that the overwhelming majority of articles were concerned with controversial questions in the *Nouvelles* gave a sense of openness to the project. All topics could be debated provided that the opposing sides conformed to the rules of right reason. Transcendental unity and openness, these two features emerging from the great variety of subjects treated in Bayle's journal in a somewhat hodgepodge-like manner, will prove essential to our final conclusions.

Turning now to the self-representation of the society of professional and amateur scholars, we need not go far to find ideas expressing the essential characteristics of this community. The most important conception is revealed in the very title of the journal: *République des lettres*, or, in its Latin original, *res publica litterarum*. As a long tradition of scholarship has made it quite clear, this concept played a central role in the self-understanding of both Renaissance humanism and the new project of early modern science.[7] It expresses the firm conviction that scholars seeking the truth in the same scientific project form a community which, bypassing the historical boundaries of any particular state and crossing the lines of national, linguistic or religious identities, can be distinguished from all particular communities, political or religious. One should not forget that the scholarly pursuit in question was the most general one, "the search after truth", which was free from our contemporary division of fields of knowledge. The Republic of Letters comprised all participants of the new learning, first on the basis of a common respect for classical antiquity, then on that of the Cartesian *bon sens*, right reason. This community was supposed to have its own structure, organisation, norms and even hierarchy. To put it in the terms of the famous jurist Samuel Puffendorf, the *res publica litterarum*, like other republics and states, was a moral entity, an entity built on natural and material bases

[7] On this concept see, for example, Richard Tuck, *op. cit.*, p. 23, and most notably, Elisabeth Eisenstein, *The Printing Revolution in Early Modern Europe*, Cambridge: Cambridge University Press, 1993, pp. 98–100. A very informative article is Marcelo Dascal and Cristina Marras, "The République des Lettres: A Republic of Quarrels?", http://www.tau.ac.il/humanities/philos/dascal/papers/republic1.html.

(books, presses, libraries and so on), but at the same time it was irreducible to these elements. It contained something more, values attached to these bases, that is to say, the work of the human mind or spirit which produced and at the same time transcended texts and other such material factors.

The expression *res publica litterarum* deserves a further comment on the term *litterae*, or *lettres*. What we now call literature was normally excluded from the meaning of the Latin word litterae, while it covered what we now call the sciences.[8] So, to concentrate Bayle's journal, the "moral entity" which is built on the material basis of the liberal Dutch press "unites liberal minds who have the vocation to overcome prejudice and partisanship and to listen to the voice of reason" – as Elisabeth Labrousse put it in her superb introduction to Bayle's works.[9] Though the idea of the *république des lettres* was current in the sixteenth and seventeenth century, Bayle's understanding of it has its own distinctive features.

In accordance with the author's general philosophical orientation, the self-representation of the readers' community is manifested in Bayle's works in terms which make clear and direct allusion to the philosophical system of Nicolas Malebranche, the most influential Cartesian thinker of the late seventeenth century, "*le premier philosophe de ce siècle*", as Bayle honoured him in his journal.[10] Malebranche exercised an enormous influence on Bayle's thought,[11] though, as we will soon see, the latter rejected or dropped several elements of the former's system.

Malebranche's philosophical outlook was shaped by his critical reading of Descartes. Like other thinkers of his age, most notably Spinoza, Malebranche recognized that the Cartesian project of metaphysics laid itself open to an important objection. In his *Meditations* Descartes had tried to base the overall system of human sciences on truths which are proof against even the most exaggerated doubt. Since Descartes extended universal doubt even to the most evident principles, an unbridgeable gap opened up between the subjective sense of evidence and the objec-

[8] Cf. Elisabeth Labrousse, "Introduction Historique", in Pierre Bayle, *Œuvres divèrses*, vol. I, pp. xii ff.

[9] "La Républiques des lettres réunit de libres esprits qui ont vocation de surmonter prévention et partis-pris, d'écouter la voix de la raison" (*ibid.*, p. xii).

[10] Pierre Bayle, *op. cit.*, p. 104b (August 1684). Bayle is more explicit on this point in his *Commentaire philosophique*, see Pierre Bayle, *De la tolérance*, ed. by Jean-Michel Gros, Paris: Presses Pocket, 1992, pp. 88 ff.

[11] "La métaphysique la plus véritable, pour Bayle, est la cartésienne ou plus exactement, la philosophie de Malebranche." (Elisabeth Labrousse, *Pierre Bayle: Hétérodoxie et rigorisme*, The Hague: Martinus Nijhoff, 1964, 2nd ed. Paris: Albin Michel, 1996, p. 205.)

tive truth-value of the things perceived. How can we attain any certainty, the question goes, if the utmost sense of evidence in our mind can be misleading? Does not this gap render inevitably circular all attempts to solve the problem? According to Malebranche, the only way to escape the difficulty involved in Cartesian procedure was to take for granted the most fundamental principles, and to exempt them from the scope of doubt. But is this move possible without giving a fatal blow to the most important insights of Cartesianism? At this point Malebranche, himself a priest of the Paris Oratory, invoked the aid of the Augustinian philosophy which had exerted an important influence on him in his formative years.[12] He argued that the only way to avoid the internal circularity of the Cartesian approach was to suppose the identity of the objective truth and the evidence of our perception. What we perceive in the case of a clear and distinct perception does not belong to the human mind but to the divine substance, the truth itself. So the Cartesian way to God, as explained in Descartes's third *Meditation*, must be slightly modified in order to avoid circularity. Malebranche rejects the causal explanation of the idea of God which the meditator pretends to find in his mind as a mark of the Creator, and insists that neither the idea of an infinite being nor other ideas involving infinity in their notion (like all mathematical concepts) can be found in a finite mind. Instead of finding the idea of God in ourselves, we find ourselves in God, according to Malebranche. Thus our reasoning is always based on divine ideas, and all veridical perception establishes an inner communion between our mind or soul and the divine intelligence. Acquiring knowledge makes us participate in an ideal community of souls, which are connected to each other by their participation in the same substance of the divine mind.

This conception clearly parallels the Augustinian idea of the City of God, a spiritual place of ideal communication where all citizens of the same spiritual republic can understand each other through the divine substance, the general and all-comprehensive truth itself, which is common and available to everyone. The City of God is a community of souls bounded by a common value, the love of God who is himself the common source of both life and truth for all members of this spiritual society. They all participate in the substance of God which is, so to speak, the ideal medium of communication, since the souls united in him can attain the truth without any spatial or temporal limitation.

[12] The most relevant Augustinian texts cited by Malebranche are: *In Joannis Evangelium tractatus* 34 – *Enarrationes in Psalmos* 25,2; 61 – *De musica* 6,1 – *De utilitate credendi* 15 – *De vera religione* 30–31; 55 – *De libero arbitrio* 2,12 – *De Trinitate* 8,6; 9,6; 14,15 – *De ordine* 2,14.

Now, as is fairly clear from numerous direct and indirect quotations from the philosopher's works, the *res publica litterarum* refers to precisely these elements of Malebranche's theory. *The République des lettres*, not unlike the heavenly City of God, is a community which transcends all political, sociological and religious conditions of the individual life. *Nous n'examinerons point*, Bayle says in one of the notes of his journal, *de quelle religion ils auront été ... il suffira qu'ils ayent été celebres par leur science*. ("We will not examine of what religion they will be, it is enough that they be famous by virtue of their science.") And again: *Il ne s'agit point ici de Religion, il s'agit de Science*. ("It is not an affair of Religion, it is an affair of Science.")[13] The articles of the journal consciously cross the borderlines of confessional identities, providing the readers with a new basis of community and, as a consequence of this, they allow the society of scholars and amateurs to overcome the old culture of verbal debates.[14]

This being so, it is all the more interesting that Bayle appears to abandon some important elements of the Malebranchist system in the pages of the *Nouvelles*.[15] Reviewing a long series of books, Bayle closely follows the development of the Malebranche–Arnauld debate, beyond doubt the most remarkable epistemological and metaphysical event of the early 1680s on the Continent. The first stage of the contention centred around the epistemology of ideas. Provoked by Malebranche's *Traité de la nature et de la grâce*, the debate was mainly of theological interest. In his treatise *Des vraies et des fausses idées* ("On true and false ideas") Antoine Arnauld, the leading Jansenist divine and one of the most celebrated proponents of the Cartesian philosophy in the decades after the death of Descartes, launched an attack against what he conceived as the main error of his antagonist's theology, the theory of human knowledge.[16] The debated question went roughly as follows: Does perception, as an act of the human mind, have the power in itself to represent the object perceived, or, as Malebranche contended, must it be supplemented with a

[13] Pierre Bayle, *op. cit.*, p. 2 (March 1684, *Préface*).

[14] Cf. *ibid.*: "on doit donc mettre bas tous les termes qui divisent les hommes en différentes factions, et considérer seulement le point dans lequel ils se réunissent, qui est la qualité d'Homme illustre dans la République des Lettres."

[15] Bayle's relation to Malebranche is examined in detail by André Robinet in his article "La philosophie de Bayle devant les philosophies de Malebranche et Leibniz", in Paul Dibon (ed.), *Pierre Bayle: le philosophe de Rotterdam*, Amsterdam and Paris: Elsevier–Vrin, 1959, pp. 48–65. See also chapter 7 of Elisabeth Labrousse, *Pierre Bayle: Hétérodoxie et rigorisme*, pp. 187–218.

[16] Cf. Antoine Arnauld, *Des vraies et des fausses idées*, ed. by Christiane Frémont, Paris: Fayard, 1986, p. 14.

representative object (the ideas of the divine mind) from without?[17] According to Arnauld, Malebranche's failure to recognize the inner representative power of our perceptions stems from childish prejudice, from an uncritical transposition of some relevant features of visual perception to the field of mental cognition.[18] In order to see something, one needs the presence either of the actual object or of its image. From this point, Arnauld says, it is just a further step to suppose, by virtue of a false analogy, that human cognition also requires one of these two kinds of presence. Since the object conceived (a star in the heavens, for example) cannot be present to the mind in its material reality (our soul does not wander among the stars when seeing them), we have to see its mental image, an idea, a proxy in our head as it were, which represents the remote object to our mind. According to Malebranche, as we have already seen, this object, as a *terminus ad quem* of our cognition, must really be distinguished from the mental act of perception and is identical with the divine substance that illuminates all other minds, while Arnauld believes it to be found in the mental act of perception itself. Our perceptions, he says, are directly representative of their object, without any intermediate object distinct from the act of perception itself.[19] In his opinion the representative power cannot be explained by the hypothesis of a third element in cognition, a kind of picture or image. The idea of God as well as other ideas involving infinity belongs to the human mind, since the power of representation is the distinctive feature of the mental in the Arnauldian theory.

Now, to return to the *comptes rendues* of the *Nouvelles*, Bayle's sympathy in the debate is in general on the side of Malebranche. However, he is forced to admit frankly that the metaphysical and epistemological subtleties of the philosopher's views surpass his understanding. "Admittedly, this is the most incomprehensible thought of the author" – he says about Malebranche's theory of the "vision in God" – "nevertheless, it does not follow that those who reject it are right. If he errs, his error is due to his penetrating mind, and very few people are capable of similar errors."[20] Instead of deciding for or against one of the opposed opinions, Bayle's conclusion is just a moralizing piece of humility. "The dispute at

[17] *Ibid.*, p. 45.

[18] *Ibid.*, pp. 31–33.

[19] "...il m'est certain que mon ame a vu une infinité de fois le soleil, les étoiles, et les autres ouvrages de Dieu et des hommes, qui n'estoient pas des spectres, mais de veritables hommes, et créez de Dieu comme moy", *ibid.*, p. 67.

[20] Pierre Bayle, *op. cit.*, p. 26a (April 1684).

hand", he writes, "shows us that the way we understand things is inexplicable, and gives us a good lesson in humility."[21] He adds a quotation from M. Patin, who says of the philologist Scaliger: "I honour extremely his other works as well, but I cannot understand them. When reading them, I bend my head and I recall the words of Martial: *Non omnibus datum est habere nasum* (Not everybody is endowed with fine senses)."[22]

To sum up, and to draw some conclusions, we have to say that the *Nouvelles* project is exposed and interpreted in terms which resemble the Augustinian epistemology adapted to Cartesianism by Malebranche. The learned community of scholars has to fit to the norms of universal reason. Though in Malebranche this terminology rests on important philosophical insights, Bayle obviously cannot catch the epistemological point that makes Malebranche adopt the theory of vision in God, with all its concomitants. The journalist uses the Malebranchist vocabulary without adopting the corresponding metaphysics. So the question arises: what fills this lack of theoretical background?

It is, I would argue, the *Nouvelles des République des lettres* in its material reality, Bayle's journal as a centre of the community of scholars and readers, which supplies Bayle's Malebranchist vocabulary with the missing metaphysical elements. Thus the *res publica litterarum*, one might say, takes over the role and adopts the main characteristics of the ideal community. It is not so much the need of a perfect scholarly community which gives rise to the journal, but the journal itself, as a centre of the readers' community all over Europe, which enables the readers to construe their community in the terms of an ideal commonwealth. The two characteristics of the journal examined above have a crucial role in this shift of emphasis. The unity of reason which gives a coherence to the different studies pursued by the particular scholars, and the openness which calls for a well-regulated debate or communication among them, are two requirements expressed in and through the *Nouvelles*. Consequently, if the enlightened vocabulary of impartial reasoning can stand on its own in the journal, without any clear and detectable metaphysical and epistemological background, or, in other words, if we find the scattered elements of the original Malebranchist theory extracted from their systematic background on the pages of Bayle's journal, all this seems to be due to the fact that a new medium of learned communication can effect and exemplify the function of the ideal community of scholars envisaged by Malebranche. What used to be a transcendent

[21] *Ibid.*, p. 26b (April 1684).
[22] *Ibid.*

and eschatological reality in Augustine, and a spiritual and metaphysical entity in Malebranche, becames a real community of readers and scholars in Bayle's journal. By virtue of the two features emphasised above, unity and openness, the discourse of the concrete community of readers and the writer of the same journal, even the authors of the books reviewed in in the journal, exhibit those elements in Malebranche's theory *in concreto* which are theoretically absent or dropped from Bayle's own philosophy. The concrete participants of a net of communication centred around Bayle's journal begin to substitute a theoretical element absent from the theory.[23] This results in a considerable shift in the network of ideas themselves, turning the transcendent reality of the City of God into a concrete community of persons connected in the network of the same culture of communication, thus promoting the project called "Enlightenment". Of course, Bayle's journal was just a small part of the general changes in the organisation of the new structures of knowledge. However, if my hypothesis stands, the case of the *Nouvelles* shows us how much even a slight change in the system of communication can materially modify the field of current ideas.

[23] We can find another theoretical use of the "Republic of Letters" in Arnauld: "Il y a là l'idée que la République des lettres est la garantie ultime de la validité de mes évidences...", cf. Denis Moreau, *Deux Cartésiens: La polémique entre Antoine Arnauld et Nicolas Malebranche*, Paris: Vrin, 1999, pp. 43 ff.

Gábor Forrai

The Epistemology of the Hypertext

Epistemological thought has always been influenced by the form in which knowledge is made available to others. This is not particularly surprising. Knowledge as possessed in the form of mental representations is not only private, but it does not even provide a good starting point for the owner of the mental representations himself. First, introspective access to mental representations is highly constrained. There is a limit to the number and complexity of mental representations we are aware of at any given time. Secondly, mental representations, as they are in themselves, are rather elusive and difficult to pin down. This is why we have to resort to a highly metaphorical language when describing our mental life. Since mental representations do not offer us a field which we can introspectively survey and explore, they do not well serve the purposes of epistemology. The various forms in which knowledge is made public offer a much better starting-point.

From the beginnings of organized inquiry until the 17th century there was only one shape scientific knowledge could take: the shape of a book. So when epistemologists thought of serious, i. e. scientific knowledge, they naturally thought of knowledge as it is contained in books. Now the book has long ceased to be the only admissible form of scientific knowledge. Scientific journals appeared in the 17th century and they have become the dominant form of scientific publication. And now we have new forms created by computer technology, on-line data-bases, electronic journals, CD-ROMs, etc. Nevertheless, current epistemology is still very much, if I may put it in this way, "the epistemology of the book". What I mean by this is that books still have a hold on epistemological imagination. Many of the problems, assumptions and emphases in current epistemology stem from the supposition that the canonical form of knowledge is the book. The questions today's epistemologists raise and the way they set out to answer them seem natural mainly because we still tend to identify scientific knowledge with the content of a book.

Let me give three examples. The first is the idea that justification has a linear structure. If we move from something to be justified to something that justifies it and then move on and on to find further justification, our journey generates a branching tree structure. Justification is linear in the sense that we never get back to where we started from. If A figures in the justification of B, B cannot figure in the justification of A. There is an intuitive fact behind this idea. You cannot justify A in terms of B and then move on to justify A in terms of B. However, this only shows that small justificatory circles are vicious. It does not speak against large circles. Moreover, there is intuitive evidence for large justificatory circles. Anyone who follows an intricate and extended debate will notice that the opponents' moves involve large circles. Now if we look at the history of epistemology we find that the idea of the linearity of justification has always been the dominant view. It was briefly challenged in the last century, but coherentism, which challenged this idea, has never become very popular. The question is then this. Why did it happen that the intuitive evidence for large justificatory circles did not inspire epistemologists to give up on linearity? Probably, because these large circles have not been regarded as representative of the structure of justification. They were written off as accidental effects of irrelevant circumstances, like the dialectical situation, failure to appreciate the opponent's point, suddenly running out of ideas, being distracted, etc. It is the grounds for their being thus dismissed which have to do with books. Books argue in a linear fashion, and if they are taken as the paradigmatic examples of knowledge, the structure of actual debates will fail to matter.

The second is the fact that the revision of views has received less attention than it should have. Throughout most of the history of epistemology it was taken for granted that knowledge will not change, i. e. if something is admitted as knowledge, it is there to stay. In fact, it has become something like a conceptual truth that knowledge cannot be revised. Think of the traditional definition of knowledge as justified true belief. Changes in views were taken to show that the views which are displaced did not constitute knowledge. Moreover, when revision came to be an issue for epistemology, it was mostly identified with refutation. The picture was something like this: if we find decisive evidence against a theory, we have to abandon the whole theory. The successful modification of a theory was understood as amounting to the creation of a new theory. Piecemeal modification was regarded as characteristic of theories which are doomed and those engaging in this practice were castigated as lacking the intellectual power or honesty to face up to the consequences of the refutation. Compare this with what happens to books. Books rarely get rewritten and rewritten again. Rather they get antiquated and replaced by other books.

Thirdly, there is the tacit assumption that the plurality of views is inessential. In principle, it is sufficient to have one theory in a domain. Plurality is due merely to the fact that it is not easy to find the one true theory. If we are smart or if we are lucky, we may find the one true account right away and bypass the period in which there are large number of conflicting views. As a result, the plurality of views, which is an obvious historical fact, was looked upon as something that is unlikely to reveal anything important about the nature of knowledge so that it can be safely disregarded in epistemological speculation. Now this assumption seems fairly natural if we regard knowledge as it is contained in books. Books are self-contained and take one single line. They create the impression that they tell a self-sufficient story, which can be understood and appreciated independently of the other things that have been written of the subject.

These examples are certainly not sufficient to establish the claim that books had a major influence on epistemological thought. But let me add two points. First, the claim is not very strong. I do not imagine that all the important characteristics of the epistemological tradition can be derived from the willingness of epistemologists to consider the book as the paradigmatic manifestation of knowledge. Epistemological thought has had many sources of inspiration, and the book is not the only and not even the most important metaphor. So "major influence" should not be taken as the only or as the most important influence. Secondly, the objections and counterexamples which, no doubt, have occurred to the reader while following the argument to this point may, in fact, add to the plausibility of the claim. You have surely noticed that the tendencies I described are much less symptomatic of the epistemology of the 20th century than of that of earlier periods. And this is indeed what we should expect if we suppose that the forms in which knowledge is made public have an impact on epistemology. For the importance of books have declined considerably in the last centuries, and in the 20th century this has become noticeable in all fields. So those problems, assumptions and emphases which were natural in earlier periods, gradually release their hold on epistemology.

Now, if it is indeed true that the orientation of epistemology has been influenced by the concern with books, there emerges the following question. Is it possible that by focussing on other forms that knowledge could take we may find epistemological problems worth exploring? Before giving some reasons for an affirmative answer, let me warn against misunderstandings. I am not suggesting that the concern with books has had pernicious effects. The merits of epistemological doctrines are determined by philosophical arguments, and these arguments do not contain the preoccupation with books among their premises. So the value of epistemological ideas which are partly due to the concern with books is pretty much independent of their origins. Showing their underlying inspiration is not a way of discrediting these doctrines. Nothing is farther from my intentions than to insinuate that the age of books has passed, the doctrines of that age are now outdated, and we should start epistemological theorizing from scratch. What I mean to suggest is rather this. By taking knowledge to be represented in other forms we may arrive at a perspective from which we can perceive new epistemological problems.

The form I am going to examine is that of the hypertext. A hypertext is a text with the following structure. There is a set of texts, called nodes. The nodes are not arranged in a particular linear order like the chapter 1, chapter 2, chapter 3 order of books. Rather they are linked to several other nodes. In principle, one may start reading the text at several different points and one may follow the links of his own choice. So what is distinctive about the hypertext is that it does not determine one particular order in which it should be read.

To be sure, scientific knowledge is not actually in hypertext format in the strict sense of the word. To generate a real hypertext one must use some particular software (e. g. Intermedia, KMS, NoteCards, SuperCard). One must first work out the node and link structure, store the particular nodes and add the links. Further links are automatically generated by the software. The author defines a set of keywords or a combination of keywords, and the software creates links between the places where the keywords occur. Finally, the software provides a user interface which allows the reader to explore the hypertext in various ways, i. e. to find and follow the links. The actual creation of a hypertext, then, is a serious enterprise, which is demanding both intellectually and financially. Thus it is not surprising that it is undertaken only if the benefits outweigh the expenses. So far few scientists have found it worth the effort.

Nevertheless, it is clear that the structure of scientific knowledge fits the hypertext format very well. Take a set of papers. They include keywords and references to other papers. The papers themselves can be conceived as nodes. The references are links. The keywords are implicit links, i. e. devices for the automatic generation of further links. All that is missing is the actual generation of a hypertext with the help of an appropriate software. So what we have is a potential hypertext. Now if we understand science in this way, we may try to use some of the issues which have emerged in connection with hypertext to cast new light on familiar epistemological questions and, perhaps, to generate new questions. In what follows I will suggest some ways in which this may happen.

1. Coherence. It is a commonplace that scientific theories should be coherent. Coherence is normally taken to include two things: consistency and richness in connections. As to the second, the idea is that the system should be tightly organized, i. e. it should not contain free-floating items which are largely independent of the rest. But what sorts of connections are required? The usual answer is: explanatory connections. So coherence would mean that each significant item should be either something that explains or something that is explained.[1] A less usual answer, which does not contradict the former one, is that the items should lend one another inductive support, which can be clarified in decision-theoretic or Bayesian terms.[2] Now coherence is an issue which has enormous significance for the hypertext as well. It emerges in the following way. A hypertext must be rich in connections. If there cannot be but few links, the advantages of the hypertext format evaporate. However, it has turned out that large systems with many links easily become unmanageable. If there are many links, the reader may get "lost in hyperspace" or may become unable to afford the "cognitive overhead".[3] One sort of remedy is the use of "typed" links. A typed link is a link that has a label which specifies the nature of the link. For example, if the reader would like to know what supports the claim made within a particular node, she does not have to check all the links anchored in the node, but can select the links labeled as support. Obviously, hypertexts used for different purposes use different types. But it seems that the types normally used can be arranged into a taxonomy.[4] And if we have a good taxonomy, we may use it to supplement and clarify the idea of coherence as it is used in epistemology and the philosophy of science.

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[1] Wilfrid Sellars, *Science, Perception, and Reality*, London: Routledge and Kegan Paul, 1963.

[2] In decision-theoretic terms: Keith Lehrer, *Theory of Knowledge*, London: Routledge, 1990, esp. chapter 6. In Bayesian terms: Mary B. Hesse: *The Structure of Scientific Inference*, Berkeley, CA: University of California Press, 1974.

[3] Lost in hyperspace: Deborah M. Edwards and Lynda Hardman, "'Lost in Hyperspace': Cognitive Mapping and Navigation in a Hypertext Environment", in Ray McAleese (ed.), *Hypertext: Theory into Practice*, Norwood, NJ: Ablex, 1989, pp. 105–25. Cognitive overhead: J. Conklin, "Hypertext – An Introduction and a Survey", *IEEE Computer* 20 (1987/89), p. 38.

[4] The most elaborate taxonomy is provided by R. H. Trigg, "A Network-Based Approach to Text Handling for the Online Scientific Community", PhD thesis, Dept.

2. Search for information. Scientists are enormously dependent upon information provided by others. How do they find it? Well, this question has not been addressed in epistemology. As if it were tacitly assumed that all necessary information is readily available, and the important questions concern how to pick out the relevant pieces and how these should be used in the assessment or reformulation of the current views. But it is clear that when one embarks on a theoretical enterprise it hardly ever happens that all information needed for the completion of the project is already at hand from the very beginning. The reason why the availability of the relevant information is still tacitly assumed is that finding information just does not seem to be an epistemological issue. One gets what one needs by reading the literature, attending conferences, talking to colleagues, etc. It is a matter of chance, and matters of chance are not amenable to philosophical analysis. Perhaps this is true. But perhaps it is not. And if it is not, then studying the use of hypertext systems may help us to think about this issue (if it is an issue). Hypertexts are of no use unless readers can get out of them what they want. Now the systems used for the creation of hypertexts provide various means of helping the reader: tables of contents, indices, Boolean search functions, guided tours, bookmarks, overview diagrams, fisheye view-like browsers, etc. It has turned out that the utility of these devices depends partly on the sort of search the user is engaged in.[5] As a result, it has become increasingly important to understand the various strategies of search. For example, Canter et al. distinguish between five strategies: scanning (covering a large area without depth), browsing (following a path until a goal is achieved), searching (striving to find an explicit goal), exploring (finding out the extent of the information given) and wandering (purposeless and unstructured journeying).[6] If the consecutive moves of people pursuing these strategies are represented in a geometrical form, it turns out that each of these strategies is characterized by a particular pattern.

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of Computer Science, University of Maryland, 1983 (University Microfilms, no. 8429934), reported by Jakob Nielsen, *Hypertext and Hypermedia*, San Diego: Academic Press, 1990, p. 108. Another taxonomy is given by Rainer Kuhlen, *Hypertext. Ein nichtlineares Medium zwischen Buch und Wissensbank*, Berlin: Springer, 1991, p. 106.

[5] It depends much more on how the author succeeds in imposing a transparent structure on the material, i. e. on the quality of editing.

[6] D. Canter, R. Rivers and G. Storrs, "Characterizing User Navigation through Complex Data Structures", *Behaviour and Information Technology*, vol. 4, no. 2 (1985), pp. 93–102. See also Ray McAleese, "Navigation and Browsing in Hypertext", in McAleese

Now it may well turn out that the scientists' reading papers, attending conferences and chatting with colleagues actually follow these patterns. The apparent chance might have a system in it. And if it is so, we may wonder how the choice of strategy is linked with the current situation described in epistemological terms.

3. The logic of discovery. The common wisdom in the philosophy of science is that discovery is not a subject we can tell much about. It is like a mysterious "creative leap", it results from a wide variety of contingent factors, which resist any sort of systematization. In short, it does not have a logic. The main reason for this pessimistic assessment of the chances of an analysis of discovery is that we do not have tools which could reveal transparent structures underlying the creative processes. The scope of deductive logic is rather limited in this respect. Most discoveries do not result from deductive inferences. And even where the major results are actually presented as resulting from such inferences, like in mathematical physics, it is probably the case that the deductive form is a secondary elaboration, and the original insight was conceived in a different way. Inductive logic is not promising either. Statistical inference, enumerative induction and Bayesian conditionalization do not produce novel ideas.

There seem to be two ways of describing processes which may issue in genuine insights. One is to talk about the inference to the best explanation. It is useful to think of these inferences as constituting a continuum. On the one end of the continuum we have rather humble inferences which merely select one member of the set of already available alternatives. At the other end we have daring inferences which involve the creation of explanatory constructs. Between the two extremes we have the cases when the inference relies on a search, but the field to be searched is not given beforehand, and the result of the search is not immediately applicable to the problem at hand. This is often described as the utilization of models, analogies or metaphors. We know a lot about humble inferences, but humble inferences belong rather to the issue of theory assessment than discovery. For the issue is not really that of finding an explanation but rather that of evaluating the available

(ed.), *op. cit.*, pp. 6–44; A. Simpson, "Navigation in Hypertext: Design Issues", *Online Information* (1990), pp. 241–255; K. Utting and N. Yankelovich, "Context and Orientation in Hypermedia Networks", *ACM Transactions on Information Systems*, vol. 7, no. 1 (1989), pp. 58–84.

candidates. With regard to the more daring inferences to the best explanation we have detailed descriptions of particular cases, but these do not provide a basis for systematization.

These daring inferences are described in cognitive science as consisting in the building of complex schemata. In the last two decades we have learned something about how schemata are built up. It seems that at least some of these processes can be modelled by approaches based on parallel distributed processing. But the success in PDP still does not offer much hope for the description of discovery. First, PDP is used to explain the development of rather simple schemata, and it is not clear whether it can reach further than that. Secondly, what PDP offers is not a transparent description, i. e. it is not really an analysis. PDP-style explanations describe the nature of the input and specify algorithms which enable the system to learn how to produce the right output. If the system does indeed learn the function from input to output, it has built up the right schemata. But the schemata themselves merely consist of an arrangement of units with different threshold levels which are connected with varying strengths. They always look the same, so if we look at them, we cannot tell what they do and how they do it. If this is the way to describe discovery, then discovery, indeed, does not have a logic.

The way hypertext might offer some help is this. There are hypertext systems which were created partly in order to organize the ideas of a group of people.[7] According to the situation envisioned, there is a group of people using a shared workspace who have to work out a solution to some problem. None of them has the solution, but each of them has something to start with. They all place their ideas, as it were, on the table and use the resources of the hypertext system to structure their ideas in various ways until a feasible structure emerges. What they start from is potentially relevant but unconnected pieces of information and what they end up with is the right arrangement. What the group of people is engaged in is indeed an elementary sort of discovery. And here we can make out something like a logic. The basic moves whose appropriate combinations lead or at least may lead to the solution are the tools provided by the system. It is not as if we could simply "read off"

[7] See Nielsen, *op. cit.* pp. 46–8, 58–60.

the logic of discovery from these systems. These systems are better or worse, and none of them is perfect. But they do provide a clue.

These were just three ways in which the hypertext may help us to think about epistemological issues. My suggestions were highly tentative, and it may well turn out that the hypertext is of little or no use to epistemology. But it does offer a perspective which is worth exploring.[8]

[8] The research leading to this paper was funded by the Hungarian National Foundation for Scientific Research (OTKA).

Kristóf Nyíri

From Texts to Pictures: The New Unity of Science

Changes in communication technologies have over and over again in the course of history resulted in changes in the nature of scientific thought. In particular, the printing press, in the specific European context, played a central role in giving rise to the development of modern science. Printed scientific texts, to a greater or lesser degree, have been regularly accompanied by diagrams and pictures; however, some spectacular exceptions notwithstanding, the text dominated the image. And while the logic of the linear text was conducive to strict reasoning, it also fostered excessive specialization and compartmentalization within science. The philosopher and sociologist Otto Neurath, a leading member of the Vienna Circle, was among the first to suggest that, with the help of a pictorial language, a new unity within science could be achieved. In this work-in-progress draft I will attempt to show how the emergence of computer graphics and multimedia computer networking might lead to a fulfilment of Neurath's vision.

I am drawing on two previous talks of mine. In the first one I ventured to suggest that "the ideal of unified knowledge had been a genuine one during [a] fleeting moment of history, the sixteenth and seventeenth centuries. Before that, it was unfounded; and after that, unattainable."[1] With the coming of the digital age however, I noted, we now observe

> possibilities inherent in electronically mediated communication which might operate against the trend of fragmentation[:] ... Complex information which when cast into the mould of the linear text becomes impossible to grasp in a comprehensive formula, might easily be taken in at a glance or absorbed in a single harmony when presented in the media of images and sounds. Secondly, printed texts, when supported by electron-

[1] "Electronic Networking and the Unity of Knowledge", in Stephanie Kenna and Seamus Ross (eds.), *Networking in the Humanities* (Proceedings of the Second Conference on Scholarship and Technology in the Humanities, held at Elvetham Hall, Hampshire, UK, 13–16 April, 1994), London: Bowker-Saur, 1995, p. 260.

> ic versions of the same, can be studied more thoroughly and comprehensively than when available on paper only. When hypertext, multimedia, and networking are *added* to the printed book, the possibilities to achieve a kind of overview of knowledge, to maintain its *relative* unity, are heightened.[2]

By the time of my second talk, presented at a conference some two years ago,[3] I was putting rather less emphasis on the printed text. I offered

> three arguments. All three are bound up with the once more strengthening continuity between theory and practice at this dawn of a network digital culture. First: when the relative weight of applied research as compared to basic research is growing, the experience of coherence in everyday life overrides the image of fragmented scientific specialities. Secondly: in the medium of the computer abstract calculation and concrete experiment meet; and since in the virtual space all skills tend to become similar in type, they are less likely to create a distance between particular theories. ... Thirdly: as a consequence of digitalization, text and picture come closer to each other. Pictures can show what texts can only describe; pictures are relatively independent of their linguistic-conceptual surroundings; and pictures ... are better at conveying practical knowledge than are texts. This state of affairs, coupled with the fact that in the medium of the internet disciplinary isolation is difficult to maintain, renders the perspective of a unified science rather less illusive than it was some decades ago.[4]

Let me here recapitulate the arguments of these two talks, adding a number of further strands. I will begin with some observations on the place of pictorial communication in the project of unified science as envisaged by Neurath.

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[2] *Ibid.*, pp. 275 f.

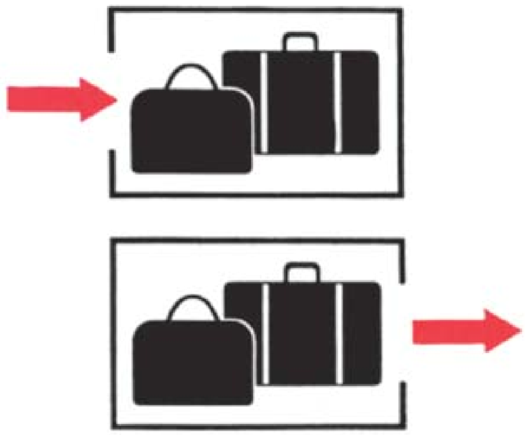
[3] *Information Society, Interdisciplinarity, and the Future of the Humanities*, conference held at the Institute for Philosophical Research of the Hungarian Academy of Sciences, Budapest, Nov. 4, 2000, www.fil.hu/highlights/tudnap_2000.htm.

[4] "Words, Pictures, and the Unity of Knowledge" (2000), www.fil.hu/highlights/nyiri_presentation.htm

Neurath's Encyclopedia

From the 1920s to the 1940s, first in Vienna, later in The Hague and finally in London, Neurath and his associates worked on the creation of an iconic language which by the mid-1930s he was calling the "International System Of Typographic Picture Education", abbreviated as *isotype*.[5] The icons elaborated within the framework of the isotype program eventually came to serve as models for those international picture signs we today encounter at airports and railway stations. However,

Where to put your boxes



Where to get your boxes

Neurath had originally pursued a much more ambitious aim: that of systematic scientific visualization. In the prefatory note to his *International Picture Language* he speaks about "turning the statements of science into pictures",[6] and envisages producing not just "a teaching book on a special branch of knowledge", but indeed an *encyclopedia.* "The ISOTYPE picture language", he writes, "would be of use as a helping language in an inter-

[5] I have described this system briefly in my paper "Pictorial Meaning and Mobile Communication", in: Kristóf Nyíri (ed)., *Mobile Communication: Essays on Cognition and Community*, Vienna: Passagen Verlag, 2003, pp. 176 f.

[6] Otto Neurath, *International Picture Language*, London: 1936, repr. University of Reading: Dept. of Typography & Graphic Communication, 1980, p. 8.

national encyclopaedia of common knowledge. Such an encyclopaedia will be the work of our time."[7] As he puts it later in the book, in the section "From Designs in Stone and the Orbis Pictus to the Isotype Encyclopaedia":

> In present Europe the idea of picture education is not more than 300 years old. Before that there was not very much connection between words and pictures. The books and the thoughts of those times had little to do with experience... In later times the relation between words and pictures became clearer, in connection with the development of science. – The Orbis Pictus of Comenius gives pictures for a great number of words and names in different languages. ... The invention of printing in black and white gave a new impulse to every sort of writing and designing for a wide public. ... One special branch of work was the making of pictures of military stations and of fights, in which the order of military units is designed in a way which is very like the ISOTYPE system. ... In the writings of Leibniz we come across the idea that picture-making is to be done with the help of science. His desire was to make an "atlas universalis" in connection with an encyclopaedia. The French encyclopaedia gave a great amount of material and a great number of pictures, but there was only a loose connection between them.[8]

And here then follows the crucial passage:

> At this time the idea of an international encyclopaedia is coming once more to the front. ... The encyclopaedia will make use of one language for all sciences, it puts out all feeling – all words for right and wrong – from the account of science, it will have as little as possible to do with any words or any signs which are not clear, it will make use of one picture language. The purpose of this new encyclopaedia, which is only an addition to other encyclopaedias, is to give all men a common starting-point of knowledge, to make one united science, forming a connection between the special sciences and putting together the work of different nations, to give simple and clear accounts of everything as a solid base for our thoughts and our acts, and to make us fully conscious of conditions in which we are living. This encyclopaedia will be all the time in the process of growth, like society, science, and language themselves. What the science of reasoning has done to make possible such a uniting

[7] *Ibid.*, p. 65.
[8] *Ibid.*, pp. 106 ff.

of the sciences and to give one word language to all the special sciences, the ISOTYPE system has done to make possible one language of pictures which will give the same sort of help to the eye for all the special sciences and for persons of all nations.[9]

Old military picture

[9] *Ibid.*, pp. 110 f.

The rudimentary technologies of design and production Neurath and his team had at their disposal obviously precluded the accomplishment of such lofty aims. The glaring disparity between intention and achievement should not however blind us to the fact that from a philosophical point of view Neurath's program was not entirely outlandish; certainly it was well embedded in Neurath's specific version of Vienna Circle logical empiricism. The book *International Picture Language* was written in "Basic English", a radically impoverished version of English, devised by C. K. Ogden, the translator of Wittgenstein's *Tractatus*, a work itself very much preoccupied with the simplicity and the pictorial aspects of language. Now it is significant that Neurath sees a fundamental similarity between iconic communication on the one hand and Basic English on the other. As he puts it:

> the uses of a picture language are much more limited than those of normal languages. It has no qualities for the purpose of exchanging views, of giving signs of feeling, orders, etc. It is in no competition with the normal languages; it is a help inside its narrow limits. But in the same way as Basic English is an education in clear thought – because the use of statements without sense is forced upon us less by Basic than by the normal languages, which are full of words without sense (for science) – so picture language is an education in clear thought – by reason of its limits.[10]

We can compare the message of this paragraph with three other important propositions by Neurath. First, from his classic paper "Protokollsätze",[11] where he says: "Einstein's theories are expressible (somehow) in the language of the Bantus – but not those of Heidegger, unless linguistic abuses to which the German lends itself are introduced into Bantu."[12] Second, an aphorism from his *Einheitswissenschaft und Psychologie*, written at about the same time: "Metaphysical terms divide – scientific terms connect."[13] Third, a sentence, in the awkward style of Basic English, from *International Picture Language*: "Words make division, pictures make connec-

[10] *Ibid.*, pp. 20 ff.

[11] Published in the Vienna Circle journal *Erkenntnis* in 1932/33.

[12] Here quoted from the English translation ("Protocol Sentences") in A. J. Ayer (ed.), *Logical Positivism,* Glencoe, IL: The Free Press, 1959, p. 200.

[13] "Metaphysische Termini trennen – wissenschaftliche Termini verbinden" (Otto Neurath, *Einheitswissenschaft und Psychologie*, Vienna: Gerold & Co., 1933, repr. in Neurath, *Gesammelte philosophische und methodologische Schriften*, ed. by Rudolf Haller and Heiner Rutte, Vienna: Hölder-Pichler-Tempsky, 1981, vol. 2, p. 610).

British
American
Scientific
International
Commercial

"One unlooked-for development of the hundred years between 2000 and 2100 was the way in which Basic English became in that short time the common language for use between nations. . . . By 2200 almost everyone was able to make use of Basic for talking and writing."—H. G. Wells.

Put into Basic from *The Shape of Things to Come*

Printed in Great Britain by
K. I. SEVERS, CAMBRIDGE

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tion." Neurath's message is unambiguous: clear thoughts can be expressed in simple language, and simple language can be translated into pictures. Unified science becomes possible once the language of science is purged of metaphysical terms; and anything that needs to be expressed within the framework of unified science can be communicated by a pictorial language.

In 1938 there appeared the first issue of the *International Encyclopedia of Unified Science*, edited by Neurath, Rudolf Carnap, and Charles Morris. The introductory essay – "Unified Science as Encyclopedic Integration" – was written by Neurath. It contained only a brief allusion to the idea of scientific visualization.[14] Important from the point of view of the present draft is however an essay by Dewey in the same issue. As Dewey here wrote:

> the scientific method is not confined to those who are scientists. The body of knowledge and ideas which is the product of the work of the

[14] "It is hoped", remarked Neurath, "that an *Atlas* can be worked out as an *Isotype Thesaurus* showing important facts by means of unified visual aids." (*International Encyclopedia of Unified Science*, vol. I, no. 1, Chicago: The University of Chicago Press, 1938, p. 25. An endnote with a reference to Neurath's book *International Picture Language* occurs on p. 27.

> latter is the fruit of a method which is followed by the wider body of persons who deal intelligently and openly with the objects and energies of the common environment. In its specialized sense, science is an elaboration, often a highly technical one, of everyday operations. In spite of the technicality of its language and procedures, its genuine meaning can be understood only if its connection with attitudes and procedures which are capable of being used by all persons who act intelligently is borne in mind.[15]

To which he added:

> Few would rule engineers from out the scientific domain, and those few would rest their case upon a highly dubious distinction between something called "pure" science and something else called "applied" science. ... Pure science does not apply itself automatically; application takes place through use of methods which it is arbitrary to distinguish from those employed in the laboratory or the observatory. And if the engineer is mentioned, it is because, once he is admitted, we cannot exclude the farmer, the mechanic, and the chauffeur, as far as these men do what they have to do with intelligent choice of means and with intelligent adaptation of means to ends, instead of in dependence upon routine and guesswork.[16]

Texts and the Fragmentation of Science

In my talk "Electronic Networking and the Unity of Knowledge", some passages of which[17] I will more or less verbatim repeat in the present section, I recalled that as long as books were copied manually, i. e. before the age of the printed press, the overall coherence of the existing literature had been inconceivable, since copies even of the same work increasingly differed from each other. Texts became interspersed by com-

[15] John Dewey, "Unity of Science as a Social Problem", *ibid.*, pp. 29 f. – One did not have to be a pragmatist philosopher to subscribe to the idea that scientific thinking is continuous with everyday thinking. In his book *Imagery in Scientific Thought: Creating 20th-Century Physics* Arthur I. Miller quotes Albert Einstein as writing (in 1934) that "[t]he whole of science is nothing more than a refinement of everyday thinking. It is for this reason that the critical thinking of the physicist cannot possibly be restricted to the examination of concepts of his own specific field. He cannot proceed without considering critically a much more difficult problem, the problem of analyzing the nature of everyday thinking" (Boston: Birkhäuser, 1984, p. 13).

[16] Dewey, *op. cit.*, p. 30.

[17] Cf. Stephanie Kenna and Seamus Ross (eds.), *Networking in the Humanities*, pp. 259 ff.

ments if copied by an expert scholar, impaired by mistakes if copied by an unqualified clerk. The notion of authorship remained blurred. Printing however could produce thousands of identical copies; mistakes were, with every new edition, progressively eliminated; a community of scholars all over Europe worked on the same texts, gradually establishing a firm framework of categories, names, of historical time and geographical space; descriptions, findings, discoveries could be increasingly compared with each other, maps, diagrams, illustrations, figures and calculations reproduced; the modern ideal of a unified knowledge emerged.

Every age of course does feel the need to bring together the knowledge society possesses. In libraries the documents of learning are physically amassed, permitting, in principle, access to all there is to know. By contrast, encyclopaedias present distilled overall accounts of knowledge. As Bolter observes, these become particularly necessary when there occurs a specific scarcity or a specific abundance of information.[18] The latter was the case in late antiquity, then again after the twelfth century, and of course ever since the invention of book printing. Both libraries and encyclopaedias face the task of not just presenting, but also *organizing* information, a task that becomes increasingly difficult as the complexity of knowledge progresses. Early encyclopaedias could rely on relatively simple, and generally accepted, mythological, theological, or educational patterns. Thus the encyclopaedia of Martianus Capella was organized along the structure of the seven liberal arts; that of Vincent of Beauvais along the six days of creation, a method also adopted by Thomas of Cantimpré, whose *De naturis rerum* served as the basis of Conrad of Megenberg's very successful German translation of 1350, *Buch der Natur*. This is how Conrad begins: "Got beschuof den menschen an dem sehsten tag nâch andern crêatûren und hât in beschaffen alsô, daz seins wesens stük und seins leibes gelider sint gesetzet nâch dem satz der ganzen werlt", man shares certain principles with other creatures, since those principles had already been operative during the earlier phases of creation.[19] Conrad's book treats of everything from the scull of man through edible fruits through signs of pregnancy to precious stones; his descriptions are crude, certainly not sufficient to convey any expertise; the knowledge he offered might have appeared as, but could not possibly have been, a coherent guide to his readers. The belief that there existed a unified

[18] Jay David Bolter, *Writing Space: The Computer, Hypertext, and the History of Writing*, Hillsdale, NJ: Lawrence Erlbaum Associates, 1991, p. 89.

[19] Konrad von Megenberg, *Das Buch der Natur*, ed. by F. Pfeiffer, Stuttgart: Karl Aue, 1861, p.3.

body of knowledge, some of it written, as the metaphor had it, in the books of men, and all of it engraved in the book of God, of Creation, of Nature, was vivid all through the Middle Ages, and was merely reformulated by Descartes and Leibniz in the seventeenth century and Bolzano in the nineteenth; however, the conditions to build up a unified framework of ideas were simply not given before the age of the printed book. And by the eighteenth century it became clear to most that the rapidly expanding world of knowledge could actually not be fitted into that framework.[20] Bacon, in the Second Book of his *Advancement of Learning* (1605), could confidently survey and systematize the existing state of knowledge, pointing out gaps and suggesting ways to fill them in. Less than a century later Fontenelle announces the publication of research results by the French Academy saying that those consist of "details detached from,

[20] Meyrowitz proposes a different explanation for the fact that "the spread of print supports compartmentalization and specialization". Printing has led to the emergence of the age-graded school. But "distinctions in reading abilities", the "different levels of reading complexity", offer "a seemingly natural means of segmenting information – and people. All fields begin to develop 'introductory' texts that must be read before one can go on to 'advanced' texts. Identities splinter into a multitude of separate spheres based on distinct specialties and mastery of field-specific stages of literacy. The new grading of texts serves as a barrier to straying from one field into another. Crossing into a new field demands that one must bear the embarrassement of starting again as a novice and slowly climbing a new ladder of printed knowledge. This contrasts markedly with the oral and scribal approach, which is inherently interdisciplinary and non-graded." (Joshua Meyrowitz, "Medium Theory", in David Crowley and David Mitchell [eds.], *Communication Theory Today*, Stanford, CA: Stanford University Press, 1994, p. 65.) The assumption of an inherently interdisciplinary scribal culture is not universally accepted. This is how Elizabeth Eisenstein sees the matter: "during the age of scribes ... opportunities for cross-cultural interchange were necessarily restricted and limited. An apprentice learning to wield the tools of the surgeon–barber, and a university student transcribing passages from Latin translations of Greek and Arabic medical texts were acquiring skills that were conveyed by entirely separate 'transmission belts'. Even within the university itself, the conditions of scribal culture prevented an interchange between disciplines that now seem to be closely related: astronomy and physics, for example. ... The charts and tables of the *Almagest* were preserved ... by a select group of professional astronomers, from which Copernicus ultimately emerged. Records containing precise computations required special training for copyists, close supervision of scriptoria, careful custody of relevant texts and detailed instruction in how to use them. Mastery of planetary astronomy under such conditions was almost bound to isolate this discipline from other branches of learning." (Elizabeth L. Eisenstein, *The Printing Press as an Agent of Change: Communications and Cultural Transformations in Early-Modern Europe*, Cambridge: Cambridge University Press, 1979, vol. I, pp. 270 f.)

and independent of, each other". But he adds that those results might one day add up to a whole. "Plusieurs vérités séparées", he writes,

> dès qu'elles sont en assez grand nombre, offrent si vivement á l'esprit leurs rapports et leur mutuelle dépendance, qu'il semble qu'après avoir été détachées par une espèce de violence les unes d'avec les autres, elles cherchent naturellement à se réunir.[21]

Another fifty years go by, and d'Alembert, though very much inspired by Bacon, rejects the idea of a definitive synthesis of all sciences. As he writes:

> Le système général des sciences et des arts est une espèce de labyrinthe, de chemin tortueux où l'esprit s'engage sans trop connaître la route qu'il doit tenir.

Now d'Alembert points out that matters are different when it comes to the project of an encyclopaedic ordering of knowledge:

> Ce dernier consiste à les rassambler dans le plus petit espace possible, et à placer, pour ainsi dire, le philosoph au-dessus de ce vaste labyrinthe, dans un point de vue fort élevé d'où il puisse apercevoir à la fois les sciences et les arts principaux; voir d'un coup d'œil... C'est une espèce de mappemonde...

However, d'Alembert goes on:

> On peut ... imaginer autant des sytèmes différents de la connaissance humaine que des mappemondes de différentes projections; et chacun de ces systèmes pourra même avoir, à l'exclusion des autres, quelque avantage particulier.[22]

D'Alembert does not, any more, believe in the possibility of a unified and unique description of our knowledge of the world. But he has no reason to doubt the givenness and unity of the world itself. The world is an ordered whole of causes and effects, governed by immutable laws. The book of nature is there – even if it cannot be once and for all translated into books of men.

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[21] Bernard Le Bovier de Fontenelle, *Textes choisis*, Paris: Editions sociales, 1966, pp. 278 f.

[22] Jean Le Rond d'Alembert, *Discours préliminaire de l'Encyclopédie* (1751), Paris: 1893, pp. 66 ff.

To register the impossibility of achieving an overview of the world of texts means to lose the ground for a belief in the unity and coherence of that world. It means renouncing faith in a single correct perspective; it means accepting the legitimacy of holding multiple points of view with respect to the same subject, of letting context take precedence over denotation; ultimately it means giving up the idea of definite meanings and objective truths, indeed giving up the idea of the unity and givenness of the world itself.[23] Towards the end of the nineteenth century this is the stance Nietzsche takes – I deliberately avoid the term "position" in the case of a philosopher whose style so intensely suggests the determination not to have a position. Nietzsche not only rejects bookishness – "we moderns" he says, are but "walking encyclopaedias"[24] – he also quite consciously eludes the magic of, and turns against, the *objektive Schriftsprache*, "objective written language".[25] And less then a hundred years after Nietzsche, by the mid-twentieth century, it has become a philosophically admissible thesis that the world of knowledge was too immense to permit any kind of overall grasp, and that, consequently, the supposition of a single reality was meaningless. Thomas Kuhn's very influential book *The Structure of Scientific Revolutions*, published in 1962, ostensibly dealt with the incommensurability of successive scientific paradigms, but it was understood to imply a thesis both diachronic and synchronic to the effect that divergent scientific theories should be interpreted as constructions of different worlds of objects, rather than as competing explanations of one and the same world. Five years earlier Gaëtan Picon, in the introductory essay to the popular collection he edited, *Panorama des idées contemporaines*, a collection immediately translated into several languages, registered a feeling of disorientation effected on the one hand by the idea of indeterminacy in quantum mechanics, and on the other hand, again, by the "spécialisation croissante" – the "growing specialization". This, as he put it, "éloigne de plus en plus de toute image ordonnée du réel. Au monde succèdent les mondes". "[D]écentré", wrote Picon, "le système de la connaissance"

[23] The inference from the loss of truth to the loss of faith in the givenness of the world is, strictly speaking, not stringent; but it is the usual move in philosophy. Thus Edmund Husserl could write (*Logische Untersuchungen*, vol. I, Halle: Max Niemeyer, 1900, p. 121): "Die Relativität der Wahrheit zieht die Relativität der Weltexistenz nach sich", *the relativity of truth leads to the relativity of the existence of the world*.

[24] Friedrich Nietzsche, *Sämtliche Werke: Kritische Studienausgabe*, dtv – de Gruyter, 1980, vol. 1, pp. 273 f.

[25] *Ibid.*, vol. 7, p. 48. The definitive monograph on Nietzsche as a philosopher of the orality–literacy tension is Rudolf Fietz, *Medienphilosophie: Musik, Sprache und Schrift bei Friedrich Nietzsche*, Würzburg: Verlag Königshausen & Neumann, 1992.

and: "Le monde a éclaté en mondes irréductibiles, qui vivent d'une co-existence sans communication ni hiérarchie."[26] When Nelson Goodman published his *Ways of Worldmaking* in 1978, he could speak of a "movement" "from unique truth and a world fixed and found" to a "diversity" of truths and a "multiplicity of worlds", and refer to Ernst Cassirer's work from the twenties and thirties as one of the earlier stages of that movement.

A work reassessing the Kuhnian notion of a paradigm in view of the current proliferation of scientific fields was Diana Crane's book *Invisible Colleges: Diffusion of Knowledge in Scientific Communities*, published in 1972. As she put it:

> An idea that is rejected in one specialty may be accepted in another. ... The existence of hundreds of fields, growing and declining, linked to some extent by concepts that have proved useful in several areas and with no clear-cut boundaries between them, permits both rapid diffusion of ideas and also the coexistence of mutually incompatible ideas if applied to different research topics."[27]

The term "invisible colleges" in Crane's book – a term that first seems to occur in the Boyle–Hartlib correspondence – refers to informal groups of scientific elites through whom the communication of information both within a field and across fields is directed. The members of research areas, Crane found, "were not so much linked to each other directly but were linked to each other indirectly" through the "highly influential members" belonging to the elite. These prestigious figures "were surrounded individually by subgroups of scientists who looked to them for information. They in turn communicated intensively with one another". As Crane, quoting another researcher, writes: it is through "the central scientists" that "information may be transferred to all other scientists in the network".[28] The reference here is of course to social, not to electronic networks – what from our present point of view makes Crane so interesting is that the findings she accepts immediately invite a reformulation of her questions in terms of today's networking practices. Is it still the case, we will have to ask, that members of the scientific elite occupy a central place in the channelling of information? The question was answered in

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[26] Paris: 1957, rev. ed. Paris: Gallimard, 1968, pp. 17 f. and 28.

[27] Chicago: University of Chicago Press, 1972, p. 39.

[28] *Ibid.*, pp. 49 and 52 f.

the affirmative both by László Babai in 1990,[29] and by Albert-László Barabási in his recent book.[30]

Pictures in a Knowable World

The notion of a comprehensive unified knowledge must be found illusive once one realizes that any branch of knowledge is invariably embedded in particular practices,[31] and that therefore, as Gordon Baker argues interpreting Wittgenstein, a single perspicuous representation of different language games is not conceivable,[32] or, to put the same point differently, that a comprehensive and unified knowledge could not be *subjectively represented* – no mind could serve as its focus, no person could embody the sum of necessary skills. However, let me make two pints. First – recall Neurath's arguments – that pictures might sometimes succeed where texts fail. Pictures, especially animated pictures – by themselves, or in combination with words – can quite effectively convey practical knowledge.[33] Also, pictures can summarize, in a way that can be grasped in a single glance, complex information that may be unintelligible when propositionally expressed.[34] Secondly, the idea of a unified knowledge need not imply the possibility of a single harmonious vision

[29] As Babai writes: "E-mail is capable of creating an *ultracompetitive atmosphere* on a much grander scale than any medium before." An e-mailing of important research results "may give unprecedented information advantage to a well chosen, sizable, and consequently extremely powerful elite group. The group of recipients ... may be fully capable of making rapid advances before others would even find out that something was happening. Although such elite groups belong to the very nature of the hierarchy of scientific research ..., their sheer intellectual force combined with the information advantage makes them look from outside like an impenetrable fortress." (László Babai, "E-mail and the Unexpected Power of Interaction", University of Chicago Technical Report CS 90-15, April 24, 1990, pp. 11 f.)

[30] Albert-László Barabási, *Linked: The New Science of Networks,* Cambridge, MA: Perseus Publishing, 2002, see esp. chapters 6 and 7.

[31] Cf. e.g. the essays by Barry Smith ("Knowing How vs. Knowing What") and by Kristóf Nyíri ("Tradition and Practical Knowledge"), in Nyíri and Smith (eds.), *Practical Knowledge: Outlines of a Theory of Traditions and Skills*, London: Croom Helm, 1988.

[32] Gordon Baker, "*Philosophical Investigations* Section 122: Neglected Aspects", in Robert L. Arrington and Hans-Johann Glock (eds.), Wittgenstein's Philosophical Investigations: *Text and Context,* London: Routledge, 1991.

[33] For some references see my paper "Pictorial Meaning and Mobile Communication", in Nyíri (ed)., *Mobile Communication: Essays on Cognition and Community* , pp. 175 f. and 179.

[34] A brilliant book on the subject is Colin Ware, *Information Visualization*, San Francisco: Morgan Kaufmann, 2000. Incidentaly, visualization might not be the only non-

of reality. It suffices if we can demonstrate the possibility of *transitions* from one field of knowledge to another; the possibility of conceptual bridges, passages, interactions. And such transitions indeed become easier when word is enhanced by image.

Pictures were the "ordering elements" in Einstein's thinking;[35] for him, verbal processes seem to have played a merely secondary role. As he put it in an oft-quoted passage:

> The words or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The physical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be "voluntarily" reproduced and combined. ... – ... Taken from a psychological viewpoint, this combinatory play seems to be the essential feature in productive thought – before there is any connection with logical construction in words or other kinds of signs which can be communicated to others. – The above-mentioned elements are, in any case, of visual and some of muscular type. Conventional words or other signs have to be sought for laboriously only in a secondary stage, when the mentioned associative play is sufficiently established and can be reproduced at will. – According to what has been said, the play with the mentioned elements is aimed to be analogous to certain logical connections one is searching for. – In a stage when words intervene at all, they are, in my case, purely auditive, but they interfere only in a secondary stage as already mentioned.[36]

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verbal means to cope with complexity. As Root-Bernstein observes: "Music ... may be a particularly useful means of training the mind to perceive the ways in which the apparent complexity of an experience (e.g., a Bach fugue or a physiological process) may result from the proper application of simple rules and patterns expressed in tandem." (Robert Scott Root-Bernstein, "Visual Thinking: The Art of Imagining Reality", *Transactions of the American Philosophical Society*, 75 [1985], p. 58.)

[35] "When ... memory-pictures emerge", Einstein wrote in his autobiographical notes, "this is not yet 'thinking'. And when such pictures form series, each member of which calls forth another, this too is not yet 'thinking'. When, however, a certain picture turns up in many such series, then ... it becomes an ordering element for such series, in that it connects series which in themselves are unconnected. Such an element becomes an instrument, a concept." (Quoted by Arthur I. Miller, *Imagery in Scientific Thought*, pp. 43 f.)

[36] Quoted by Arthur Koestler, *The Act of Creation*, London: Hutchinson, 1964, pp. 171 f. Koestler is quoting from Jacques Hadamard, *The Psychology of Invention in the Mathematical Field*, Princeton University Press, 1949. The integrative role of motor – "muscular" – images is emphasized by Allan Paivio, in his *Imagery and Verbal Processes*. As he puts it: "a motor component (implicit or explicit) appears to be generally characteristic of images

Visual thinking, working with mental images, has obviously played a fundamental role throughout our history. However, this mode of thinking was for a long time hampered by the absence of physical counterparts – a problem which was solved only in the fifteenth century with the invention of the new the technology of picture printing.[37] After 1400, and most notably in the sixteenth and early seventeenth centuries, scientific – or proto-scientific – visualization became widespread. The sixteenth century, as Freedberg puts it, was "the first great age of visual encyclopedias".[38] And the year 1543 witnessed the publication of Copernicus' *De revolutionibus* and Vesalius' *De humani corporis fabrica*, both making decisive use of pictures – indeed there is even a common logic to the way the two books employ them. James Franklin refers to Tartaglia's Italian Euclid of 1543 to introduce the argument. The latter work, he writes, "is geometry in the narrow sense. But the big two books of 1543 ... are also geometry, if a slightly wider sense of the term is allowed. ... the three books share more than just pictures... ... The point of Euclid is to *reason* about the diagrams, and expose the necessary interrelations of the spatial parts. So it is with Copernicus and Vesalius."[39]

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of movement, and of the transformations involved in the generation of an integrated figural image or the solution of more complex problems requiring visual thinking. The motor component somehow facilitates the transition from one substantive part of the stream of thought to another." (New York: Holt, Rinehart and Winston, 1971, p. 31.)

[37] I have told the story in some detail in my "Pictorial Meaning and Mobile Communication".

[38] "It is true", Freedberg continues, "that throughout the Middle Ages attempts had indeed been made to assemble compendia of visual information about the world of nature, but they were mostly sporadic and scant in comparison with those that appeared in the wake of the printing revolution. Printing – and the associated arts of woodcut and engraving – enabled the easy reproduction and dissemination of visual information, and students of the natural world were not slow to exploit it." (David Freedberg, *The Eye of the Lynx: Galileo, His Friends, and the Beginnings of Modern Natural History*, Chicago: The University of Chicago Press, 2002, p. 3.)

[39] James Franklin, "Diagrammatic Reasoning and Modelling in the Imagination: The Secret Weapons of the Scientific Revolution", in Guy Freeland and Anthony Corones (eds.), *1543 and All That: Image and Word, Change and Continuity in the Proto-Scientific Revolution*, Dordrecht: Kluwer, 2000, p. 53. Franklin adds: "Galileo's famous saying that the universe is written in the language of mathematics, which when quoted in isolation makes us think, for example, 's = 1/2 gt2', continues in the original, 'its characters are triangles, circles, and other geometrical figures, without which it is humanly impossible to understand a single word of it'. ... The later phase of the Scientific Revolution is ... algebraic, but the earlier one is diagrammatic" (*ibid.*, pp. 53 f. and 67).

And yet Martin Kemp can, in the same volume as Franklin, convincingly argue for the position that in the sixteenth century there did not emerge "any obvious prospect of a grand, unifying theory based on new forms of representation as corresponding directly to (or precipitating) some great overarching reform of the means of visualization. The relationship between illustration and visualization seems quite different in the various sciences...".[40] Pictures and diagrams could not play a truly unifying role in early-modern science, since the creation of sufficiently sophisticated illustrations was simply not possible with the then available technologies of graphic design. Kemp quotes Copernicus as saying that his problems "are not easily explained adequately with words. Hence they will not be understood when heard ... unless they are also seen by the eyes. Therefore let us draw on a sphere the ecliptic ABCD..." However, as Kemp points out, "the diagrammatic resources available to [Copernicus] were not visually eloquent to anyone who had not already cultivated an ability to visualise in the mind in non-verbal form ... the complex consequences of the relative motions of bodies moving in orbits and epicycles with eccentrics." Actually it was not through the use of printed illustrations, but "through the use of astronomical instruments that the essential mediation between the observed phenomena and their geometrical analysis could be accomplished, and it was through astronomical models that representation could be best achieved for the purposes of instruction".[41]

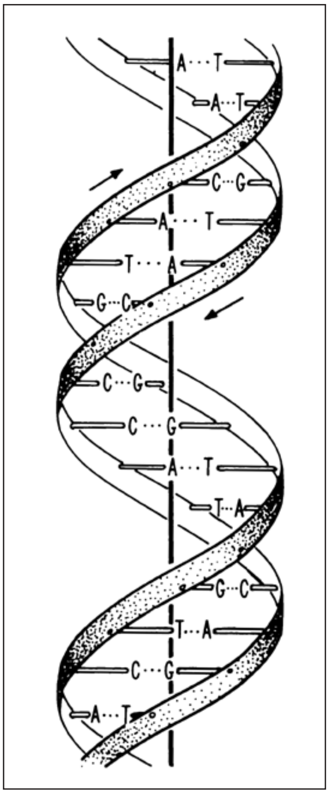
Throughout modernity, pictures and diagrams had to remain subservient to mathematical and verbal argumentation. I agree with Franklin when he says that it is due to "the very recent availibility of computer-intensive visualization tools" that images today are gaining "scientific respectability".[42] Let me here refer to what was undoubtedly the greatest discovery in twentieth-century biochemistry, as also a path-breaking step towards a new interdisciplinarity: the discovery of the double helix by Crick and Watson. This discovery relied quite fundamentally on visualization – initially on visual imagining, and ultimately on 3D-modelling. The modelling of course was done – in 1953 – without the aid of com-

[40] Kemp, "Vision and Visualization in the Illustration of Anatomy and Astronomy from Leonardo to Galileo", in Freeland and Corones (eds.), *op. cit.*, p. 46.

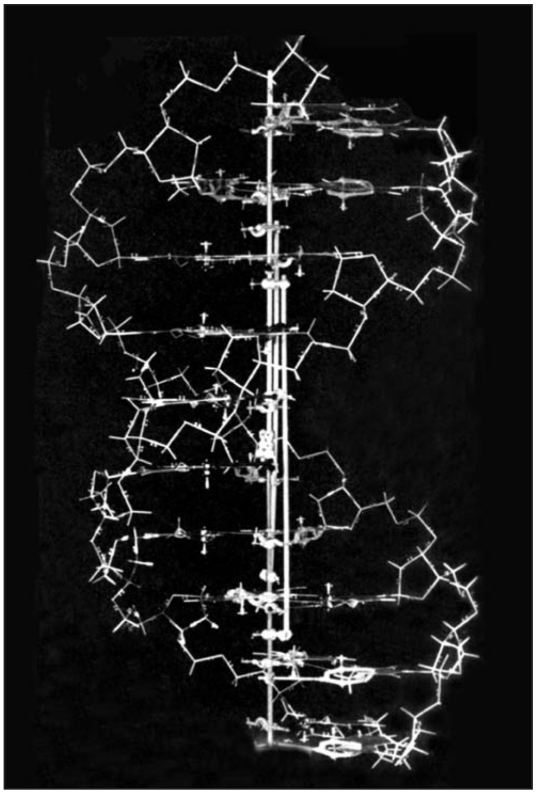
[41] *Ibid.*, pp. 34 f.

[42] Franklin, *op. cit.*, p. 85.

puter graphics. As readers of Watson's *The Double Helix* are aware, this implied that substantial time and energy had to be spent on manual experimenting with, and installing of, bits and pieces of wire and metal.[43]



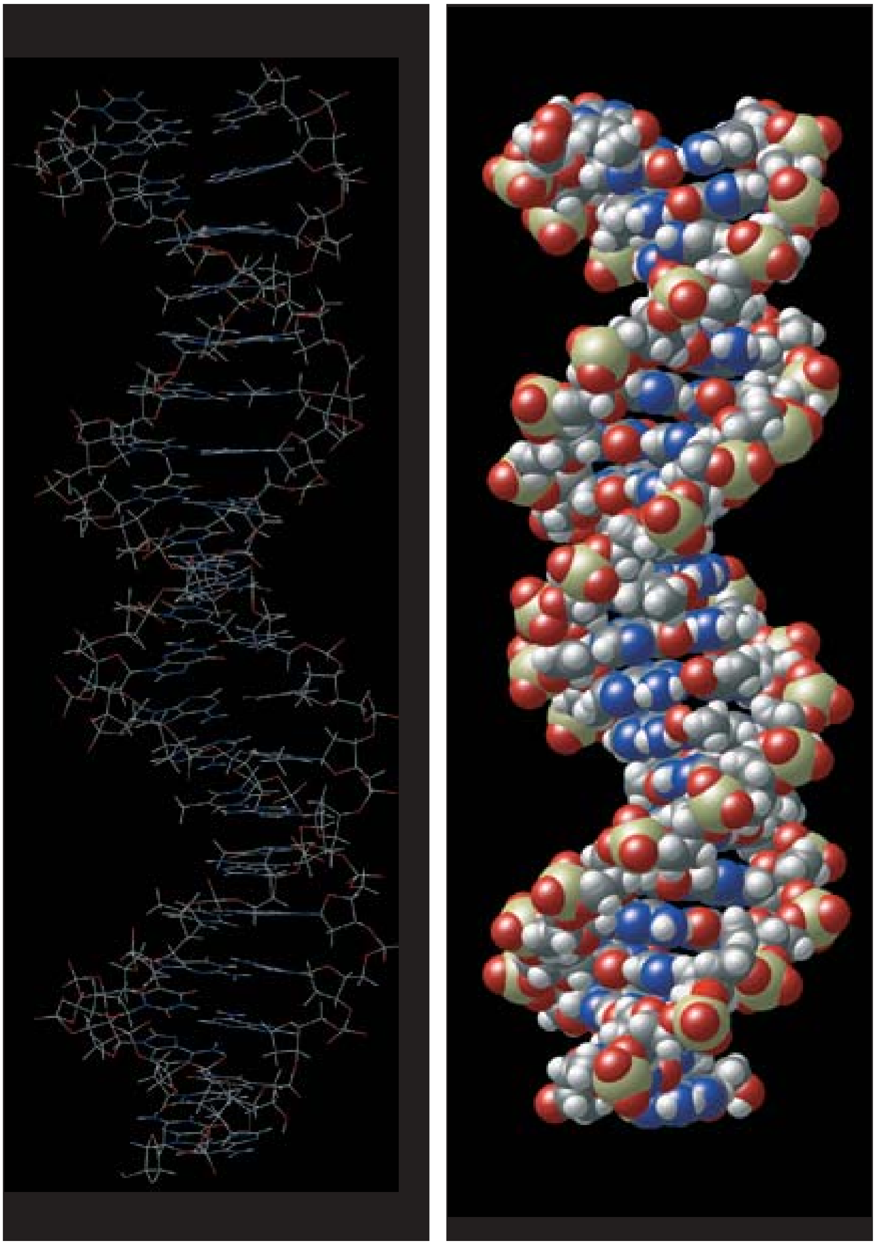
A schematic illustration of the double helix



The original demonstration model of the double helix

(Source: Watson, *The Double Helix*)

[43] James D. Watson, *The Double Helix: A Personal Account of the Discovery of the Structure of DNA* (1968), New York: Simon & Schuster, 2001, pp.



Double helix models created by computer graphics

In his book *Image and Logic: A Material Culture of Microphysics* Peter Galison analyzes the relations between contemporary particle physics and image recording.[44] He refers to two competing traditions of instrument making. As he puts it: "One tradition has as its goal the representation of natural processes in all their fullness and complexity – the production of images of such clarity that a single picture can serve as evidence for a new entity or effect. These images are presented, and defended, as *mimetic* – they purport to present the form of things as they occur in the world. ... Against this mimetic tradition", Galison continues, "I want to juxtapose what I have called the 'logic tradition', which has used electronic counters coupled in electronic logic circuits." In the early 1980s, Galison points out, the "image" tradition and the "logic" tradition fused, "with the production of electronically generated, computer-synthesized images. It was just such an electronic 'photograph' that heralded the discovery of the *W* and *Z* particles in 1983 – the first time a single electronic detection of an event had ever been presented to the wider physics community as compelling evidence in and of itself."[45]

The emergence of digital graphics is of course only one aspect of the profound change in the course of which the computer has become an everyday element of scientific routine. When I say "computer" I mean, obviously, *the computer as part of the interactive multimedia global network.* Those patterns of mobility, immutability, compoundability, and demonstrability analyzed by Latour in his paper "Visualization and Cognition"[46] gain an entirely new meaning in the medium of the internet. Science as based on the book is replaced by science as based on the global network. The barriers separating different specialties seem today to become fluid once more. A new, transdisciplinary mode of science emerges. This change is not independent of the fact that, as Gibbons et al. put it in their book *The New Production of Knowledge*, "the density of communication among scientists through various forms of mobility has been greatly increased in recent decades", resulting in the "linking together of sites in a variety of ways – electronically, organisationally, socially, informally – through functioning networks of communication." Transdisciplinarity, write Gib-

[44] In the following paragraphs of the present paper I am taking over some formulations from my talk "Words, Pictures, and the Unity of Knowledge", cf. note 4 above.

[45] Chicago: University of Chicago Press, 1997, pp. 19 and 21.

[46] Bruno Latour, "Visualization and Cognition: Thinking with Eyes and Hands", *Knowledge and Society: Studies in the Sociology of Culture Past and Present*, vol. 6, Greenwich, CT: JAI Press. I have briefly described Latour's position in my "Pictorial Meaning and Mobile Communication".

bons et al., "has been facilitated through the availibility of ... enhanced means of communication". They stress that the computer is a tool that "generates a new language and images", that "the experimental process ... is increasingly complemented, if not in part replaced, by new computational models of simulation and dynamic imaging", and that this contributes to a "diffusion of ... techniques from one discipline to another". This new mode of science is characterized by problem solving "organized around a particular application", rather than by problem solving wich is "carried out following the codes of practice relevant to a particular discipline".[47] When the relative weight of applied research as compared to basic research is growing, the experience of coherence in everyday life overrides the image of fragmented scientific specialities. As Barbara Stafford puts it in her brilliant book *Good Looking: Essays on the Virtue of Images:*

> we need to forge an imaging field focused on transdisciplinary *problems*... But even [the] transdisciplinary initiative does not go far enough. I believe we must finally renounce the institutionalized notion that only the "pure" study of anything, including images ... is admirable. ... serious consideration should be given to the proposition that a great part of our most meaningful inquiry goes on precisely because it gives thought to practical ends. ... it is dynamic visualization that can transform an incomprehensible data file into more than a meaningless string of bits and pieces or an infinite series of unrelated fragments. Consequently, many astrophysicists, radiologists, meteorologists, and engineers have begun to decry the widening gap between the accumulation of raw numbers and their transformation into a visual format enabling practical analysis. Thunderstorm modeling and the animation of planetary magnetospheres represent only two small instances of how visualization of complex data – otherwise literally unimaginable – is now critical to the advancement of many fields of science.[48]

In philosophy there still dominates the mid-twentieth century position, according to which there is no such a thing as a world that is given – an in itself connected whole, describable by a coherent over-all theory.

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[47] Michael Gibbons, Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter Scott and Martin Trow, *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*, London: SAGE Publications, 1994, pp. 38, 6, 39, 45, 44, 3.

[48] Barbara Maria Stafford, *Good Looking: Essays on the Virtue of Images*, Cambridge, MA: MIT, 1996, pp. 10, 14 and 25.

By contrast, scientists today are by no means of a single mind when it comes to rejecting the possibility of a unified theory. Those who do reject such a possibility can be seen to be generalizing from their actual research experiences; but on the other hand, as Galison puts it in his introduction to the volume *The Disunity of Science*, they generalize certain social-political experiences, too. "[T]hese 'internal' scientific debates over fundamentality, reducibility, and so on, do not exist in a vacuum. They are profoundly embedded in a culture in which the quasi autonomy of different subcultures is valued as essential now in a way that it simply was not in the prewar years or even in the 1940's and 1950's."[49] Much research is conducted, even today, with the aim of developing a comprehensive theory. One can refer here to those efforts in physics Galison, too, lists;[50] or to the perspective offered in sociobiologist Edward Wilson's 1998 book bearing the subtitle *The Unity of Knowledge*. "Disciplinary boundaries within the natural sciences", writes Wilson, "are disappearing, to be replaced by shifting hybrid domains in which consilience is implicit. These domains reach across many levels of complexity, from chemical physics and physical chemistry to molecular genetics, chemical ecology, and ecological genetics. None of the new specialties is considered more than a focus of research."[51] The spirited talk given by Nobel laureate physicist Sheldon Glashow in 1989 at a symposium titled "The End of Science?" probably reflects the majority view of the scientific community. Philosophical scepticism will obviously not erode, said Glashow, belief in science as a "unified, universal, objective endeavour". "Does anyone really doubt", he asked, "the existence of the moons of Jupiter, which Galileo discovered centuries ago? Does anyone really doubt the modern theory of disease?"[52]

By way of conclusion, let me refer to Galison once more. He does not believe that physics divides into "self-contained and self-stabilizing" blocks. As he sees it, there is an "intercalation of diverse sets of practices (instrument making, experimenting, and theorizing) that accords physics

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[49] Peter Galison and David J. Stump (eds.), *The Disunity of Science: Boundaries, Contexts, and Power*, Stanford: Stanford University Press, 1996, p. 8.

[50] Cf. *ibid.*, pp.5 ff.

[51] Edward O. Wilson, *Consilience: The Unity of Knowledge*, New York: Alfred A. Knopf, 1998, p. 11. I am quoting from the New York: Vintage Books, 1999 edition.

[52] The talk is referred to by John Horgan in his *The End of Science: Facing the Limits of Knowledge in the Twilight of the Scientific Age* (1996). Second edition with a new afterword, New York: Broadway Books, 1997, p.62.

its sense of continuity as a whole, even while deep breaks occur in each subculture separately considered"; he believes that it is possible "to demonstrate the deep continuity of experimental practice through an analysis of the instruments of modern physics".[53] We seem to be back at Dewey's contention that there is no real separation between "pure science" and the laboratory. Indeed we are back at Copernicus' instruments. Instruments of visualization in the networked digital medium are major unifying forces in contemporary science.

[53] Galison, *Image and Logic*, p. 19.

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Zsuzsanna Kondor

Changing Media: A Perennial Challenge for Philosophy

As the title of my talk suggests, I would like to speak about the history of philosophy as a history of searching for instruments and methods to avoid difficulties that are caused by the possibilities and limits of the ever new media of expressing ideas; difficulties dimly perceived, but not yet, at that moment, becoming fully conscious. First I'm going to sketch some main characteristics of the major epochs of the technology of communication, then attempt to give a kind of outline of the history of philosophy with regard to its crucial problems. I'll focus especially on the changes of some concepts of metaphysics from the point of view of the technology of communication. By way of conclusion I would like to point out that it is not by chance that the technology of communication has today come into the focus of philosophical investigation.

Outline of a History of Communication Technologies: Epochs and Characteristics

The investigations especially of Harold Innis, Walter J. Ong, and Eric A. Havelock imply that the medium in which ideas are formulated is of major importance with regard to the cognitive capacity, intellectual disposition, and indeed the very organization, of communities. Let me here briefly compare the noetical worlds of oral and literate cultures.

A primary oral culture is one which – according to Ong's terminology – does not possess any knowledge of writing. Such a culture must be conservative and traditional. Since the only possibility to store information was in people's minds,[1] they developed a special language – a storage language as Havelock puts it – which was "devised orally for the purpose of survival".[2] This meant that it was possible to preserve infor-

[1] Cf. Donald's emphasis on the novelty and importance of the written record, i.e. the external storage system: Merlin Donald, *A Mind So Rare: The Evolution of Human Consciousness*, New York: W. W. Norton & Company, 2001.

[2] E. A. Havelock, *The Muse Learns to Write: Reflections on Orality and Literacy from Antiquity to the Present*, New Haven: Yale University Press, 1986, p. 59.

mation only by communicating, i.e. by sustaining live intercourse among people. This restriction required a special technology to weave ideas together, and to transmit awareness of the new facts of life. According to this special technology the way of expression was additive, redundant, and the expressions and words used were very closely embedded in concrete situations. Intercourse was empathetic, participatory and agonistic.[3] This kind of language was regulative, it strongly determined beliefs as well as people's attitudes and relationships to each other.

After the invention of alphabetical writing several modifications took place.[4] On the one hand the transmitting of ideas was liberated from certain restrictions; on the other hand written contexts had to be created for texts to be meaningful. With the help of writing, ideas became remarkably easier to handle and to elaborate. Part of the energy – earlier simply needed for remembering – could be mobilised for other purposes. Alphabetical writing gave rise to the technical-practical potential of creating concepts free of emotions, distantiated from the human life-world,[5] the potential to systematically analyze ideas, to regard events as linearly structured in time,[6] to be able to recognize the eternally human.[7] Knowledge could be transmitted in a new way, namely by written records.

While in a primarily oral community the preservation of factual knowledge and regulative norms was strictly bound to a perpetual process of face-to-face communication and a kind of embeddedness in concrete situations, due to alphabetical writing it became possible to preserve information without personal presence. Of course to replace the live situation with mute words required considerable intellectual effort and caused plenty of difficulties.

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[3] See Walter J. Ong, *Orality and Literacy: The Technologizing of the Word*, London: Methuen, 1982, pp. 36–46.

[4] Alphabetical writing was the instrument of the most accurate and the most abstract recording of the acoustic phenomenon of speech. Havelock underlines the fact, that – with respect to social control and governance – alphabetical writing was the only system to create a flexibility comparable to oral communication, since it did not ritualize and simplify the contents of the latter. See E. A. Havelock, *The Muse Learns to Write*, p. 59; Ong, *Orality and Literacy*, p. 28, and on the different types of writing also Ong, *op.cit.*, pp. 85 f.

[5] See Ong, *Orality and Literacy*, especially pp. 31–57 and 103–112; E. A. Havelock, *The Greek Concept of Justice: From its Shadow in Homer to Its Substance in Plato*, Cambridge, MA: Harvard University Press, 1978; and E. A. Havelock, *The Muse Learns to Write*.

[6] See Ong, *Orality and Literacy*, p. 143; P. Gendolla, "Punktzeit: Zur Erfahrung in der Informationsgesellschaft" in R. Wendorf (ed.), *Im Netz der Zeit*, Stuttgart: S. Hirzel, 1989.

[7] See I. Hajnal, "Európai kultúrtörténet - írástörténet", in Hajnal, *Technika, művelődés: Tanulmányok*, Budapest: 1993, p. 18.

The invention of the printing press made these changes more radical. Print, as Ong puts it, "goes farther in suggesting self-containment. Print encloses thought in thousands of copies of a work of exactly the same visual and physical consistency."[8]

The technology of printing texts in thousands of identical copies gave rise to the important novel concepts of originality and authorship. And let us note that this development was of course enhanced by the possibility to multiply images.

History of Philosophy as a Mirror of the Technology of Communication

When considering questions which for centuries were decisive topics of philosophy, one can soon realize that these questions were conceived originally as answers to some entirely practical experiences of everyday life. The historical modifications of some central concepts of metaphysics and indeed of the defined task of metaphysics can furnish good instances of the connections between the technology of communication and certain topics of philosophy.

As the *Oxford Companion to Philosophy*, which I will here use as a kind of reference point, puts it: "Metaphysics is the most abstract and in some views 'high-falutin' part of philosophy"[9]; but – let us add – a central part as well. Metaphysics created the basis of secularized western thought. Metaphysics, as the *Oxford Companion to Philosophy* formulates, aimed to define "the features of ultimate reality, what really exists and what it is that distinguishes that and makes it possible". The process of secularization took form first in the realm of metaphysics, and from its strivings originate ontology as well as epistemology.

Let us single out some main turning points in the history of metaphysics. Aristotle thought of what later came to be called metaphysics as "a science which investigates being as being and the attributes which belong to this in virtue of its own nature".[10] In the Middle Ages meta-

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[8] Ong, *Orality and Literacy*, p. 132.

[9] See www.xrefer.com/entry/552796.

[10] "There is a science which investigates being as being and the attributes which belong to this in virtue of its own nature. Now this is not the same as any of the so-called special sciences; for none of these others treats universally of being as being. They cut off a part of being and investigate the attribute of this part; this is what the mathematical sciences for instance do. Now since we are seeking the first principles and the highest causes, clearly there must be some thing to which these belong in virtue of its own nature." (Aristotle, *Metaphysics*, Book IV, 1, W. D. Ross transl.)

physics was closely bound to theology, and the question of transcendency vs. immanency with regard to the fundament of being constituted its central issue. By the time of the Renaissance metaphysics became a kind of guarantee of scientific knowledge, as opposed to theology, and by the 17th century the creating of some methodological foundations for scientific knowledge was considered as the main task of metaphysics. Hegel looked upon metaphysics as something essential with regard to the "pure Spirit". To quote the *Oxford Companion to Philosophy* again, Hegel "thought reason could certainly do what Kant thought impossible, leading to the idea of an identification of self and object".[11] He tried to create a new basis for metaphysics by positing a historical objectifying activity of the Spirit which made it possible to comprehend as an identity concept and reality, the idea of a thing and the thing itself, the subject and the object. In the 20th century metaphysics took form in some holistic theories of reality while there of course emerged anti-metaphysical theories as well.

As the *Oxford Companion to Philosophy* writes: "In contemporary philosophy problems of metaphysics often take the form of a trilemma concerning some large and important feature of our life or discourse: illusion, well-founded appearance, and fundamental reality."[12] But looking at the 25 centuries of metaphysics we may realize that metaphysics saw as its main task simply: grasping reality in the right way. To be able to do that it was indispensable for it to give a definition of reality and later to define the suitable/adequate way of knowing the same. These questions of metaphysics originated in literacy, i. e. thought alienated from the living situation.[13] Contemplating pre-Socratic philosophy we can notice that, as the *Oxford Companion to Philosophy* aptly puts, it "was metaphysical in character, although it was initially presented in a dress which made it sound more like physics".[14] Think of the different notions of arkhé. Arkhé was the name of entities or things from which everything was made at the beginning.

After the invention of alphabetical writing external memory, i.e. the preservation of information outside the human mind, developed new potentials. It was a radical change. As we saw, in a primary oral culture knowledge of different facts, norms and rules was available only through

[11] See www.xrefer.com/entry/552796.

[12] See www.xrefer.com/entry/552798.

[13] Cf. Havelock's famous thesis to the effect that Platonic ideas – abstract concepts – became possible only after the invention of alphabetical writing.

[14] See www.xrefer.com/entry/552796.

live intercourse. As knowledge became attainable through written records as well as via communication with others the question of reality and the accessibility of reality became central issues. Think of Plato's criticism in *Phaedrus*,[15] where he considered true knowledge as something "graven in the soul" in contrast to the written text which is useful only as "a reminiscence of what we know".[16]

The main questions of medieval metaphysics were also related to the issue of reality. Thinking about universals, the existence of God and the question of transcendency and immanency with regard to the foundation of being gave rise to the central questions of metaphysics. Considerations connected to these questions had an abstract and complicated conceptual background. Concepts created a specific hierarchical world far from everyday experience.

Metaphysics in the Modern Age turned to the question of the reliability of knowledge – of knowledge that originates from the past, or from the senses. This specific distrust can be connected to the perceiving of a change in the technology of disseminating ideas, *viz*. the technology of the printing press. Due to the technology of printing, the unreliability of manuscripts with regard to verbalized ideas as well as diagrams, illustrations and pictorial statements became conspicuous. To find the right manner of cognition, which means at the same time to create a firm basis for the sciences, became the most important task for metaphysics. Think of Cartesian doubt. As Descartes put it: "[And similarly] I thought that the sciences found in books – in those at least whose reasonings are only probable and which have no demonstrations, composed as they are of the gradually accumulated opinions of many different individuals – do not approach so near to the truth as the simple reasoning which a man of common sense can quite naturally carry out respecting the things which come immediately before him."[17]

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[15] "[E]ven the best of writings are but a reminiscence of what we know, and ... only in principles of justice and goodness and nobility taught and communicated orally for the sake of instruction and graven in the soul, which is the true way of writing, is there clearness and perfection and seriousness, and ... such principles are a man's own and his legitimate offspring" *Phaedrus* 278a (Benjamin Jowett transl.).

[16] In *The Seventh Letter* we can find some remarks which seem to query even this advantage of writing: "There neither is nor ever will be a treatise of mine on the subject. For it does not admit of exposition like other branches of knowledge; but after much converse about the matter itself and a life lived together, suddenly a light, as it were, is kindled in one soul by a flame that leaps to it from another, and thereafter sustains itself" (341d, J. Harward transl.).

[17] *Discourse*, translated by Elisabeth Haldane.

The Crusoe tradition, or atomistic individualism, as Ernest Gellner referred to it in his posthumous book *Language and Solitude*, started with Descartes. This tradition considered human knowledge as developing step by step due to the intellectual effort of the individual – as indeed the practice of intellectual work was done more and more in isolation,[18] and directed at specialized topics. Knowledge was considered as something which the individual gains by his own cognitive efforts and/or private experiences, and the acquisition of knowledge as something which is only possible through abstract, distinct, and well-defined concepts, in the course of some systematically ordered process.

The intellectual prestige of science increased at that time. The importance of the technology of communication with regard to the development of early-modern science is excellently discussed by Elisabeth Eisenstein. She emphasizes that scientific development was due to the relatively easy acquisition of contemporary texts as well as those of the past, and the possibility of correctly multiplying/duplicating diagrams, all of which were made possible by the printing press.

The intellectual atmosphere of typographic culture is usefully represented by the views of Leibniz on the question of reality. He used the well-articulated abstract terminology of Scholastic philosophy to which he added his firm trust in scientific truth. Leibniz thought reality knowable through the senses, but only with the help of science. "Only indivisible substances and their different states are absolutely real"[19] – he wrote. These indivisible substances, i.e. monads constitute the actual world. "The states of a monad are called 'perceptions'. ... In its perceptions every monad mirrors every other monad."[20] But there's no interaction among them – as Leibniz puts it, "they have no windows".[21] Every monad perceives everything in the universe including ourselves. Unfortunately most of our perceptions are confused. For example, as Benson Mates writes, "our perception of a rainbow is a confused visual perception of a huge number of droplets of water; subliminally we see each

[18] Which of course was not independent of the historical trend towards silent reading. See József Balogh, *Voces Paginarium: Adalékok a hangos olvasás és írás kérdéséhez*, Budapest: Franklin Társulat, 1921.

[19] "What is real [res] is either immutable, i.e. God, or mutable, i.e. created being [ens creatum]. A created being is either a substance, which can perdure through change in itself, or an accident, which can not." (B. Mates, *The Philosophy of Leibniz: Metaphysics and Language*, New York: Oxford University Press, 1989, p. 47.) Aggregates of substances Leibniz includes under the heading of real things.

[20] Mates, *op. cit.*, p. 37.

[21] *Ibid.*, p. 39.

one, but at the conscious level we are aware only of the arc of colour."[22] Leibniz called this a "phenomenon", but a well-founded phenomenon as opposed to illusions, dreams or hallucinations. As Mates puts it: "The information is only gleaned via scientific laws that allow us to conclude, from the features of the phenomena, the structure of the world they express. Our problem, in short, is to discover the laws that relate appearance to reality."[23]

In the 17–18th centuries language was considered as a distorting element with regard to knowledge. We can think of Francis Bacon who considered the Idol of the market – due to which erroneous conceptions appear in language – the most troublesome; Thomas Hobbes in the 4th chapter of *Leviathan* called attention to misuses of language; Berkeley in the preface of A *Treatise Concerning the Principles of Human Knowledge* warned about the deception and delusion caused by language; Leibniz also dealt with this problem in his *New Essays on Human Understanding*. He worked on the project of a universal language. As Eco writes: "He looked for a sort of mathematical language by virtue of which scholars, when debating a problem, could sit around a table, to implement some logical calculuses, and find a common truth."[24]

The other consequence of the printing press which is in close connection with the miraculous development of science was of course the re-detection of pictures. As Eisenstein noted, it was at that time that there spread the old "Chinese maxim that a single picture was more valuable than many words".[25] And as Robert Pattison writes: "Leibniz

[22] *Ibid*., p. 41

[23] *Ibid*., p. 200.

[24] "The first European scholar to speak of a 'universal character' was Francis Bacon (*De dignitate and augmentis scientiarum*) and, in order to prove its possibility, he quoted the Chinese writing. Curiously enough, neither Bacon nor Wilkins understood the iconic origin of ideograms, and took them as purely conventional devices: in any case the ideograms looked as endowed with the double property of being universal and able to establish a direct contact between the character and the idea. The impact of the discovery of Chinese ideograms had an enormous influence on the development of the research for a Universal Philosophical Language in Europe, but it is not this the point that interests us today. – Leibniz was working on binary calculus, that is that mathematical calculus which proceeds by 0 and 1 and which is still used today for programming computers. Leibniz was convinced that such a calculus had metaphysical foundation because it reflects the dialectic between God and Nothingness." (Umberto Eco, "From Marco Polo to Leibniz: Stories of Intercultural Misunderstanding", lecture given in 1996, http://www.italianacademy.columbia.edu/pdfs/lectures/eco_marco.pdf.)

[25] Elisabeth L. Eisenstein, *The Printing Press as an Agent of Change: Communications and*

considered Chinese characters as the prototype for an ideal philosophical system of notation, free of ambiguities of our spoken language and directly correlated to the objects of thought without the distorting intermediacy of spoken language."[26]

The demand to make language unambiguous with the help of a certain scientific method on the one hand, and the recognition of the expressive power of pictures on the other, can be considered as attempts which quite explicitly confront the barriers of thinking determined by literacy.

In the 19th century Nietzsche emphasized the magnificence of ancient poetry as against the pale, abstract and inanimate writings of his time.[27] In the 20th century there were many critical remarks concerning the metaphysics of the Modern Age and the accompanying notions of language. Also in that century several terms emerged in philosophy which were bound up with the idea of everyday practice. The issues e. g. of reality and of the nature of language now emerged from the perspective of everyday life and practice.

We can sum up these changes by saying that philosophical interest gradually turned its back on literacy alienated from everyday practice and tried to find new ways to grasp reality through coming to terms with the actualities of everyday life. This turn is occurring in the age of secondary orality. Secondary orality set in with telephone, radio, television, and the various kinds of sound tapes and similar electronic technologies. "This new orality", as Ong puts it, "has striking resemblances to the old in its participatory mystique, its fostering of communal sense, its concentration on the present moment, and even in its formulas. But it is essentially a more deliberate and self-conscious orality based permanently on the use of writing and print, which are essential for the manufacture and operation of the equipment and for its use as well."[28]

To be sure, I do not think that all the said changes are exclusively caused by modifications in the technology of communication. But I do think that they are decisive elements with regard to the general features of intellectual capacity and attitude.

Cultural Transformation in Early-Modern Europe, I–II, Cambridge: Cambridge University Press, 1979, p. 69.

[26] Robert Pattison, *On Literacy: The Politics of the Word from Homer to the Age of Rock*, Oxford: Oxford University Press, 1984, p. 34.

[27] See *Nietzsches Werke*, Leipzig: Alfred Kröner, vol. XVIII, 1912, p. 248. Quoted by Balogh, *op.cit.*, p. 27.

[28] Ong, *Orality and Literacy*, p. 136.

Let me call attention to some remarks by William M. Ivins, Jr. In his *Prints and Visual Communication* Ivins sketched the development of the printed picture from the 16th century to the emergence of photography in the 19th century. Besides the technical inventions he also takes into account their cognitive consequences. “I propose”, writes Ivins, “to look at the evidence from the point of view of that communication of visual information and ideas which, for the last four centuries, has been the primary function of the exactly repeatable pictorial statement.”[29] The importance of exact reproduction becomes obvious if we think of verbal communication. Ivins stresses that the institution of verbal communication is built upon the fact of there being exactly repeatable linguistic elements. We consider exact repeatability as something evident in the case of oral or written communication, mediating thoughts verbally, but this is not the case with pictures. As Ivins puts it: “pictures were of little use as definitions or descriptions because they could not be exactly repeated” for a long time.[30] There is no use of definitions and descriptions which can change each time when they are repeated. As Ivins continued:

> Plato’s Ideas and Aristotle’s forms, essences, and definitions, are specimens of this transference of reality from the object to the exactly repeatable and therefore seemingly permanent verbal formula. An essence, in fact, is not part of the object but part of the definition. Also, I believe, the well-known notions of substance and attributable qualities can be derived from this operational dependence upon exactly repeatable verbal descriptions and definitions – for the very linear order in which words have to be used results in a syntactical time order analysis of qualities that actually are simultaneous and so intermingled and interrelated that no quality can be removed from one of the bundles of qualities we call objects without changing both it and all the other qualities.[31]

Accordingly, ancient Greeks, and even “reasonable” people of the 19th century, lack the proper technology with which they can take into account, and handle, particularities; so they think in generalities.[32]

[29] W. M. Ivins, Jr., *Prints and Visual Communication*, Cambridge, MA: Harvard University Press, 1953, p. 24.

[30] *Ibid.*, p. 62.

[31] *Ibid.*, p. 63.

[32] Even in the 18th and 19th centuries educated people “had not the means to think in particularities, which are always irrational, and they had to think in generalities. ... To a very considerable extent they were still in the situation and the frame of mind that had caused the Greeks to think as they did about some of the basic problems in philos-

According to Ivins' remarks verbalization was tending to be abstract and general from the moment there was a proper technology to be able to repeat definitions correctly. Since the correct duplicating of pictures or pictorial statements became possible only in the 19th century, the main realm for thinking, the realm expected to be suitable for the accumulation of knowledge, was, in the beginning, oral discourse, and, after the invention of alphabetical writing, the written text.

But verbalization at the same time means some loss of information. Let me here recall some remarks by Michael Polanyi to the effect that in the course of reproducing or describing our experiences we have to choose between either being precise or being close to the richness of the living context. It is impossible to simultaneously grasp precision and the "immense wealth of living shapes", the richness of the whole context. As he put it:

> Higher degrees of formalization make statements of science more precise, its inferences more impersonal and correspondingly more "reversible"; but every step towards this ideal is achieved by a progressive sacrifice of content. The immense wealth of living shapes governed by the descriptive sciences is narrowed down to bare pointer-readings for the purpose of the exact sciences, and experience vanishes altogether from our direct sight as we pass on to pure mathematics. – There is a corresponding variation in the tacit coefficient of speech. In order to describe experience more fully language must be less precise. But greater imprecision brings more effectively into play the powers of inarticulate judgement required to resolve the ensuing indeterminacy of speech. So it is our personal participation that governs the richness of concrete experience to which our speech can refer. Only by the aid of this tacit coefficient could we ever say anything at all about experience – a conclusion I have reached already by showing that the process of denotation is itself unformalizable.[33]

Similarly, the process of "applying language to things" is "necessarily unformalized".[34] – In the light of these remarks by Polanyi the situation

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ophy. Thus just as the ancient Greeks developed the Platonic doctrine of Ideas and Aristotle's essences, so the eighteenth century developed ideas of the Truth of Science and of the Laws of Nature" (Ivins, op.cit., p. 91).

[33] M. Polanyi, *Personal Knowledge: Towards a Post-Critical Philosophy*, London: Routledge & Kegan Paul, 1962, pp. 86 f.

[34] "The lesson derived [earlier in this book] from reflecting on the application of the exact sciences to experience can be extended now as follows. We have seen that in all

described by Ivins becomes a little bit more complicated: while expressing ideas verbally is effective with regard to the accumulation and dissemination of knowledge, at the same time verbalization creates precisely those very unsolvable anomalies which philosophy traditionally tried to solve or to eliminate.

Why Is Communication a Significant Issue of Philosophy?

Gellner, in a critical remark on Wittgenstein, considers philosophy as an institution to devise proper concepts for the purpose of grasping reality.[35] His attitude furnishes a good instance of the traditional attitude of philosophy flourishing in the culture of literacy. And indeed philosophy practically from its beginnings is tied to literacy. In the course of the history of philosophy it is the first transition from primary orality to literacy which we can, many centuries later, realize to have happened at all, and this realization quite probably hangs together with the next radical change now imminent.

Possibilities recently provided by the technology of communication make us capable to re-present and/or to communicate some events, some phenomena or some new experience almost as if they were observed by ourselves in a live situation. This means that it is not necessary to verbalize the whole situation of an experience or some insight – the pressure to prepare linearly ordered text is radically decreasing. As the pressure of having to interpret ideas in the very process of formulating them decreases, we can concentrate on the communication of them, i.e. the lesser the obstacle is to formulate ideas the more visible is the importance of the technology we use for communicating them.

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applications of a formalism to experience there is an indeterminacy involved, which must be resolved by the observer on the ground of unspecifiable criteria. Now we may say further that the process of applying language to things is also necessarily unformalized: that it is inarticulate" (Polanyi, *op.cit.*, p. 81).

[35] „But philosophy started precisely because commonsensical notions became unworkable or inadequate." (E. Gellner, "The Crisis in the Humanities and the Mainstream of Philosophy", in J. H. Plumb [ed.], *Crisis in the Humanities*, Middlesex: Penguin Books, 1964, p. 68.)

Ahti-Veikko Pietarinen

Peirce's Theory of Communication and Its Contemporary Relevance

Introduction

The mobile era of electronic communication has created a huge semiotic system, constructed out of triadic components envisaged by the American scientist and philosopher Charles S. Peirce (1839–1914), such as icons, indices and symbols, and signs, objects and interpretants. Iconic signs bear a physical resemblance to what they represent. Indices point at something and say "there!", and symbols signify objects by conventions of a community.[1] All signs give rise to interpretants in the minds of the interpreters.

It is nonetheless regrettable that the somewhat simplistic triadic exposé of Peirce's theory of signs has persisted in semiotics as the somehow exhaustive and final description of what Peirce intended. The more fascinating and richer structure of signs emerging from their intimate relation to intercommunication and interaction (Peirce's terms) has been noted much less frequently.

Despite this shortcoming, the full Peircean road to inquiry – performed by the dynamic community of learning inquirers, or the com-

[1] In fact, according to Peirce (2.278 [1895]): "The only way of directly communicating an idea is by means of an icon; and every indirect method of communicating an idea must depend for its establishment upon the use of an icon." Peirce's *chef d'œuvre* came shortly after these remarks into being as his diagrammatic system of existential graphs, a thoroughly iconic representation of and a way of reasoning about "moving pictures of thought", which encompassed not only propositional and predicate logic, but also modalities, higher-order notions, abstraction and category-theoretic notions. The importance of iconic representation (such as images and pictures) in scientific and everyday communication was since noted many times, starting with the works of Bertrand Russell, Ludwig Wittgenstein and Otto Neurath, although as logics they had to await the heterogeneous systems of the late 20th century. (The references to Peirce are to the *Collected Papers of Charles Sanders Peirce*, 8 vols., ed. by Charles Hartshorne, Paul Weiss and A.W. Burks, Cambridge, MA: Harvard University Press, 1931–1966, by volume and paragraph number.)

munity of quasi-minds consisting of the liquid in a number of interconnected bottles, or the scientific communities of the users of the data that is being provided by Nature or the vastly mounting electronic sources – reflects the contemporary weight put on all kinds of multi-agent systems in computation. However, the weight ought still to be amplified by incorporating the Peircean idea of communication as a dialogue between the interlocutors of a general nature of a mind who are putting forward signs, into the richer semiotic picture emerging from a truly transdisciplinary multi-agent research. The agents are not only abstract communicators but also signs, and thus also minds and in a bona fide relation with objects. As some signs are in a sense phenomenal they are suitable for framing the electronic communication of machine-like quasi-minds. What the correlates of Peirce's concepts of representamen (a sign put forward by the Utterer), interpretant (what the sign determines within the mind of the Interpreter), and various subspecies of interpretant (e.g. the intentional, effectual and communicational ones) in the context of contemporary media-driven communication and learning are, is something that needs to be sought for in the general amalgamation of Peirce's sign-theoretic triadism and the communicational and action-theoretic dyadism. This is yet to be accomplished. Its importance can be seen, for instance, from the perspective of Peirce's unexpected late idea of the *commens* as the locus where the thoughts of all minds participated in the creation of the common ground meet.

The formation of common ground by continuous communication and interaction reflects the computational desire to furnish multi-agent systems with properties that would enable them to entertain appropriate interoperation. Thus the initiatives of semantic and pragmatic webs receive increased semiotic motivation, as soon as they are adjoined with an understanding of Peirce's theory of communication. Above all, the phrase "medium of communication" was taken by Peirce to illustrate a broader notion than just the noun "sign", namely a species of Thirdness, a category of mediation, synthetic consciousness, prediction of the future courses of events, continuity, learning, growth.

The Rationale and the Goal of the Present Paper

In evaluating what is going on in the interplay between technological growth and philosophy, one fruitful approach is to try to draw focal parallels and to do comparisons between the notions used in both fields, rather than to seek some overarching philosophical foundation for some particular set of technological innovations wedding them in one fell swoop. One reason for this is that technological advancements have often been made, and sometimes rightfully so, completely in ignorance of philosophical problems. But in doing so, these developments have invented as well as reinvented concepts that have already been far and wide in philosophy. In some cases philosophical terminology has just been hijacked by hackers. Such is the case with the all-pervading use of the concept of ontology in computer science, which has hardly anything to do with its metaphysical homograph. In web technology, there is no single ontology, but a library of "possible modes of being". It is up to the users to make queries and pick relevant ontologies that would work as shared formal specifications of the conceptualisations of what there is. Ontologies tend to reflect interpretations of terms of logical or representational languages, and in that way are dependent on the universes of discourse, or more precisely, on those universes that are in some sense common and shared between the agents who operate on them. There are no self-sustaining substances in user-independent reality.

In the long run, we may witness a convergence of at least some subset of such concepts and vocabulary. For instance, this is likely to happen due to the recently emerged paradigms that aim at new approaches to the organisation, acquisition and evolution of data contained in the web, namely the programmes of the "semantic" and "pragmatic" webs. The aim that has been announced quite openly is that these systems are, or will be, built upon the sign-theoretic principles of pragmatic or pragmaticist philosophy, most notably upon those that Peirce is claimed to have envisioned.

I want to know why. My purpose here is thus to concentrate on two interrelated issues. First, the aim is to understand, not the overall and certainly very complex pragmaticist and sign-theoretic philosophy of Peirce's, but rather what is going on in his highly interesting concept and theory of communication. Of course, this theory cannot be severed from other parts of Peirce's thinking, such as his doctrine of categories, pragmaticism, and sign-theoretic and logical semeiotics. But as I hope it will turn out, its essentials can be understood without overkill from Peirce's phenomenology ("phaneroscopy"), metaphysics, or the later theory of signs.

Second, the purpose is to assess the relevance of Peirce's theory of communication to some of the emerging contemporary issues in computer science, web technology, and the overall modern era of communicating systems. I have no interest in presenting details of these innovations; I hope that many of them will be familiar. As it turns out, a number of technological and computational innovations will have probing contacts with Peirce's ideas (or ideals) of scientific inquiry and communication. One of the main reasons is that being semeiotic, his philosophical and logical concepts are very widely applicable and not limited to human users or inquirers. For that reason they are not limited to the linguistic notion of communication either, but reach over virtually anything that one can think of communication to be now and in the future, including notions that one day will emerge from the sciences of artificial intelligence, neuroscience, quantum theory, bioinformatics, and so forth.

The second task is easier. Even though we by no means yet have before us a full picture of Peirce's theory of communication, I believe that we understand it well enough to perceive its relevance to a host of issues in the applied sciences of computation, communication and information.

Triangulate Them All

So, what is Peirce's theory of communication? There is no simple answer to this, and the question has been debated in the literature progressively more during the last decade or so.[2] It is becoming an increasingly topical issue in attempts to understand his philosophy from the perspective that aims at strengthening the coherence of his writings, and avoids drawing his boundless fields of interests away from each other.

One of the curious aspects of Peirce's communicative approach to signs is its apparently dyadic, two-place nature. Prima facie, one may think that his view of communication is related merely to transmissional aspects of signs between two (possibly interpersonal) agents, the utterer and the interpreter of the sign, in a suitable medium of communication – not unlike Shannon's and others' later syntactic theories of communication, which focus on the question of in what media and how information ought to propagate. This, as I hope to be able to communicate, does hardly any justice to Peirce's own intentions.

[2] See e.g. Mats Bergman, "Reflections of the Role of the Communicative Sign in Semeiotic", *Transactions of the Charles S. Peirce Society: A Quarterly Journal in American Philosophy* 36 (2000), pp. 225–254; Jürgen Habermas, "Peirce and Communication", in Kenneth L. Ketner (ed.), *Peirce and Contemporary Thought*, New York: Fordham University Press, 1995, pp. 243–266; Jørgen D. Johansen, *Dialogic Semiosis: An Essay on Signs and Meaning*, Bloomington: Indiana University Press, 1993; Joseph Ransdell, "Some Leading Ideas of Peirce's Semiotic", *Semiotica* 19 (1977), pp. 157–178.

Second, Peirce's theory of communication is primarily a logical theory. This is the reason why some researchers, among them Richard J. Parmentier, have dismissed it as unsuitable for inquiries involving social and cultural aspects.[3] In response to this, it can be noted that the concepts of what is social and what is cultural can be stretched and given Peircean twists; for instance, a broad understanding of socialisability transpires in the currently popular multi-agent systems research in computation.[4] Whether that is justified, I do not seek to address here. Likewise, the 20th-century concept of logic, pulled apart from its semiotic roots, is exceptionally limited and certainly not representative of Peirce's overall aims. In fact, according to Peirce "logic is rooted in the social principle" (2.654 [1893]). (Cf. the somewhat contrapositive declaration in another place, "the social principle is rooted intrinsically in logic", 5.354 [1893].) It is vital in deciphering these sentiments to recognize that for Peirce, logic takes in also all kinds of considerations of what one's rational action would be in situations that call for moral judgements. This is connected with the fact that for Peirce, logic is a normative science, *viz*. the notion of truth in logic has a normative component in it.

As is well known, Peirce laid practically all his divisions out in the triadic, three-place format. The reasons for this were many. Most notably, there was a mathematical reason: given Peirce's assumptions concerning mathematical relations (he was one of the founders of the algebraic logic of relations), no three-place relation can be constructed out of just one and two-place ones. Because of this, it seems that his overall method of communicating signs is in some way in discrepancy or disagreement with the triadicity of the other parts of his theory of signs.

So, the question is: how does the notion of communication between two agents fit into this triadic picture? The answer is in fact found in Peirce's unpublished MS 318 [1907].[5] In that manuscript, Peirce explains his sign-theory from the communicational perspective. First of all,

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[3] Richard J. Parmentier, *Signs in Society: Studies in Semiotic Anthropology*, Bloomington: Indiana University Press, 1994.

[4] In my forthcoming paper "Games and Multi-Agent Systems: Limitations, Prospects and Foundational Perspectives" I argue that one rarely noted virtue of multi-agent systems is that they provide much more precise sociological analyses of social codes and practices than the semi-formal notions of "a game" or "games people play" in social inquiries.

[5] MS references are to Charles S. Peirce, Manuscripts in the Houghton Library of Harvard University, as identified by Richard Robin, *Annotated Catalogue of the Papers of Charles S. Peirce* (Amherst: University of Massachusettes Press, 1967), and in "The Peirce

there are signs that have no utterers. These are the signs found in nature. Then there are signs that have no interpreters, such as encrypted messages, or the golden plate on the side of Pioneer 11 at the moment of uttering this sentence. The utterers and the interpreters associated with these kinds of signs will receive the prefix "quasi", and they can be thought of as positions, phases of the thinking mind, or semiotic roles in the process of semiosis. In other words, they are theoretical entities devoid of actual minds connected with brains. (Cf. the concept of "natural intelligence" in automated reasoning research.) In the special case of signs being linguistic, that is, symbolic natural language assertions, the utterers and interpreters are characteristically human beings. In that interpersonal situation the utterer and the interpreter are to a degree distinct from those of the object and the interpretant.

But what are we to say about the residual cases? According to Peirce, the object-interpretant axis represents a continuum that is not meant to demarcate objects and interpretants in any non-fuzzy, clear-cut manner. Intertwined with the fact that some utterers can according to him be assimilated or equated with objects, and some interpreters can likewise be assimilated with interpretants, we get two dynamic scales within the triadic division of signs, one representing the object–interpretant continuum and the other representing the utterer–interpreter continuum. Depending on the nature of signs, these two scales may coincide, as is the case for instance with non-linguistic signs that have utterers and interpreters.

The general picture that emerges is schematised in Figure 1. There are two main trichotomies, the sign–object–interpretant one and the sign–utterer–interpreter one. By moving along the base of the latter triangle towards interpretants and the interpreter, the utterer's state of information increases. Conversely, by moving from the interpreter towards the object and the utterer the state of the information of the interpreter increases. The dashed arrows show the increase and decrease of the states of information of the utterers and the interpreters. The overlapping area is the common ground, where the communicational interpretants are determined. The angle α measures the degree in which the objects and their utterers converge, and the angle β measures the degree

Papers: A Supplementary Catalogue", *Transactions of the C. S. Peirce Society* 7 (1971), pp. 37–57, by manuscript and, where applicable, page number. See also Charles S. Peirce, "Pragmatism", *The Essential Peirce* 2, Peirce Edition Project, Bloomington: Indiana University Press, 1993, pp. 398–433, a critical transcription of this complex and multilayered manuscript.

in which the interpretants and their interpreters converge. They thus measure the degree of interpersonality in communicational sign-theoretic situations. From this figure it can be also concluded that it is the breadth of the base of the sign–object–interpretant triangle that measures the distance between objects and their interpretants.

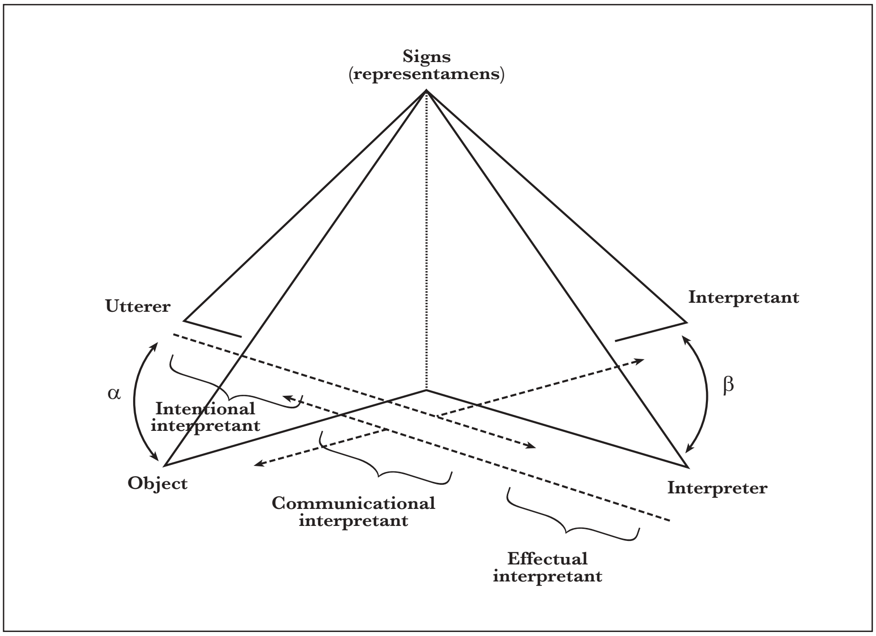

Figure 1
Triadic system of communication in Peirce's sign theory

The affinity of the utterer with its object is called by Peirce "the essential ingredient of the utterer" (MS 318: 21). It is found in the utterer's job to delineate the class of the universe of discourse understood to be at issue in the dialogue, thereupon choosing the object or its instance from the domain as intended by the utterance and as understood to be predicable by the (uninterpreted) predicate term (termed by Peirce the *rhema*) of the proposition in question. I will not delve into the issue of how such choices are made; I can outrun comprehensive explanation by noting that when the act of uttering and the object intended by the utterance are in fact one and the same thing, there is no factual decision to be made. When they are not, the notions such as the purpose and strategic considerations of the utterer and the interpreter will be of prime importance. These are in turn related to Peirce's notion of a habit and its cultivation in possibly infinitely repeated runs of semiotic plays.

An open question that has not been noted before is whether Peirce intended this interpretation to supply an *objectual interpretation* of the logical quantifiers Σ and Π in the sense of choosing objects from the domain, and intending the names of these objects to function as values of the rhemas and the quantifiers (the complex rules of such choices plus applications of them to quantification were termed by Peirce *selectives*). Or, did he espouse the *substitutional interpretation*, namely one where the participants of the dialogue would be picking out names that are instances of some given substitution-class of non-logical constants?[6] Peirce's typical choice of the term was that of choosing "instances" as proper values for logical constants, but in the end he left unspecified what he actually meant by them. To what extent are we justified to take them as corresponding to model-theoretical entities?[7]

Quite another aspect of Peirce's theory of communication is that if the interpretant is what Peirce termed the *ultimate logical interpretant*, then, because it represents a state of perfect knowledge, the ontological and epistemological distinctions make no difference in scientific inquiry. The object merges with its interpretant, disintegrating the triangle into a dyadic relation between the sign and this ultimate logical interpretant. The maximal state of information leaves no latitude of interpretation because there no longer is any difference between objects and interpretants.

There are a number of other notions of interpretants in Peirce's system which I will not go on to review here but which all make negligible distinctions between the interpretant and the object.

It may also be thought that because Peirce was keen to repudiate all psychological influences from the province of logic and semeiotics, he might have wished to altogether eliminate the concept of utterers and interpreters from the dominion of sign action. This may be suggested by his frequent tendency to assimilate, on the one hand, the utterers and objects, and on the other, the interpreters and the interpretants. Upon a closer inspection, this assimilation does not mean reduction. Rather, the concepts of the utterers and the interpreters are, as Peirce puts it, "welded" in one sign (4.551 [1906]), but they move along the distinct

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[6] This is the interpretation that was so named mainly after Saul Kripke, "Is There a Problem about Substitutional Quantification?", in G. Evans and J. McDowell (eds.), *Truth and Meaning*, Oxford: Clarendon Press, 1976, pp. 325–419.

[7] Some passages suggest that Peirce came close to the "discourse referent" idea of the discourse representation theory of Hans Kamp and others.

scale from that of the objects and the interpretants, because the bases of the triangles may have independently variable breadth.

Since every thought is a sign, no thought can evolve unless conceived as dialogic, either between multiple, interpersonal parties or as a quasi-dialogue within one mind. This quasi-dialogical perspective presents us with a useful method of assigning semantic values to logical propositions, whereas the former person-to-person dialogue is practical for various pragmatic linguistic theories of communication and discourse.[8]

However, it is worth pointing out that Peirce's opinion was that there is little difference between multi-party interaction in, say, a social setting, and the intrapersonal reasoning and action in logic, because "a person is not absolutely an individual" (5.421 [1905]).[9]

There are further important issues. As remarked, Peirce's theory of communication comes extraordinarily close to the dialogical and game-theoretic interpretations of logic. These interpretations can be viewed as formal (logical) and strategic regimentations of relevant parts of Peircean semiosis. Although invented quite independently,[10] they follow suit and endorse elements of communal or social approaches to meaning.[11] Their idea is to check the truth-values of propositions of a logical language. For the most part, they lurk behind Peirce's diagrammatic and iconic systems of existential graphs, and point towards ways of extending these

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[8] The fully strategic versions of such dialogues give rise to, among other things, the game-theoretic semantics of Hintikka (Jaakko Hintikka, *Logic, Language-Games and Information*, Oxford: Oxford University Press, 1973), optimality-based theories for phonological, syntactic, semantic and pragmatic inquiries in linguistics (Paul Dekker and Robert van Rooy, "Bi-directional Optimality Theory: An Application of Game Theory", *Journal of Semantics* 17 [2000], pp. 217–242), and various conversational and dialogue games for actual language users (Lauri Carlson, *Dialogue Games: An Approach to Discourse Analysis*, Dordrecht: D. Reidel, 1983). These theories provide major frameworks from which expressions – not only logical ones but also those coming from the domain of natural language semantics/pragmatics interface – derive their meaning.

[9] The multi-agent nature of communities has multiple contact points with Peirce's theological, cosmological, evolutionary and agapistic metaphysics. That he was caught between the two fires of exact sciences and religious thought was one of the reasons of why his time frittered away, hindering him of presenting his logical systems in a sustained, unitary form.

[10] Risto Hilpinen, "On C. S. Peirce's Theory of the Proposition: Peirce as a Precursor of Game-Theoretical Semantics", *The Monist* 65 (1982), pp. 182–188.

[11] Ahti-Veikko Pietarinen, "Some Useful Social Metaphors in Logic", in *Proceedings of the Second International Workshop on Computational Models of Scientific Reasoning and Applications*, CSREA Press, 2002.

systems.[12] The difference between dialogical and game-theoretic semantics is that dialogues address proof-theoretical validity, whereas games are semantic in the sense of establishing when the propositions are true in a model and when they are false in a model. These theories distinguish players' roles in terms of the polarity of the logical constant encountered in the formula, including logical connectives, and switch the roles when negation is encountered. They are both strategic in that the notion of a winning strategy represents the concrete concept that agrees with the notions of validity (dialogues) and truth (semantic games) of propositions. Peirce had most of these features incorporated into his system of logic, although he did not come to endorse any unequivocal game-theoretic terminology.

However, Peirce's communication theory is somewhat richer still. Its all-important concepts of the *common ground* and the *universe of discourse* (not limited to what we recognise as logical and model-theoretical domains) make it applicable beyond proof theories and ordinary semantics, placing pragmatic and discourse-related phenomena in linguistics under logical and semiotic scrutiny. Because of this, one may see the origins of speech-acts and theories of relevance in it, too.

The notion of the common ground is exceptionally important. It is the very core for the success of the communicational view of semiotic dialogues. It refers to what is common and shared between the dialogue participants, determined in their common mind as the common communicational interpretant (*cominterpretant*), which gets them to understand each other's utterances. This common mind was once given a special name of the *commens*.[13]

[12] Ahti-Veikko Pietarinen, "Diagrammatic Logic and Game-Playing", in Grant Malcolm (ed.), *Multidisciplinary Studies of Visual Representations and Interpretations*, Elsevier Science, to appear.

[13] See Peirce's remark on pp. 196–197 in C.S. Hardwick (ed. with J. Cook), *Semiotics and Significs. The Correspondence Between Charles S. Peirce and Victoria Lady Welby*, Bloomington: Indiana University Press, 1977, explaining the *commens* as "that mind into which the minds of utterer and interpreter have to be fused in order that any communication should take place". This is the mind that determines a dynamic object of cominterpretant in a meaningful communication. They are not objects located outside the minds, yet are capable of representing a shared element of communication. Their determination, the *commens*, is also an ancestor of that which in many recent pragmatic theories of language is referred to as the common ground of interlocutors. The significance of the *commens* in the theory of signs is shown by Peirce's omitted remark that it consists of all that is understood between the communicative parties "when the sign in question is just about to be made" (MS L 463: 29 [1906], not preserved in the normalised transcrip-

The overall idea that is emerging but was never explained in full by Peirce is not unlike what ensues from Donald Davidson's triangulation scheme.[14] It permits one to conclude that whereas individually and communally the speakers and hearers of language may be in error and ignorance, in larger respects, for any communication to be successful, the beliefs of others are not to be taken to be radically different from our own. Having a belief must be understood so that the belief is true, even if it may turn out to be false. Peirce's warrant for a similar outcome was the inevitability of collateral observation and mutual experience plus the maxim of *summum bonum* that the communities of inquirers share in communication. The main idea is thus also congenial to Davidson's principle of charity in interpretation.

Secondly, also the concept of the universes of discourse is central in Peirce's theory of communication. In dialogues, they are not just domains in a logician's sense, but presuppositions shared in the conversation and established by the same principles as the existence of mutually gained common ground.

Applications and Complications

Let us then look at what use some of these Peirce's ideas can be put into.

A Night at the Interopera

Interoperability is a show-off boasted in all corners of computing. Dictionaries tend to define it as "compatible software or hardware". But it does not present just a technical challenge of some coding or manufacturing problem. Towards the other end, it has in fact been described as "the ongoing process of ensuring that the systems, procedures and culture of an organisation are managed in such a way as to maximise opportunities for exchange and re-use of information, whether internally or externally".[15]

This pragmatic definition places central concern on what goes on in the communities of engineers, researchers, managers, and other users of

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tion). This phrase Peirce rejected and amended to the more cautious "in order that the sign in question should fulfill its function".

[14] Donald Davidson, *Subjective, Intersubjective, Objective*, Oxford: Clarendon Press, 2001.

[15] Paul Miller, "Interoperability. What Is It and Why Should I Want It?", *Ariadne* 24 (2001), http://www.ariadne.ac.uk/issue24/interoperability/intro.html.

knowledge. It is also a utilitarian definition, where one is to maximise something (here: chances to exchange information). Intentions to do this clearly depend on the scope of common interest to have interoperative systems and products in the first place. Indeed, humans can be stunningly interoperable...

Besides computation, interoperability involves linguistic, social/communal, legal and normative aspects, and so it is a good example of Peircean inquiry as an indefinitely extendible and inexhaustible activity. Its goal is to create communicational interpretants in a variety of cases, across the boundaries of what is artificial and what is human, whatever entities the subjects engaged in communication are taken to be.[16]

Weave This: Semantic and Pragmatic Webs

The goal of the next-generation web technology is to define meaning into web documents. The increasingly popular albeit not yet very widely implemented approach known as a semantic web uses mark-up methods that instead of plain keywords, define the class and subclass hierarchies and the relations between the concepts that appear on the page.[17] This metadata information provides the "semantics" or "meaning" of the document. According to this project, it is hoped that the increased production of metadata and ontology languages will create the network of documents whose content could be automatically processed in a much more elastic and adaptable manner than in the standard syntax-driven string-matching search methods.

One may think that this approach has really nothing to do with semantics. However, it in fact is a practical present-day version of the Peircean notion of semantics, because it provides meaning of the data or a code by translation. This is because for Peirce, semantics is in fact a theory of translation, a rendition of a given symbolic statement into some other statement, diction, or paraphrase, or into some other language, or perhaps a hyperlink or a dictionary-like definition of it.

However, this understanding of semantics lacks the semiotic components of the utterers and the interpreters of the data. And so one still needs to understand how the metadata, such as one provided by the

[16] Shared ontologies are good examples of cominterpretants in artificial systems.

[17] See e.g. Tim Berners-Lee, *Weaving the Web*, London: Orion Business Books, 1999; D. Fensel and M. A. Musen, "The Semantic Web: A Brain for the Mankind", *IEEE Intelligent Systems*, March/April 2001, pp. 24–25; The Semantic Web Agreement Group, "What is the Semantic Web?", 2001, http://swag.webns.net/whatIsSW.

newly devised schema of the Resource Description Framework (RDF), will be connected to the interpreters and objects of data. This connection defines the pragmatic meaning of data. However, as such it does not seem to hover at the back of the vision of a pragmatic web.[18] The perspective to the pragmatic web is rather in bringing the community of inquirers, most notably web users, to bear on the issues of the purpose of information. While such intentions and contexts of users surely play a significant role in pragmatic accounts of meaning, and while these researchers are certainly right in criticising the semantic web approach in its limitation to the metadata idea ignoring the communities of human users and engineers, this approach sidesteps the perhaps more profitable possibility of incorporating truly semiotic pragmatics into the automatised and computational level of the web. It correctly notes the insufficiency of the vision of the semantic web that does not think that all human users, not just knowledge engineers in this self-critical approach are indispensable. It asserts that new meanings or concepts do not simply emerge by adding more and more structural features onto the web pages and by linking them more and more efficiently. Even so, there is still a need for methodeutic, or semiotic pragmatics, that makes contact with the third main aspect of inquiry beyond grammar and logical semantics, but which would take place solely between computerised agents.

The Hydra of Lerna

One only hopes that from ashes of the vast amount of research done on the multi-agent systemics precisely this pragmatic web challenge springs into life. The challenge involves an attempt of building agents, or pieces of advanced software, which are designed to play the different semiotic roles of the quasi-utterers and the quasi-interpreters. That is, they would play the different positions in the cycles of dialogical semiosis as prescribed by Peirce's theory. This is the way in which they are intended to contribute to the generation of new objects and the evolution of new meanings in the web.

Agent systems still lack the truly goal-directed specifications of processes. Only when that is accomplished, could they be seen to create habits and produce wherewithal for their revision and adaptation. This is a long way off. Autonomous and proactive agents need to build sec-

[18] As announced e.g. by Aldo de Moor, Mary Keeler and Gary Richmond, "Towards a Pragmatic Web", in U. Priss, D. Corbett and G. Angelova (eds.), *Conceptual Structures: Integration and Interfaces*, Lecture Notes in Computer Science, no. 2393, Springer, 2002, pp. 235–249.

ond-order evaluations of their own strategies, noting when a "habit-change" occurs, namely when *logical interpretants* are produced in the quasi-minds of agents as the end products of the process of semiosis that terminates or is about to terminate. They need to learn whenever they "feel" pain; whenever something meaningful happens to one of the individual agents. But to know when that is to happen depends on a correct evaluation of those habits that already are in agents' possession.

Questioning the Web

Elements of such goal-directed agent systems are emerging with the vision of a knowledge web. According to this vision, one tries to overcome these shortcomings and supersede both the semantic and the pragmatic web enterprises by taking agents as constructors building a huge question-answering system on the web data, and responding queries on an information-need basis. This is certainly a long way off, because one needs to accomplish two things: one needs to (i) have a comprehensive logic of questions and answers, and to (ii) define a workable possible-worlds structure of the web. Neither has been accomplished as yet.

As to the first item, the quest for a logical relation between questions and answers stands upon the edge of the theories of presuppositions. (The task is also related to the extensions of Peirce's theory of abduction.) This is because requests for information can be viewed as epistemic statements. The query "Bring it about so that *S*" has a meaning in the non-imperative epistemic sentence "I know that *S*". As to the second item, the web nodes are to be viewed as knowledge providers, and via that emerging structure the epistemic statements can be translated to mean that "the user knows *S* in the information state *w* if and only if *S* holds in all the web nodes accessible from *w*".

The inquirers of the web information need to start off with mutually agreed initial states representing actual states. But as they are software agents querying other software agents, w codifies the knowledge in the position they have reached within a "model-checking" game on the web.

An alternative, and I believe a complementary way to the building of a knowledge web uses conceptual graphs.[19] They are descendants of Peirce's existential (beta) graphs put in modern clothing. Their purpose

[19] Guy W. Mineau, "A First Step toward the Knowledge Web: Interoperability Issues among Conceptual Graph Based Software Agents, Part I", in Uta Priss, Dan Corbett and Galia Angelova (eds.), *op. cit.*, pp. 250–260.

in the domain of a knowledge web is to provide good representational formalisms to describe workings of software agents.

Semantic + Pragmatic Webs = The Semiotic Web

Both semantic and pragmatic web visions share the concern for the inadequacy of the current conceptual scheme of the web. The initiative of a semantic web aims at providing a "logical analysis" of the data, while the initiative of a pragmatic web adds the human perspective to it. Both approaches are somewhat unsatisfactory alone, but their merger, when conceived from the perspective of semiotic and logical outlook on inquiry, has attractive emergent features. The outcome is what could be called the *semiotic web*. It combines both the semantic web and the pragmatic web initiatives but surpasses them in being faithful to Peirce's pragmatic approach to inquiry. Unlike the proposed semantic and pragmatic webs, one can operationalize the semiotic web by effective multiagent systems, by a logic of questioning and answering, and by taking agents as roles in a dialogical semiotic inquiry of signs in the universe of the web. The upshot is that not only the weaknesses of both semantic and pragmatic web conceptions become addressed, but also it is seen that these two enterprises cannot and should not be separated from each other.

Pragmaticism in a Communicational Perspective

In the light of previous remarks, the common ground of pragmatically inclined software agents is bound to be quite different from that of humans. It is clear that software agents do not have similar self-awareness properties, such as those telling what it is to be a member of the common genus of *homo*; it is also quite clear that knowledge of the language and knowledge of the universal aspects of grammar or specifications of a code is in the hands of the programmer. It is also clear that the world experience differs. But agents do not need to be taken as fundamentally different from humans in all their aspects. For instance, common knowledge of rationality and common knowledge in general, essential in the creation of cominterpretants, are notions quite efficiently definable at the logical level. To link languages to the world presupposes that there is a great deal of common experience shared by the utterers and interpreters of languages. In Peirce's system, it is typically the copula that ties predicate terms to the elements of the domains of discourse. In received systems of logic, the interpretation of a language is simply given by the valuation function that assigns values to its non-logical constants (functions, predicates and symbols). This provides the boundary conditions upon which the semantic clauses are devised. However, in the semiotic perspective such a valuation is itself subservient to a revised dynamic and dialogical interpretation.

To summarise, the preceding discussion suggests that the two components of being pragmatic should be taken equally into account in semantic/pragmatic web enterprises:

First, there is the *contextual/situational/environmental dependency* of signs. There are logical ways of attacking this, as witnessed by the conceptual graph research based on the diagrammatization of propositions by Peirce's theory of existential graphs. Diagrammatic reasoning systems plus other heterogeneous representation formalisms are typically context-dependent by their very nature.

Second, there is the *utterer's meaning* as distinct from that of the literal meaning of the utterance. Recalling the divisions between different notions of interpretants, the utterer's meaning is to be found in the intentional interpretant, intended to be mediated in as meaning-preserving way as possible to the receiving effectual interpretant created in the mind of the interpreter. By contrast, the literal meaning is to be found in the immediate interpretant of the sign. The immediate interpretant is that which is created even if there is no interpreter.

These points relate to the Peircean concept of the universe of discourse, which can be conceived in two ways.

First, there is the *contextualisation task*, which is made easier by there being collateral observation and mutual experience shared by agents. This is the task of "model-building". It is quite explicitly described in the presuppositions of Peirce's diagrammatic and iconic theory of existential graphs as a collaboration between the Graphist and the Grapheus, namely between the agent who proposes modifications to the graphs and the agent who "creates the universe" and decides the truth of atomic expressions.[20] There is no opponency or competition in this description.

Second, there is the sign-theoretical *communicative task*, where signs represent objects, their instances being chosen from the mutually observed domain of discourse by the dialogue participants. This is the task of "model-interpreting", which is described by Peirce in the constitutive

[20] Ahti-Veikko Pietarinen, "Diagrammatic Logic and Game-Playing", in Grant Malcolm (ed.), *Multidisciplinary Studies of Visual Representations and Interpretations*, Elsevier Science, to appear.

rules of interpretation and considerations pertaining to the education of partakers' habits. The discourse participants will have opposing purposes.

In view of these, the following points are to be noted:

(i) The easier it has become to transmit data through computerised networks, the more difficult it has become to share data for mutual processing and understanding. This is not so much a shortcoming due to technological challenges than a failure to recognize Peirce's concept of a person not absolutely an individual. The multi-agent systems are the proxy forces set out to do what humans have failed to accomplish.

(ii) What is more important than the complex attempt of making incompatible vocabularies of databases and web documents to understand each other is to refurbish methodologies for the sharing of meaningful information. Already Peirce laid emphasis on the importance of methodeutics for the community of inquirers, in order to study "the methods that ought to be pursued in the investigation, in the exposition, and in the application of truth" (1.191 [1903]). This is central in communication, for "it is the doctrine of the general conditions of the reference of Symbols and other Signs to the Interpretants which they aim to determine" (2.93 [1902]). Ultimately, there is then a need for finding a "method of discovering methods" (2.108 [1902]) that would enable inquiries to manage the ever-increasing streams of computerised information.

Conclusions

I have identified some of the main issues and problems involved in a general amalgamation of communicative and triadic viewpoints on signs, and assessed the contribution it makes to the emerging contour of a full Peircean notion of communication, as sculpted by the recent era of intercommunicating computational systems.

What are the implications for a new research agenda for philosophy? Peirce's philosophy represents a drastic departure from the Cartesian view of philosophy, the one-time programme of those who were trying to understand, on the one hand, the discourse of the distinction between mind and matter, and on the other, the discourse of the interaction between them. Peirce presents all interaction as triadic between signs, objects and interpretants. Of late, his philosophy has been reproduced as an open-systems philosophy where systems, be they artifacts or human beings, react upon environments in a non-programmed, habitual manner. For that reason, some may regard it a never-never-philosophy, a Peircean "would-be", hypostatically abstracted metaphilosophical *Erewhon*. My view is that it is strictly rational, adhering to principles of logic, and keeping a critical eye on other socio-logical principles of inquiry, including the much less logical post-Marxist utopias of global communication communities, or dystopias of all-pervading power relations. It emphasises the role of the community of inquirers, be they quasi-minds of software agents or human interpreters, in creating new objects, developing new meanings and concepts, and ultimately achieving the main goal of scientific inquiry, namely the attainment of truth.

It is remarkable how well Peirce's never-never philosophy has held up its promises in the light of current technological advances – I see this as a self-returning pragmatic maxim. I predict prosperity for Peirce's philosophy in the 21st century, not only because of its pragmatic solutions to ever-increasing pragmatic questions, but also because we are only beginning to see the grave limitations of the last century's conceptions of logic and the *impasse* of analytical philosophy.[21]

[21] This work has been supported by the Academy of Finland (project no. 104262) and the Ella and Georg Ehrnrooth Foundation.

Roberto Frega

The Secularization of Knowledge: Towards a Pragmatist Theory of Reason

> Knowledge is the core element in the emerging mode of production, and learning is the most important process. Yet our knowledge of how knowledge is created, transferred and used remains partial, superficial and partitioned in various scientific disciplines, with the result that the basic concepts of knowledge and learning are defined and interpreted in different ways.
>
> *Knowledge Management in the Learning Society*[1]

Interest in classical American Pragmatism has been growing over the last two decades, in philosophy as well as in other fields. Contemporary uses of Peircean semiotics in communication and linguistics are well-known, and there has been a renaissance of James scholarship in psychology.

Concerning the works of John Dewey, scholarly studies have mostly been devoted to his political and educational theory. Recently, though, a new generation of scholars has focused attention on the importance of Dewey's logic and epistemology.[2] What has not been explored yet is the relevance of his theory of knowledge and thinking for the study of the relationships between cognition and action in different fields such as theory of organization, cognitive psychology, and sociology of action.[3] In

[1] Centre for Educational Research and Innovation, *Knowledge Management in the Learning Society*, Paris: OECD, 2000, cf. http://www.mszs.si/eurydice/pub/oecd/lnowledge.pdf, pp. 11 f.

[2] The work of Tom Burke, especially his *Dewey's New Logic*, Chicago: Chicago University Press, 1994, is worth mentioning. More recently, a new collection of essays on Dewey's logic has appeared: T. Burke, M. Hester and R. Talisse (eds.), *Dewey's Logical Theory*, Nashville: Vanderbilt University Press, 2002. As remarked by L. Hickman in his foreword, it is the work of this new generation of scholars that has drawn new attention to the epistemological and logical works of John Dewey.

[3] A remarkable exception is offered by the works of Hans Joas, especially his *The Creativity of Action*, London: Polity Press, 1996; but see also his *Pragmatism and Social Theory*, Chicago: University of Chicago Press, 1993.

this paper I would like to show which are the philosophical reasons that justify such an exploration and how Dewey's philosophy could be relevant for a new philosophical agenda.

My aim is to show how a theory of rationality built on a Deweyan foundation could help us understand the theories and practices that concern the production, distribution and functioning of knowledge in specific domains, with particular respect to the epistemological implications of such theories and practices. Having outlined an interpretation of Dewey's theory of thought and knowledge through the concept of thinking in action and through his functionalist theory of knowledge, I will try to show that the actual developments concerning the position of knowledge in organizational and educational theories and practices may be understood as a radical transformation of the logic of knowledge itself. Due to the broad scope of this project, I shall confine myself to a general overview of the perspective here introduced.

In the first section I shall lay down the conditions of a pragmatist theory of rationality, and I will try to ground it in a theory of thinking as action and in a theory of knowledge in which the dualism between theory and practice is overcome.

In the second section I shall examine the thesis that knowledge has undergone a radical process of secularization which has been neglected by the major philosophical schools of the last century. I shall show that Deweyan pragmatism constitutes the most interesting attempt to define this concept of secularization of knowledge from a philosophical and not merely cultural or anthropological perspective. I shall then conclude with the claim that the core concern of Deweyan pragmatism is not technical instrumentalism or technology but the place and function of knowledge in relation to experience and society.

In the third section, I shall introduce the topic of learning and education as arenas in which a fully secularized conception of knowledge should be reflected. My aim will be to interpret the contemporary interest in learning and knowledge as a result of a secularized practice of knowledge and to sort out the consequences of this transformation for philosophical practice. I will claim that Deweyan pragmatism has to be understood as the project of a society based on the idea that learning is the most important way people have of experiencing themselves, others, and in general their lives.

In the fourth and last section, I will show how the notions of knowledge management, knowledge society and learning organization are actually shaping the frame of a new conception of knowledge, to be formulated in Deweyan terms. From these analyses, theoretical but also practical consequences will follow for the actual practices of philosophers.

Active Thinking and Knowledge in Action: The Principles of a Pragmatist Theory of Rationality

In recent years, the work of Richard Rorty[4] and especially that of Hilary Putnam[5] has drawn attention to the theoretical frame of Dewey's philosophy, especially to his critique of the "spectator theory of knowledge". The growing criticism of a positivist philosophy of science and the end of the myth of analysis are at the root of this renewal. But what is still missing is a comprehensive theory of rationality built on Deweyan foundations and capable of drawing all the consequences of Dewey's thought for a contemporary practice of philosophy. Such a theory of rationality can be built on the basis of two distinct sets of assumptions.

The first set is constituted by Dewey's theory of active thinking, whose origins are traceable to his logical writings of 1902–1917, but whose accomplished formulation is to be found in his *Logic* of 1938.

In his Prefatory Introduction to the 1902 *Studies in Logical Theory*,[6] to which he contributed five separate chapters, Dewey identified the main principles of a pragmatist theory of thinking as follows:

First of all, in such a theory "judgment is the central function of knowing, and hence affords the central problem of knowledge".[7] This principle will be at the core of his theory of thinking as inquiry, fully developed only in his later *Logic*.

The second point is that thinking is "intimately and indissolubly connected with the like yet diverse functions of affection, appreciation, and practice". Being a function inside the context of experience, thinking should be interpreted not as a "self-enclosed and self-explanatory whole" but as a function subjected to the needs of the experience in which it is embedded.

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[4] See especially his books *Philosophy and the Mirror of Nature*, Oxford: Basil Blackwell, 1979, and *Consequences of Pragmatism*, Brighton: Harvester Press, 1982.

[5] See Hilary and Anna Putnam, "Epistemology as Hypothesis", *Transactions of the C. S. Peirce Society*, vol. 26, no. 4 (Fall 1990), pp. 407–434; and H. Putnam, *Renewing Philosophy*, Cambridge, MA: Harvard University Press, 1992.

[6] J. Dewey, *Studies in Logical Theory*, now published in *The Middle Works of John Dewey*, Carbondale: Southern Illinois University Press, 1976, vol. 2, pp. 293–378, here cited as MW 2.

[7] MW 2, p. 296.

As a consequence – and this is the third point – “its works and aims must be distinctively reconstructive or transformatory”. This means, as we will see, that in Dewey’s perspective the aim of thought is not the attainment of a representational knowledge of a situation but the active involvement in it, what he calls a critical reconstruction of a problematic situation. In this way Dewey is trying to settle logic on the path of the experimental sciences, transforming it into a discipline concerned with human behaviour: if to think is to accomplish some form of action, then logic must be a science of behaviour and not of formal relationships between semantic contents. Put in different terms, logic should be context-dependent, and its object not thought of as an independent cognitive function but as something that occurs in specific situations and with reference to specific problems and aims. The act that defines thought is not then considered to be the cognitive apprehension of meaning, but judgement as an active intervention in a problematic situation. To understand properly the meaning of this reference to action and practice, one should not forget that for Dewey the best instantiation of his theory of active thinking is experimental science. One of its fundamental assumptions is in fact that we have to act in order to know and that we know in order to act. The basis of Dewey’s conception is pretty simple. He starts with the idea that modern science has introduced the principle that what should be studied are not the permanent properties of things but those transformations induced in them by way of their perturbation. From Galileo’s experiments to contemporary social and natural sciences, we have witnessed the disappearing of a contemplative paradigm of science in which knowledge is modelled after what was supposed to take place in the act of vision.

By contrast, what contemporary science has made clear is that in order to know things we have to manipulate them, as is constantly done in laboratories.

The second set of assumptions consists in the progress from a conception of knowledge as the stable possession of a true belief (to know is to possess a true representation of reality), to *thinking as the activity of using true beliefs in the context of an individual situation where an action is required* (to know is to use an appropriate[8] representation of reality in order to formulate a judgement on a specific situation). This second set has to be

[8] We cannot deal here with the question of pragmatist theories of truth. As is well known, Dewey preferred to abandon the traditional concept of Truth in favour of a “warranted assertibility” that, in his opinion, better suited his naturalized conception of knowledge. For a review of the different positions, see T. Burke, *Dewey’s New Logic*.

kept separate from the first, as it is not directly connected with Dewey's interpretation of science but rather with his bio-anthropological conception of knowledge and thinking.

A Deweyan theory of rationality could then be set out on the basis of the following two principles:

1. the idea of thought as a transformative action to be concretely accomplished in the context of a single situation, rather than as a cognitive apprehension of a propositional content;
2. the idea of knowledge as a set of symbolic tools to be used in the course of knowing activities.

An important corollary of these two principles is what Dewey calls an instrumental conception of knowledge: general laws and theories are not considered anymore to be the final object of thought activity, but are viewed as tools used by thought in order to accomplish its proper task, which consists in the process of inquiry. It is Dewey's opinion, then, that research activity – i.e. the discovery and formulation of general laws and theories – should be considered as nothing more than the activity of producing useful tools. By contrast, proper thinking activity consists in the use of these conceptual tools within concrete enquiry activities aimed at the formulation of a judgement on an individual problematic situation.

Here again it is important to specify that "concrete situation" does not stand for ordinary practical activities like going to buy bread or repairing a machine. In an article significantly titled "Context and Thought",[9] Dewey clearly explained that what he meant was simply that thinking is not situation-independent, but that it always takes place in the framework of a problematic situation: the resolution of a mathematical problem, the pursuit of a scientific inquiry, the proceedings in a law court, the activity of a doctor diagnosing a disease, and so on. In this sense, and in this sense only, the activity of both a mathematician and of a skilled worker are said to be *practical*: they are accomplished in the context of a practice.

It has to be specified that in the expression "judgement *on* a situation", "on" means both *within* and *above* the situation. The relation between judgement and situation has, in fact, a double status. On the one hand, the judgement is an event occurring inside the problematic situa-

[9] J. Dewey, "Context and Thought" (1931) now published in *The Later Works of John Dewey*, Carbondale: Southern Illinois University Press, 1981–1991, vol. 6.

tion and for that reason is capable of transforming it. On the other hand, the situation as a whole is the proper and only object of judgement.[10]

This reversion between general and particular which displaces representational knowledge from the status of goal to the status of instrument represents one of the most important results of Dewey's theory of rationality. It implies that the goal of knowledge is not constituted by the formulation of general laws and theories, but rather by their use in the context of a concrete, individual inquiry. At the same time, it is important to note that Dewey does not deny the existence of a sort of representational form of knowledge; he just changes its place and function within the logic of knowledge.[11]

Naturalizing Epistemology: The Secularization of Knowledge

Secularization of knowledge is a major topic especially among anthropological and sociological scholars. Philosophers, on both the continental and the analytical side, seem to have been rather concerned with the problem of secularization of truth. With this formula, I refer to two separate but corresponding philosophical traditions. On the continental side, the questioning of the meaning of truth was taken up by Friedrich Nietzsche during the last third of the nineteenth century and carried on – among others – most notably by Heidegger, and later by French philosophers such as Gilles Deleuze, Michel Foucault and Jacques Derrida. As far as Nietzsche is concerned, the secularization of truth stands for the idea that truth has no more to be considered as the neutral and independent object of thought but its pursuit has to be explained "as a need among other needs".[12] Through his genealogical approach, Nietzsche came to state that "the impulse for truth has proved to be also a life-preserving power". This implies that truth has lost its status of transcendent value governing the thought activity. Continuing the Nietzschean path, Martin Heidegger developed a great narrative – the history of

[10] Of course, there are cases in which the relevance of thinking as action is minimal and cases in which it is of the utmost importance. As in relation to the question of context, what Dewey is stating is that *in principle* we should take into consideration the existence of such a dimension and eventually decide in which specific cases this factor is not relevant. It is for this reason that Dewey can claim that "the most pervasive fallacy of philosophy thinking goes back to neglect of context", LW 6, p. 5.

[11] For the same reason, there is no denial of the value of objectivity in knowledge but radical redefinition of its place and meaning.

[12] F. Nietzsche, *The Gay Science*, § 110, Walter Kaufmann transl.

Being – in which conceptions of truth are considered as being relative to specific historical epochs. This same tradition has been renewed in recent decades by Michel Foucault's genealogical and archaeological approach, through the hypothesis that truth-games are the results of historical configurations of relations between knowledge and power.

On the analytical side, the linguistic turn applied to the question of truth has led to shifting from an analysis centred on "truth" as a noun to the analysis of the uses of "true" as an adjective. In this displacement, intended as a way out of the metaphysical machinery of speculative philosophy, truth has undergone the same diminution of power as was announced by Nietzsche. As an adjective, "true" is just a sign we use to indicate the fact that we are stating a proposition. This theory, now well-known as the "deflationist theory of truth", is a way of affirming that the concept of truth has no substantive role to play in logic and philosophy.

In spite of their huge differences, these traditions share a common effort in secularizing "truth" as a sacred word of philosophy. What was missing in Dewey's time, and is partially still missing, is an analogous process of secularization on the side of knowledge. Dewey believed that philosophy continued to carry a religious conception of knowledge, whose frame was determined by the following principles:[13]

1. the separation of the domain of theory from the domain of practice and the veneration of the former as against the latter;
2. the conception of a pure knowledge as the proper object of thought, which expresses itself in a "spectator theory of knowledge";
3. the idea that the relation between the act of knowledge and its result is external. As a consequence, knowing should not be affected by its empirical conditions, as this would influence the possibility of grasping a reality considered to be "antecedent to the mental act of observation and inquiry"[14].

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[13] It would be easy – and Hilary Putnam among other has partially done it – to show that, for the most part, twentieth-century philosophy of science operated within this frame.

[14] J. Dewey, *The Quest for Certainty* (1929), now published in *The Later Works of John Dewey*, Carbondale: Southern Illinois University Press, 1981–1991, vol. 4 (here cited as LW 4) p. 19.

In Dewey's view, philosophy could renew itself only by overcoming this religious conception of knowledge. To this extent, philosophy should dismiss its pursuit of an objective knowledge of the world, conceived in terms of neutral representation, in order to take on the task of involving itself in the development of the "kind of intellectual capabilities necessary to deal with problems as they present themselves".[15]

Secularization opens to philosophy the possibility of a new understanding, in which *knowledge problems are essentially use problems*. We pass then from *a priori* questions concerning conditions of possibility to empirical questions concerning problems of usage. In Dewey's terms, the main task of philosophy is defined by the questions: "how shall our most authentic and dependable cognitive beliefs be used to regulate our practical beliefs? How shall the latter serve to organize and integrate our intellectual beliefs?"[16]

Dewey found the signs of the possibility of such a radical transformation in the origins of experimental science, whose findings philosophy should use in order to reconstruct its conception and practice of knowledge. Through the extension of this active and transformative conception of thought and knowledge to the world of human experience, philosophy would complete the process of secularization of knowledge begun by the scientific revolution.

Dewey, then, set philosophy on the path leading to a pragmatist society, in which the place of knowledge and thought would be highly expanded.

In Dewey's naturalized epistemology, logical forms and methods of knowledge are not *a priori* but grow out of forms of life. It is for this reason that the scientific revolution was said to have transformed the logic of knowledge and at the same time set the basis for the development of new logical structures. If thinking is a natural biological function, its *modus operandi* changes with the changing conditions of human experience. Epistemology and logic then become historical, as our ways of thinking and knowing change with the varying conditions of our concrete existence.

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[15] *Ibid.*, p. 17.

[16] *Ibid.*, p. 15.

From the Technological Age to a Knowledge Society

Dewey was aware that the economic, political and scientific revolutions of the last two centuries had radically transformed the place and function of knowledge in our societies. In fact, they set up the process of secularization we are here discussing. But this process, far from having been accomplished by the scientific revolution, was in Dewey's time at its very beginning. A fully secularized practice of knowledge and thinking was in fact confined to scientific practice and was not recognized either by philosophy or by common sense. Dewey's philosophical project aimed at pursuing this extension, both by creating the theoretical frame capable of stating its conditions and by assigning to philosophy the task of realizing it. Dewey claimed that his theory of thinking and knowledge was able to "give the only promising basis upon which the working methods of science, and the proper demands of the moral life may cooperate".[17]

The post-positivist turn in the epistemology of science associated with Thomas Kuhn[18] set up the conditions for recognizing the relevance of a pragmatist theory of science in the context of the experimental theory and practice of scientific research. What has not been realized yet is the second part of Dewey's project, that is, the progressive extension of secularization to all the domains of knowledge related to human action and experience.

In Dewey's time, natural science was the place where new forms of knowledge and thinking were under experiment. As for most philosophers of his era, the new epistemological constitution of physics was the great challenge for philosophical thought.

The new and growing possibilities of control made possible by science are also at the basis of Dewey's biological paradigm of life as an integrated system of interrelations between an organism and its environment. In relation to this, the originality of Dewey's thought lies in the fact that this Darwinian frame was developed as a theory of adaptation, but grew into an anthropology of learning, intelligence and creation. In this way the age of knowledge and learning in which many scholars say we are actually living was theorized long ago by Dewey, who framed its theoretical conception.

[17] MW 2, p. 296.

[18] But already initiated by Popper's critical epistemology based on fallibilism, a principle previously articulated by both Peircean and Deweyan pragmatist epistemology.

It is my claim that the role once played by experimental science in transforming logic and epistemology is now actually being played by disciplines and practices concerned with work experience, education and organizational behaviour. It is in this context that, as in physics at the beginning of the last century, new forms of knowledge are emerging. As a consequence, the grammar of epistemology should in turn be transformed.

I will here confine myself to the analysis of two main aspects of this stream:

1. the role of education as an expression of a fully secularized knowledge;
2. the theme of knowledge management and learning organization as new ways of practicing knowledge.

As far as the first point is concerned, the contemporary interest in learning and knowledge should be considered as a consequence of the secularization of knowledge. It is already present in Dewey's idea of education as the form that a fully secularized knowledge should assume. But Dewey goes even further, affirming that education should become the general aim of a reconstructed practice of philosophy. As indicated above, the proper object of philosophy is for Dewey the development "of this kind of intellectual capabilities necessary to deal with problems as they present themselves"[19]. In other words, philosophy must both set the frame for a conception of thinking as concrete inquiry and proceed to make it effective by spreading it through all arenas of social and personal life.

This idea of philosophy as education can be developed in two separate corollaries.

First of all, there is the idea of education as the proper object of thinking. This is a necessary implication for a theory which views thinking as active and transformative and which attributes to thought the task of actively intervening in experience in order to reconstruct it. Education should be intended here as formation, that is, as a specific form of *trans*formation.

At the same time, vocational education, and more generally adult education, today becomes the explicit and concrete expression of a sec-

[19] LW 4, p. 17. This theme has been fully developed by Dewey in his *Reconstruction in Philosophy* (1920), now published in *The Middle Works of John Dewey*, Carbondale: Southern Illinois University Press, 1976, vol. 12, pp. 77–203.

ularized conception of knowledge, as its main concern is the *emancipation of people through knowledge*. As currently envisaged, adult education has to become a real means for self-realization in both the personal and the public sphere of life.

In Dewey's idea of a pragmatist society, individuals determine themselves through an active and reflective exercise of thinking, and institutions set the conditions for the improvement of these processes. Here there is explicitly stated the project of a cognitive democracy and of a learning and knowledge society as they are currently theorized in several fields.

From this general overview we have to distinguish two separate sets of consequences.

The first set concerns the importance of Dewey's theory of thinking in the actual configuration of these disciplines and practices. Its relevance here lies in the fact that it may provide the theoretical frame most viable for understanding the changes that practices of knowledge and thinking are undergoing. To this extent, two different aspects have to be underlined. First of all, most of the analyses actually carried out in these fields tend to understand knowledge through its reduction to external factors such as work transformations, technology improvement, globalization, economic instability, etc. All these analyses clearly acknowledge the fact that the practice of knowledge is changing, but they fail to grasp these events from an epistemological point of view.

They clearly realize that theory and practice are merging, that action and thought are becoming more and more intertwined, that artefacts play a role in knowledge production, and that we are faced with collective subjects of knowledge. What is still missing, however, is a theory of rationality capable of explaining both the epistemological meaning of these transformations and the new conception of thinking emerging from it. At the same time, traditional epistemology fails to provide an account of knowledge capable of overcoming the dualisms of theory and practice and of knowledge and action that, according to Dewey, block the road towards a secularized conception and practice of knowledge.

The second set of consequences includes the feedback that practices of knowledge taking place in these fields can have on general epistemology. As noted above, a naturalistic epistemology claims that forms of thinking and models of knowledge are not *a priori*, but are historically produced in the context of concrete practices.[20] This means that philo-

[20] See J. Dewey, "Some Stages in Logical Thought" (1900), now published in *The Middle Works of John Dewey*, Carbondale: Southern Illinois University Press, 1976, vol. 1,

sophical questions like "what is knowledge?" and "what is thinking?" must be settled in historical terms.

This point was explicitly stated by Edward Murphy in an important article on Dewey's theory of knowledge, where he recognized that in a pragmatist perspective knowledge should be defined "by reference to the contexts in which various knowledge-claims have meaning and testable validity in use". More precisely, the knowledge-claims that philosophy should study and evaluate "occur in the first instance in non-philosophical activities and are to be understood by reference to their role in such activities"[21]. But were this true for what concerns the epistemological impact of the scientific revolution, for the same reason it would apply to other kinds of knowledge practices, and most notably to the changes that are actually taking place in the practice of knowledge in work experience.

The most important philosophical consequence of this claim is that these transformations should in turn modify our general conception of knowledge, of its rules of functioning and its place in society.

Concerning the practices and theories which have been tested and elaborated in an organizational context, the main topics which in my opinion are of great import for contemporary epistemology are the following:

1. passage from a static notion of *knowledge* to a dynamic notion of *knowing*;
2. priority of process over result: knowing means setting up inquiry processes and not, anymore, the possessing of true beliefs (primacy of use over possession);
3. "competence" as a concept that unifies thought, action and context and defines the empirical field for a new theory of thinking as action;
4. "learning by doing" and "learning on the job" as specific examples of overcoming the dualism between theory and practice;
5. "knowledge management" as a new way of producing, processing and finally conceiving knowledge;

pp. 151–174, and C. S. Peirce, "The Fixation of Belief", *The Popular Science Monthly*, Nov. 1878, now in the *Collected Papers of Charles Sanders Peirce*, Cambridge, MA: Harvard University Press, 1931–1958, vol. 5.

[21] A. E. Murphy, "Dewey's Epistemology and Metaphysics", in A. Schilpp (ed.), *The Philosophy of John Dewey*, New York: Tudor, 1939, p. 200.

6. "learning organization" as a frontier of the philosophical grammar of knowledge: knowledge becomes here the attribute of a collective subject;
7. "life-long learning" as an instance of the pragmatist society imagined by Dewey;
8. "learning society", "community of inquiry" and "community of practice" as concepts recognizing and improving the function of intelligence in shaping a cognitive society.

Active Thinking and Knowledge in Action: Towards a Pragmatist Epistemology of Organization

In the fields of knowledge management and organization science, inquiries into the nature of knowledge have led to broadening of the very meaning of the term "knowledge". In the attempt to understand the processes of knowledge acquisition, transfer and creation inside organizational settings, scholars have rapidly realized that the epistemological frame put forward by the traditional philosophy of science was largely insufficient. Cook and Brown,[22] in an important article, define this frame as the "epistemology of possession" and characterize it by the fact that knowledge is here considered only in terms of acquisition and possession. In Dewey's terms, it is an epistemology centred around the "spectator theory of knowledge".[23]

In these fields we can identify a set of conceptual oppositions that circumscribe the conception of knowledge here referred to. It is actually through these oppositions that the theoretical frame of a pragmatic epistemology of knowledge in action emerges. The distinctions considered are the following:

1. theory–practice;
2. individual–collective;

[22] S. Cook and J. Brown, "Bridging Epistemologies: The Generative Dance between Organizational Knowledge and Organizational Knowing", *Organization Science,* vol. 10, no. 4 (1999), pp. 381–400.

[23] Another researcher – Tryggvi Thayer – maintains that "philosophers have tried to define 'knowledge' for over 2500 years and still the concept remains just as elusive as ever. Do these [management] gurus know something that philosophers do not, or might their understanding of 'knowledge' be something different from that which philosophers have so ardently sought?" (T. Thayer, "The Limitation of Computers in the Management of Knowledge", in B. Nyhan, [ed.], *Taking Steps towards the Knowledge Society*, Luxembourg: Cedefop Reference series, 2002, p. 124.)

3. explicit–tacit;
4. knowledge–knowing;
5. truth–efficacy.

In this field, scholars debate whether knowledge is a matter of theoretical or of practical concern and whether there can be a collective bearer of knowledge or not. The notion of knowledge is enlarged in order to include also forms of tacit knowledge, irreducible to the conscious propositional state of beliefs. Definitions of knowledge tend to turn more and more around questions of efficacy, effects and real consequences rather than of adequacy to states of affairs.

For example, Massimo Tomassini[24] observes that in organizational contexts

> knowledge, far from being seen as a "timeless body of truth", is assumed to comprise different disciplinary insights and abstractions that experts use creatively in specific circumstances. The focus is on "knowing" rather than "knowledge" and the conventional distinction between knowledge and learning is not made. ... The process of "knowing" is at the heart of a new theory that encompasses knowledge but which overcomes its connotations of abstraction and permanency.

Drawing on the "knowledge"–"knowing" distinction, Massimo Tomassini remarks that understanding knowledge in work contexts demands a reshaping of many of the concepts through which knowledge has traditionally been categorized. Among those, he refers to the distinction between abstract and concrete, general and specific, individuals and communities, and the social and the technical.[25]

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[24] M. Tomassini, "Theories of Knowledge Development within Organizations", in Nyhan (ed.), *op. cit.*, pp. 103 f.

[25] Other researches focus on aspects more related to the functioning of knowledge in work contexts or to the laws ruling its transfer. In these cases knowledge is being studied as a technological factor. But it is mostly around the topics outlined above that we come to a change with epistemological import, as the assumption of a knowledge which is theoretical, individual-based, explicit and representational is put into question. Along these lines, M. Tomassini identifies three epistemological frameworks, all closely connected with recent trends in epistemology and cognitive studies: a connectionist model, a constructivist model and a cognitivist model. For a deeper analysis of these three frameworks see Von Krogh et al., *Organizational Epistemology*, New York: Macmillan, 1995, pp. 37–43.

In the article by Cook and Brown cited above, the distinction between knowledge and knowing and the critique of the epistemology of possession draw explicitly on Dewey's philosophy, in order to build an "epistemology of practice" in which the logic of knowledge in practice is directly taken into consideration. But here again, what is missing is an exhaustive inquiry into the philosophical foundations of such an epistemological frame. As an example, the distinction between "knowledge" and "knowing" lacks sufficient argumentation and the announced "epistemology of practice" is missing.

On the same basis, Frank Blackler has argued that in order to understand the logic of knowledge in organizational contexts, "rather than regarding *knowledge* as something that people have, it is suggested that *knowing* is better regarded as something that they do".[26] This shift from knowledge to knowing is a consequence of the fact that "it is becoming clear that traditional conceptions of knowledge as abstract, disembodied, individual, and formal are unrealistic".[27]

Along similar lines, Silvia Gherardi recently spoke of the need of a "practice-based theorizing on knowing"[28] as a platform comprising a plurality of perspectives, all of them sharing the same assumption that "*practice* is the figure of discourse that allows the processes of 'knowing' at work and in organizations to be articulated as historical processes, material and indeterminate".[29] This focus on practice is intended as a way out from an epistemology centred on knowledge as the explicit and mental attribute of an individual subject, underlining once again the importance of the collective and tacit dimensions of knowledge.

As I have tried to show, studies concerning knowledge as something which is produced, used and transferred in cognitive and practical contexts tend to underline the collective, tacit, practical and pragmatic sides of knowledge. As Frank Blackler has remarked, "knowledge is multifaceted and complex, being both situated and abstract, implicit and explicit, distributed and individual, physical and mental, developing and static, verbal and encoded".[30]

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[26] F. Blackler, "Knowledge, Knowledge Work and Organizations: An Overview and Interpretation", *Organization Studies*, vol. 16, no. 6 (1995), p. 1023.

[27] *Ibid.*, p. 1034.

[28] S. Gherardi, "Practice-based Theorizing on Learning and Knowing in Organizations", *Organization*, vol. 7, no. 2 (2000).

[29] *Ibid.*, pp. 220 f. Among these perspectives, she quotes *activity theory*, *actor–network theory, situated learning theory* and *cultural perspective on organizational learning.*

[30] F. Blackler, *op.cit.*, pp. 1032 f.

All these studies call for a new philosophical frame in relation to which it would be possible to formulate the questions concerning those new configurations knowledge and thinking assume in organizational contexts. At the moment, this frame is still missing and we are striving towards, and participating in, "an intellectual movement that as yet has no name", to quote Susan Star.[31]

There arises, then, the need for a new philosophical agenda, whose object should be the framing of a theory of rationality capable of dealing with the followings assumptions:

1. *knowing as a process* in which knowledge is being used rather than aimed at;
2. *knowing as situated* and therefore subject to conditions which are context-dependent;
3. *thinking as a form of active and transformative inquiry* that is carried out in specific situations.

Conclusions: Active Thinking and Reflective Rationality

In the first part of this paper I identified the two fundamental principles framing Dewey's theory of rationality. Concerning the nature of thinking, pragmatism claims that the act of thought does not consist in the apprehension of a true proposition but in the active intervention in a problematic situation.[32] With respect to knowledge, pragmatism proposes a shift from a conception of knowledge as the stable possession of a true belief to a conception of knowing as the activity of using true beliefs in the context of individual situations where an action is required.

Dewey believed that these principles were common both to scientific and common-sense thinking, thus overcoming the very idea of a gap between theoretical-speculative science and practically-oriented thought. This common frame will be useful in surmounting the still persistent tradition of distinguishing science as truth-oriented from practice as aiming at the transformation of reality. When the hypothesis of a common epistemology forms the background, theoretical science and organizational behaviour may easily be considered as the extremes of a continuum, characterized by what Dewey used to call *intelligent behaviour*: the fact that human beings produce and use knowledge in order to live. In this sense,

[31] S. Star, "The Trojan Door: Organizations, Work and the 'Open Black Box'", *Systems Practice* 5 (1992), pp. 395–410.

[32] Of course, through the *use* of true propositions.

there is no activity without knowing and there is no knowledge outside the practical frame of a form of life.

Dewey tried to formulate the general theory of rationality necessary in order to legitimate this vision. He intended it as a way to bridge the scientific spirit and common sense.

Nearly a century after his proposal, different problems have to be coped with now, opened by the expansion of a field of practice and research which is neither theoretical science nor ordinary behaviour but which concerns highly specialized activities, in which a great deal of knowledge and intelligence is embedded. In order to understand the manifold ways in which knowledge and action on the one hand, and theory and practice on the other, merge, Dewey's philosophy provides us with a useful tool.

Such a philosophical agenda could then be fruitfully pursued through a recovery of Deweyan philosophy, as it sets the frame for a theory of knowledge and thinking capable of dealing with all the epistemic factors that have been underlined by studies on knowledge and thinking in practical situations. These studies in turn could be fruitful for philosophers inquiring into the nature of knowledge and thought.

Donald Peterson

Context and the E-Condition

Are the conditions of knowledge and learning the same as they used to be? Is the information revolution giving us more of the same old thing, or is it giving us something new? We have now seen four phases in this revolution. Phase-1 saw the creation of basic hardware for digital processing, using first valves and then silicon, and the "von Neumann machine" which still defines the architecture of computers today. Phase-2 saw the development of software: programming languages, compilers, interpreters and debuggers. Phase-3 saw the development of better interfaces: the graphical user interface, menus, the mouse and the beginnings of speech recognition. Phase-4 has seen the development of networking, providing us with the internet, and in 1991 the inauguration of the World Wide Web (the web). Now, as the third millennium begins, these developments are progressively entering the workplace, education and the home. Furthermore, we see the beginnings of "ambient" and "semantic" technologies which are not so much tools as parts of our environment. We are gradually coming to inhabit environments or ecologies which are saturated with these technologies, some of which are adaptive in that they are designed to provide us with what we need according to who we are, where we are and what we are doing. This is the beginning of Phase-5 of the information revolution: the ecological phase.

These developments alter the conditions of knowledge and learning in two basic ways: they alter the balance between the tasks of accessing and utilising information, and they alter the role which machines play in the generation of knowledge. On the first of these points, we see a continuation of changes which began with the printing press and then the photocopier. Documents are far easier to distribute and access than they used to be, and what used to require time, money and travel to obtain is now located and downloaded in seconds. Documents are easier to find than they used to be, since the development of search engines, and the environments of the workplace, school and home are information rich as never before. In this regard, what used to be difficult is becoming easier, and our epistemic condition is changing. There exists, of course, a "digital divide", and this change does not affect all people equally, but where it happens its effects are radical, and its propagation has already affected, to some extent, all countries in the world.

There is another side, however, to this coin. As the quantity of available information increases, so does the challenge of managing, interpreting and utilising it. In short, information is becoming easier to get hold of, and harder to do something useful with. The world's major telescopes generate a mass of data so large that it mostly lies uninterpreted in storage. Television now has so many channels that a demand is emerging for technologies which filter and personalise what we consume, mediating between the user and the space of available information. E-mail, which makes the distribution of messages so much easier, also challenges the recipient to filter, select and skim so as to extract what is relevant from a clamouring mass which renews itself daily. Online databases have advantages over paper books (in their search facilities and ease of updating), but the lawyer making use of legal databases, for example, may then find it necessary to use several incompatible, non-interacting systems, with all the stress and complexity which this involves. The web presents us with free access to a massive virtual library: but, having found a document, we are still challenged to decide whether we trust its contents, what is the agenda of its authors, in what context it was produced, and whether our search engine's selected "top 10" reflects our needs in the first place.

This shift has some similarity to a shift which took place when the printing press was used to produce vernacular translations of the bible. Access became easier, in that more people could actually obtain and read the text. But interpretation became more of an issue and a challenge, in that the individual now faced a task previously performed by the priesthood. This similarity, however, is limited, since the technologies at issue go further than the printing press. They do not simply reproduce or disseminate information: they also play a role in interpreting and managing it. When we use a search engine, for example, its algorithm determines in part what result we get. We have filtered and selected from the vastness of cyberspace, but we have not done this alone: we have done it in partnership with a machine. This partnership is not entirely open, since we may not know the exact nature of the machine's algorithm and the data it uses. But it is necessary, since we cannot practicably do without the machine. We therefore have a cyborg relationship with the machine: it is not simply a tool which makes a job easier, but rather a partner which makes a job possible. The results of these searches are increasingly intrinsic to our processes of learning and generating of knowledge, and in this case our knowledge is not simply of our own making, but is generated through a partnership with a machine.

We need to ask, therefore, whether or not this is a partnership with a deterministic automaton which we can understand. Does the machine simply implement an algorithm which we employ as an epistemic prosthesis, and whose behaviour is potentially transparent to us? Unfortunately, perhaps, the answer is "no". The machine will implement an algorithm, and its general architecture and behaviour will reflect the intentions of its designers, and so to some extent it is potentially transparent. However, it also uses data, some of which is produced by humans, some by tracking the behaviour of humans, some by machines, some by machines which have consulted machines, and so on. Our increasingly cyborg state is not one in which we add a deterministic, predictable or transparent prosthesis to our existing mental faculties, but rather one in which we enter a mixed and unpredictable web of humans and machines. A search engine, for example, may rank web pages according to how many links point to them from other web pages. These web pages may be generated through human activity, but they may also be generated automatically, for example by software agents, and these agents in turn may draw their data from other such agents. Again, a software agent may help us to navigate through "learning objects" (sources of information appropriate to formal or informal education). The agent may implement an algorithm which is deterministic in itself, but this will process data which we cannot predict or fully explain. This data may include metadata describing learning objects (which the agent compares against its profile of the needs of the user in order to offer its advice on navigation). And this metadata may be variously produced: by one community, by another community, or by other agents. Such technologies, then, do not simply provide us with tools, but with an environment in which the products of humans and machines are interwoven. The machines with which we form partnerships may be deterministic and predictable in themselves, but they are woven into a larger fabric whose behaviour does not have this character.

These factors define a new "e-condition" in the circumstances of knowledge and learning. In this condition, access to information is easier than it was, the utilization of information is more challenging than it was, and cyborg partnerships between human and machine are closer than they were. This e-condition, in turn, defines a new agenda for philosophy: the task of understanding and articulating the basic principles involved in these new conditions of life. This is not to say that the old philosophical questions disappear, however it can mean a significant change of focus and emphasis. In Plato's *Theatetus*, for example, we find the definition: "knowledge = justified, true belief". This places a primary emphasis on the issues of truth and justification: information (our beliefs) becomes knowledge when it is correct and it is justified, and the value of information depends on these properties. These properties have been the focus of a great debate in epistemology: a debate concerning foundations, certainty, regresses of justification, incorrigibility, and the nature of truth. This debate has been running two and a half millennia, and under the emerging e-condition, its concerns do not disappear: we still want our information to be correct, and we still prefer to have reasons, evidence and proof to back it up. What has changed, however, is any possibility that these concerns are sufficient. An individual inhabiting an ecology saturated by information technologies needs more than truth and justification: a deluge of miscellaneous information renders us confused and ineffective, and we do not recover from this condition just because the deluge is free of falsehood and unprovability. If information is to become knowledge, if it is to allow us to grasp and work with the world, we need more than this. Philosophy will be of service, it will be relevant, only if it addresses the areas in which we are challenged, and the e-condition does bring new challenge. If it fails to do this, philosophy will be seen to have lost its project, and to indulge in concerns which may be legitimate in principle but which lack contemporary urgency.

The main issue which the e-condition presents to philosophy is that of context. In the e-era, if we are to turn information into knowledge, we need to filter, manage and manipulate what we have in order to make it serve our current context. The alternative is the paralysis and confusion of information overload, whether or not this overload contains items which are correct and provable. Take the example of a lawyer at work on a case or "matter". On one hand, we have an ocean of statutes, cases and decisions, now available online through legal databases to which the lawyer has access, together with a mass of in-house know-how and experience held by other partners in the same firm. On the other hand, we have the issue of context: the lawyer's role in a team, the stage to which the matter has developed, and the particularities of the case determine that a fraction of this ocean is relevant. And if this fraction is to be useful, it also needs to suit the individual: his or her accustomed forms of presentation of information, level of expertise, and available time. These desiderata are not new, and existed before the information revolution. What is new is a shift in priority (the challenge of access is shrinking and the challenge of contextualization is growing), and a change in method (we now rely on machines in a more intimate way than ever before): and if philosophy is to remain relevant, it needs to move with this shift. In the e-condition, our primary challenge is to interact with machines so as to act effectively in context, and the requirement for correct and provable information is located as part of this larger picture.

It is useful here to ask how information can fail to become knowledge. What deprives us of effective action in context, and in particular, what factors in our relation with machines and cyberspace can contribute to this failure? In addressing this question, it is important to remember that information comes to us as presentations: we do not encounter information in a raw or neutral state, but presented in particular languages, terminologies, diagrams and formalisms. These determine the actions and process which we can undertake: presented in one way, it may be possible to understand and solve a problem, and presented in another way, this may be impracticable. The issue is especially clear in mathematics, where the key to solving a problem may reside in its initial formulation: presented in one way the problem may even become trivial, but presented in another way it may invite no practicable process of solution. Our question can be reformulated, therefore, by asking: what characteristics of the presentations of information cause it to fail to become knowledge? Here we need to distinguish between functional and individual context. The functional context of a presentation is the task at hand, and its current stage and aspect. The individual context is the needs and particularities of the user of the presentation. Thus, for example, a lawyer might have the task of finding existing court decisions which are potential precedents for the case at hand: some have already been found and a few more may be useful. And this particular lawyer may be accustomed to a particular format for presenting cases, and may have a high level of experience in this particular area of law, say personal injury. These two types of context impact decisively on whether the information provided by the lawyer's computer system produces useful knowledge. Regarding the functional context, if the system is unable to select cases which are potential precedents, it may then provide information which is correct and reliable but useless. If the case at hand concerns personal injury in a workplace sustained by a person who is not an employee, then data on injuries to employees working at home is unlikely to be useful. Worse still, data on cases in competition law arising in a different jurisdiction will not help with the present task. And regarding individual context, if the system presents its information in a format foreign to the person using it, this will be disadvantageous, as will a presentation which does not suit the user's level of expertise. To take another example, given a geographical information system and a particular geographical area, the map which helps us to fly an aeroplane safely is different to the map which helps us to navigate its roads or to mend its water pipes. These, respectively, will emphasise tall pylons, one-way streets, and underground constructions, and there is no such thing as "one fits all". Also, the person who is flying the aeroplane, driving the car, or mending the pipes will have better or worse eyesight, usually or on this particular day, and will be able to read some languages better than others, and the form in which information is presented will determine whether this person can make effective use of it. In short, if a machine presents information which is not relevant to the task at hand and not tractable to the user, then whatever its other virtues, this information will not produce effective action in context.

We can therefore provide a working definition of knowledge for the cyborg conditions of the e-era: "knowledge in context = functionalised, individualised presentation". Comparing this to Plato's definition "knowledge = justified, true belief", what we see is essentially a difference in emphasis. Both definitions state conditions which are necessary but not jointly sufficient. Information fails to become knowledge if it is false or unsubstantiated just as it does if it is irrelevant or intractable, and the pilot using a geographical information system in the cockpit will be ill served by incorrect or speculative data on pylons just as he or she will be ill served by unreadable data on water pipes. It is also fair to say that understanding of the focus of the present definition is not absent from ancient Greek philosophy: the Sophists argued clearly that the presentation of information needs to be adapted to the purpose and the audience at hand. The difference, however, is crucial, and delineates two very different research programmes in epistemology. It also has an ironic or reflexive aspect since if philosophy is to produce knowledge in a context in which our epistemic conditions are changing, its presentations need to be relevant to human–computer interaction (HCI) and tractable to its practitioners, rather than focusing on the desiderata of a quasi-Euclidean foundationalism.

One feature of the present definition, and one which is attuned to the issues of HCI, is that it concerns the tasks and individual characteristics of users of information systems. This is not to say that these information systems must be autonomous grey boxes on table tops: as hardware becomes ubiquitous, and "sinks into the woodwork", and as the planet becomes ever more connected and networked, the notion of a ecology is more appropriate than that of a standalone PC. In the smart office, the smart home and the smart school a person inhabits an environment which consists partly of information technologies. Habitation involves possible action: we achieve different things in different environments. In a given functional and individual context we need our environment to be facilitative of action which satisfies that context. Our definition of knowledge in context therefore leads to a further definition: "a knowledge ecology which is facilitative = an environment which supports a context". This context, as already noted, will have functional and individual aspects: tasks to perform and personal characteristics to be satisfied. And this provides us with a conceptualization of stress in the e-era: we encounter stress in non-facilitative knowledge ecologies. That is: we encounter stress when our ecology does not support action which satisfies our functional and individual contexts. The most obvious case of such cyber-stress is "information overload": we are deluged by e-mail, television, fixed and mobile telephones, pagers, public announcement systems, paper mail, billboards, and so on. The issue, however, is not one of quantity but of relevance: the appropriate unit of analysis is not the individual technology, any of which can be useful, but the relationship between environment, action and context. As the Roman architect Vitruvius put it, a good building affords "strength, accommodation and delight". (I owe this point to Mike Sharples of the University of Birmingham.) In these terms, Plato's definition of knowledge concerns the strength of an ecology, and the present definition concerns its accommodation and delight. For the e-era, these latter concerns can be conceptualised by expanding our previous definition: "a knowledge ecology which is facilitative = an environment in which actions which are easy utilise information which is presented so as to satisfy a context which is current". Stress, then, arises where our ecology is not facilitative: where it is hard simultaneously to utilise what is provided and achieve what is needed.

The point can be put schematically. We have an ecology E (consisting of sources of information under particular presentations), we have a context C (consisting of functional and individual aspects), and we have actions A (which utilise E so as to satisfy C). In these terms, stress (or "expense" as the term is used in computer science) is a function of the triangulation T of these elements. That is: A triangulates E against C, expressed as T(E, C, A), and stress S is a function of the difficulty D of this triangulation, expressed as S = D(T(E, C, A)). In the terms used by Vitruvius, we have accommodation and delight where this triangulation is facilitated, and we have stress where it is not. Information overload, then, may involve excess, but its central character is that of a bad relationship between an ecology and a context, such that action which triangulates the two is not easy. In philosophical terms, the central challenge for design for HCI is the reduction of such stress. And in terms of the ancient Greek debate between Plato's Socrates and the Sophists, it is the latter rather than the former whose focus is most relevant to the challenges of the e-condition. We inherit a tradition and a literature in which Plato's position may, however, appear to be the more noble and principled. The efforts of the Sophists, according to Plato, were directed to persuasion and even deception: eristic rather than truth. Euclid's axiomatic geometry provides a model on which action is derived from solid and transparent foundations, while the Sophist in the debating hall provides a model on which action is determined by circumstance and expediency.

The choice between these two perspectives depends on the structure of the situations which we encounter. If there exists a unitary rule or algorithm which accommodates all contextual factors, then the structure described above collapses, and we have no task of triangulating, stressfully or otherwise, between principle and context. In ecological terms: if our environment provides a single source which adequately tells us how to act, then we can do its bidding, and free ourselves of the efforts of negotiation and compromise. This scenario presents an ideal whose attractiveness cannot be denied: the messiness and effort of triangulation are avoided, and knowledge of an essential principle or logos is sufficient to determine right action. The fundamental question which Socrates addressed was that of how we determine right action, and his working hypothesis was that this might be achieved through knowledge of an adequate principle which accommodates all circumstances so as to dictate right action in an autonomous manner. This monomorphic view, as I shall call it, of the situations which challenge us led him, as presented by Plato, into *aporia*: the early Platonic dialogues in particular end in recognition of the failure of this strategy. And now in the emerging e-condition, as then in ancient Greece, we find the same impracticability: the situations which challenge us are polymorphic, as I shall put it and as schematised above, and require that we balance and negotiate between competing factors in the determination of action. This was recognized by Aristotle in his treatment of *phronesis*, or practical wisdom, and by the Stoic philosophers in their treatment of *ataraxia*, or peace of mind. Both saw the impracticability of the ideal investigated by Socrates. In present terms, both saw the impracticability of the assumption that the situations which we encounter have a simple, monomorphic structure which relieves us of the effort of triangulation between principle and context. And as the e-era unfolds, as the e-condition establishes itself, we will be ill served through aspiration to this monomorphic ideal: we will be ill served by attachment to the elegance and certainty afforded by this picture of the relation between information and action. Our knowledge ecologies are complex, and increasingly so as information technology proliferates through our planet: and the proper task of contemporary philosophy is to understand and articulate the polymorphic and cyborg structures which we encounter in our emerging ecologies. We have asked how information turns into knowledge, and we have answered in terms of triangulation and adaptation to context. We can also ask how knowledge turns into wisdom, and here the views of Aristotle and the Stoic philosophers are germane: "wisdom = production of action which balances the demands of multiple and competing contexts". Wisdom, in present terms, is engagement with complex polymorphic situations, and the e-condition places a particular demand on this facility.

The discipline of computer science, in its early life in the 20th century, also showed a focus on the adequate algorithm: the ideal that a computer system, or artificial intelligence, might implement an elaborate rule which served us well. As the 3rd millennium begins, however, with its semantic web and ambient technology, this foundational ideal has started to convert into a focus on the role which information technology plays in the non-deterministic and polymorphic ecologies of a connected planet. This creates a demand for understanding, an agenda for contemporary philosophy, and a need to follow the same shift in focus. Socrates was right: truth and proof are important. But he is now insufficient: our ecologies are increasingly polymorphic; we need to understand how to make them adaptive to context; and we need to use the resources of philosophy to produce views, articulations and conceptualizations of this challenge. This enterprise cannot be purely analytic: we are presented not with eternal problems and static conditions, but with change and emergence which is ill captured by the established usage of words. It cannot be essentialist: we are presented with polymorphic ecologies which require polymorphic cognition, a negotiation between source and multiple contexts, as described above. And it cannot be avoided if we are to adapt to the conditions of knowledge and learning of our emerging, cyborg state. This state calls for a new relationship between engineering and the humanities: if we are to maintain and create enchantment in the ecologies of the present and the near future, if we are to steer as well as to acknowledge our conditions, then we need to treat the two as being interwoven as never before.

Viktor Bedő

Networks of Knowledge in a Virtual Landscape

Digital technologies have not only enabled us to digitalize knowledge, they have opened up a space for new strategies of handling and processing massed information. The meta-hyperdocument – the internet – is one such phenomenon, perhaps the most pervasive one. Simultaneously with the skyrocketing growth in the size of the internet, we had to face new forms of orientation and searching. The content of the internet creates a cyberspace of documents and of connections between these documents – thus orientation in the virtual space of the Web is also a concern of cartography. The geographical distance between the storage location of documents is of little relevance, while the relationship between the content of the documents is more important, showing itself in links which determine the path of access. Any visualization must be adapted to the topography of cyberspace. Traditional static maps are due to be replaced by the new dynamic visualizations of cyber-geography.

In this paper, I would like to examine the preconditions of a virtual knowledge landscape, which is a visualization of contents and their relationships in cyberspace. The cyberspace of the internet will serve as an example in several ways, though *knowledge landscape* does not necessarily refer to the visualization of the internet; it is, rather, a more general orientation tool and visualization strategy. I have chosen the metaphor of a knowledge landscape to emphasize the role of traditional and intuitive mechanisms of orientation and movement in space – in order to highlight roaming as opposed to browsing.

An examination of the arrangement of knowledge is important for two reasons as far as the knowledge landscape is concerned. The arrangement of knowledge points to the functioning of our orientation in the world on the one hand, and specific mechanisms may serve as a threshold for the programming algorithms necessary for designing visualizations on the other hand.

In the passages below, I will draw upon examples from several scientific disciplines and from philosophy, examples which describe the arrangement of concepts, the structure of the mind, and discursive fields as networks, in order to draw a parallel between these examples, the Internet, and the network behind the knowledge landscape.

The Network of Abstract Concepts

Barsalou[1] examines the network-like interweaved functioning of abstract concepts from the perspective of a cognitive psychologist. Concepts are not isolated records in the brain, rather they are interconnected with other concepts and other information, which also entails that gaining new information through perception modifies the network of concepts. So our concepts, the mental representation of things, are modality-dependent on the one hand and perceptual on the other. Since the activation of neurons during perception can be localized in the brain, cognitive psychology enables us to draw conclusions regarding the spatial arrangement of abstract concepts. This of course does not mean that the exact location of a particular concept in the brain can be defined, though it does mean that we can draw a parallel between the structure of the nervous system, the topology of activation, and relationships of the conceptual network. Barsalou describes the perceptive emergence of conceptual representations, the so-called simulators as follows: When we see an object, feature maps are activated in the proper sensory or motor parts of the brain. During the visual processing of a chair, some neurons fire for edges, vertices and planar surfaces, while others fire for colour, orientation and direction of movement. Feature maps are indeed formed by the pattern of neuron activations. Acoustic, tactile and motor activations work in analogy to visual processes.

[1] L. W. Barsalou, "Abstraction as Dynamic Construal in Perceptual Symbol Systems", in L. Gershkoff-Stowe and D. Rakison (eds.), *Building Object Categories*, Mahwah, NJ: Lawrence Erlbaum Associates, cf. http://userwww.service.emory.edu/~barsalou/Papers/Abstraction/ abstraction_02.pdf.

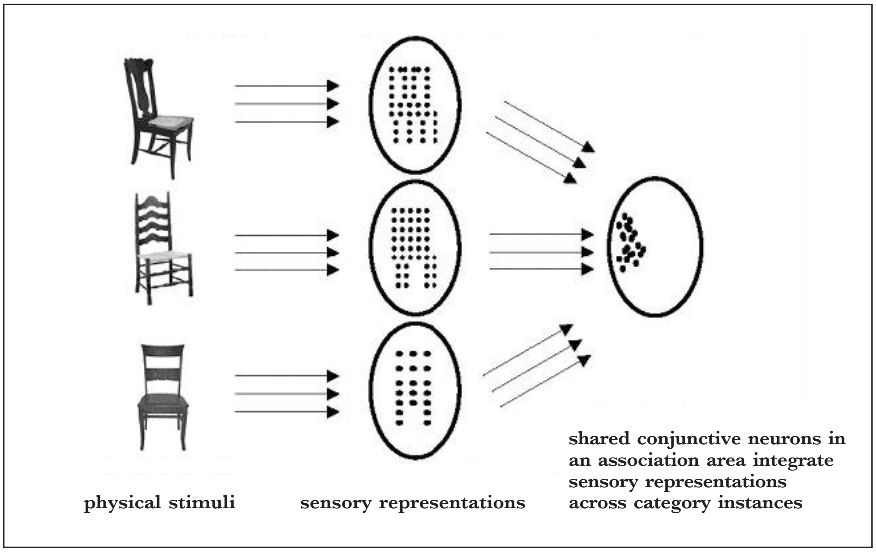

Figure 1: Storage of Multiple Instances in a Simulator

(Source: Barsalou)

Barsalou notes that the topological representation of visual entities in feature maps may be in accord with the visual properties of the perceived entity, though the functioning of the perceptual symbolic system is – because of further processing – independent of this analogy.

If specific patterns are activated in the feature maps, they are captured by conjunctive neurons in the association areas – convergence zones – and are saved for later reenactment. Convergence zones near the visual cortex react to activations of the visual system, but the ones near the motor parts of the brain react to patterns connected with action.

Information stored in different convergence zones establishes the multi-modal representations of our categories. In the case of the category CAR, for example, not only visual, acoustic and olfactory information is integrated, but also somatosensory information, such as driving skill and information regarding how it feels to drive fast on the motorway. The arborescent, modality-dependent systems of concepts are simulators. The simulators discussed above refer to the properties of perceived objects, accordingly they are called property simulators. Barsalou also discusses relation simulators which refer to spatial relations such as "under", "next to" and "above". Relations and properties affect the emergence of abstract concepts in an equal way, meaning that topology plays a decisive role concerning cognition and interpretation as well.

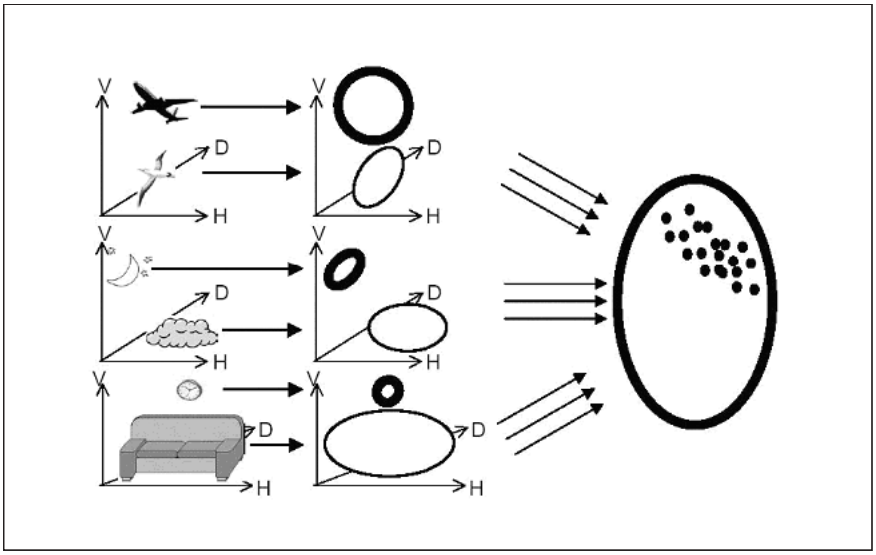

Figure 2: Storage of Multiple Instances in the "above" Simulator
(Source: Barsalou)

The modality-dependence of simulators shows itself during perception, hence they change dynamically while reacting to new information. However, reenactment is also dependent on the situation: different situations reenact different relations. Simulators are therefore not discrete units, they react sensitively on each other and – through perception – on the outer world. The following two positions underpin these two characteristics of the simulator model:

Valery Gray Hardcastle and C. Matthew Stuart[2] suggest a dynamic, non-discrete constellation of brain functions. They criticize cognitive neurologists, who are searching for isolated, physically constant modules, while trying to localize specific brain functions. These researchers know but seem to ignore the fact that every functional change in the central nervous system leads to compensatory changes in another part of the brain, as shown in lesions studies.

Xian Chen underpins perception-dependence when he states: "Perceptual symbols are schematic fragments extracted from perceptual states via selective attention. Which perceptual symbols can be used as attributes in concept representation depends upon what the perceptual

[2] Valerie Gray Hardcastle and C. Matthew Stuart, "What Do Brain Data Really Show?", *Philosophy of Science* vol. 69 no. 3, Supplement (September 2002), p. 73.

states can offer, and we can only select attributes from a list of candidates decided by the perceptual states."[3]

Chen suggests a close connection between concepts and action, with the difference between the two being that some structural aspects of concepts become temporal in the case of action. From Chen I would like to bridge over to Searle's philosophical theory of intentional states.

The Network of Intentional States

Modality-dependence is also applicable to the functioning of Searle's mental or intentional states model. Searle examines how rules given by the brain's structure influence action. He is not the first to deal with the question of the brain's construction and the rule systems based on it. He calls his proposal – discussed in his book *Minds, Brains and Science*[4] – an unfinished experiment. For instance, he refers to Chomsky, who presupposes the existence of an entire and complex system of universal grammar in the brain. A consequence of this grammar would be the existence of rules – based on the brain's general properties – valid for every language. This issue contradicts the assumption of modality-dependence and presupposes isolated modules in the brain. Searle alters Chomsky's assumption by stating that the brain's physiological structure determines the limit of possible grammars.[5] Searle approaches the mind/brain relation in a nominalistic manner: mind is the representation of neurobiological processes in his perspective.

Searle differentiates two levels in his approach to the mind/body question: mind as the macro level and neurobiological processes as the micro level.[6] These two levels are causally connected: their functioning and structure are closely interwoven. Neurobiological processes are represented in the functioning of the mind, and processes in the mind manipulate neurobiological processes. The mind's properties are traced back to the brain's neurobiological constellation and its processes. Thus the mind – as the network of intentional states – is the representation of neurobiological processes.

[3] Xiang Chen, "Perceptual Symbols and Taxonomy Comparison", *Philosophy of Science* vol. 68, no 3. Supplement (September 2001), p. 208.

[4] John R. Searle, *Minds, Brains and Science*, Cambridge, MA: Harvard University Press, 1985.

[5] *Ibid.*, p. 51.

[6] *Ibid.*, p. 20.

[7] Cf. *ibid.*, p. 68.

Searle formulates the functioning of action motivated by intentional states as follows:[7] the exact and unambiguous pattern of an action is not stored in the brain, because an action can be carried out by several kinds of movements, and a specific movement may be the part of different actions. Every intentional state can only be considered in correlation with other intentional states. If a human being wants to perform an action, this effort can be realized only in the context of other, further goals. The fulfilment of an intentional state has special conditions. The successful delivery of an action motivated by intentional states is dependent on whether they can adapt to the physical world.

Having discussed neural and intentional networks, I will now come to Foucault's discourse theory, which formulates the relationship between things on another scale: the level of social interaction.

Discourse

Foucault's discourse theory offers a dynamic spatial constellation of the things surrounding us.[8] Different scientific disciplines deal with the arrangement and relations of things; the discourses of the different scientific disciplines have different underlying discursive rules.

In discourse, statements (énoncés) are dispersed in a continuously changing space – the discursive field. Statements always occur on that spot and in that moment where and when there is an opportunity to link to other elements of the discourse according to the discursive rules.[9] According to the occurrences and the links determined by discursive rules, a specific pattern emerges in the discursive fields. The function of discursive analysis is to disclose and examine these patterns and rules.

The multitude of scientific disciplines produces a multitude of discourses. The question of how the inherent rules of different disciplines are confrontable arises, and whether the difference in the patterns of discursive fields is just a concern of different scales, or whether we can also observe significant topological differences.

General Rules of Networks

Albert-László Barabási draws on different scientific disciplines to delineate the behaviour of complex systems, extrapolating general properties of different networks. The hub (i.e. connector) is one of the phe-

[8] Michel Foucault, *The Archaeology of Knowledge*, London: Tavistock, p. 26.
[9] *Ibid.*, p. 44.

nomena that can be found in several scientific discourses: "Connectors – nodes with an anomalously large number of links – are present in very diverse complex systems, ranging from the economy to the cell. They are a fundamental property of most networks, a fact that intrigues scientists from disciplines as disparate as biology, computer science and ecology."[10]

Another general property which seems to be valid for all non-random networks is scale-freeness.[11] The internet, social networks, and neuronal networks, for example, are considered to be non-random. In a scale-free network there is no typical distribution of the number of links and nodes. Some nodes (hubs) have a vast number of links, whereby the overwhelming majority of nodes are only connected by a few links to other nodes. The internet is a good example of a system where the density of interconnections is much less dependent on the average number of links connecting all the nodes, but dependent rather on how many hubs are included in the network. Hubs are a kind of black hole, in light of their ability to attract more and more links. The number of links per node is not distributed linearly in a scale-free network; very few nodes have very many links, and very many nodes have relatively few links.

Global properties like this, inherent in different scientific disciplines, could serve as tendencies or pivots in the visualization of knowledge in a virtual space.

Scale

Adding Foucault's discourse theory – which represents the social level – to Searle's view on relation of the micro and macro levels concerning neuronal network and mind, we find the following chain: discourse is to mind what mind is to the neural network. In this chain we are confronted with three scientific disciplines – neurobiology, philosophy, and sociology – which are built upon each other. The system powering each discourse effects the functioning of the two other systems and it is the scale that changes.

Hence passage through different discursive fields entails a change of scale and vice versa. To examine an individual from a sociological perspective, we have to take a step backwards. From a suitable distance, the social field becomes visible, containing the examined individual along

[10] Albert-László Barabási, *Linked: The New Science of Networks*, Cambridge, MA: Perseus, 2002, p. 56.

[11] *Ibid.*, p. 70.

with other individuals and their connections. And if we want to examine the individual from a neurobiological perspective, we have to step much closer, so close that the network of cells becomes visible. This is exactly the path covered by Humberto R. Maturana and Francisco J. Valera – starting at the molecular scale and moving to the scale of societies – when they base the question of the human mind on biological grounds in their book *El arbol del conocimiento*.[12] Scales were defined by the two Chilean neurobiologists as orders – the order of cells, the order of human body and the order of social networks. But orders are discrete units in the system of Maturana and Valera. The influence between two cells, for example, turns out to be perturbation, encounter in a non-disruptive sense. Thereby a relationship between the levels of orders as between Searle`s micro and macro-level is out of the question. A change in the order level is also a change in kind, according to Maturana and Valera. Thus at the human level the ability of observation arises, and one level higher, on the social level, language emerges as the observation of the observation. Due to these qualitative changes, the concept of autopoesis and the ability of reflection emerges. The arrangement of things takes place at the level of language, entailing in this case that changes in the physical world cause changes at the level of language (level of thinking), but the quality of the stimulus does not influence the quality of the change in thinking at all.

Virtual Landscape of Internet Documents?

Using the example of an imagined intelligent internet search engine, I would like to show how internet documents can be arranged in a virtual knowledge landscape. The label *intelligent* here does not refer to artificial intelligence. After all, the search engine does not have consciousness. At best it has a weak artificial intelligence, and it is no more than a tool. In this sense the mental capacities of all users are behind the intelligence of the search engine. The intelligent performance of all users can be considered as the micro-level, and the search engine can be considered as the macro-level.

A conventional search engine looks in the documents indexed by the system for the keywords entered by the user. After finding the appropriate documents, the search engine lists them according to specific priority rules. A very simple rule would be a ranking according the number of

[12] Humberto R. Maturana and Francisco J. Varela, *The Tree of Knowledge: The Biological Roots of Human Understanding*, Boston: Shambhala, 1992.

keywords included in the text of the found document. Google, for example, uses, besides text-matching techniques, a page-ranking system that takes the number of connected links into account while defining the relevance of a document. But these methods do not show the relationship between the listed documents and other documents; even a perfectly ranked list is unable to give an overview of the topic(s) of the documents in question.

The search engine has to come up with more sophisticated techniques for being able to show the relationships between documents. The rules we gain by analyzing the complex systems mentioned above can be the starting points for creating the tools for analyzing the relationships between documents and the possibilities of connections. Converted into proper algorithms, these rules can be integrated into the search engine.

After translating the relationship between documents – the intensities of connections – into spatial units, we can create a multidimensional virtual space that includes not only documents, but through the use of spatial arrangement their relationships as well. The user – while moving in this space – can not only reach documents that are connected with the initial document through a direct link, but can see other – maybe very relevant – documents in the space next to the initial document, which he may ordinarily only reach through two or more links form the hyperdocument. Consequently the search path is quicker and more transparent. The structure of the virtual space is opened up through the visualized topology of the network's elements.

This kind of document arrangement is just a programming foundation whereby a search engine can turn into a real – dynamic and modality-dependent – discourse engine.

The discourse engine, and thus the knowledge landscape, must be dynamic and modality-dependent if it is to be able to react to new documents and to documents already included by the system at the same time. The first condition is fulfilled if the engine puts new documents into the system, and places them into the landscape according to the algorithms mentioned above. The second condition can be fulfilled as follows: if the system is capable of tracing the common paths (common sense) covered by the users, it can consider these paths when calculating the distances to be visualized. The paths used more often become shorter, the documents on such paths come closer to each other. Paths that are used less often become longer, hence according to the user's behaviour they are needed less, and the documents on these paths drift away from each other. The visualized space of documents is dynamically changing, and through the knowledge and behaviour of all users it becomes a knowledge landscape that shows the relationships between documents – knowledge fragments – by using distances. A discourse map evolves.

All users of the system share the authorship of that dynamic map, because they define the distances on the map with their movement. Users create a landscape that is a visualization of the relationships in the network, and the arrangement of knowledge is realized in a communicational space.

The discourse engine described above and the landscape showing its content were applied to the content of the internet. But the strategy of the knowledge landscape is capable of visualizing different kinds of content. The crucial point is the manifestation of things and relationships between things through topology.

I am interested in how the topology of this knowledge landscape reveals anthropomorphic topologies which we know from the neuronal networks structure, or on a different scale, in the case of social networks.

Roaming

Another mark of the knowledge landscape is the effect of intuitive orientation. The perception of the knowledge visualized in the knowledge landscape is primarily visual. There is no predefined roaming path in the landscape that precisely specifies the sequence of documents to visit.

A. Paivio's psychological research underpins the advantages of the visualization of complex relational systems: 1) the visual perception of human beings proceeds synchronously, and therefore there is no predefined order for perceiving picture elements, 2) the processing of visual information is faster than that of verbal information. Nevertheless, we have to consider the mechanisms of Barsalou's relation simulators, which drag the spatial arrangement into the process of understanding. Accordingly, visualization makes complex relational systems easier to overview. Documents in the knowledge landscape appear as signs, they can be opened after being selected. Users who are roaming in the landscape first orientate themselves visually, and after opening a document a user can read, watch, or listen.

The linearity of reading would appear in the knowledge landscape as follows: documents must be read in a predetermined order and are arranged on a straight axis – the user can move forwards or backwards. This is nothing more than a special and limited spatial construction in the knowledge landscape. Akin to movement without moving, it can be achieved by standing in one spot using a magnifying lens or telescope.

In this case there is only a directed perspective, the landscape is static and only the scale of zooming changes.

On the other hand, with roaming, the landscape's topology changes continuously with the movement of the user, which also changes the perspective. Everything emerging on the horizon or appearing in the user's field of vision changes the relational system of the things seen in the landscape, and with that the topology of these things. The knowledge landscape is constantly reacting to the position and the perspective of the user.

Moving freely in any direction, not only on one axis, causes a dynamic and modality-dependent arrangement of things in space. In this space, not only is perspective playing a decisive role, scale does also. If the observers step back while maintaining their line of sight, things on the landscape become smaller, but many more objects become visible in the same field of vision. Instead of seeing some documents, the observer overviews a whole topic, the arrangement of which is in accord with the discursive field's topology of the topic.

Conclusion

The virtual knowledge landscape is a though experiment, but one that is nonetheless constructible.

Arranging things, topics, documents and their relationships in space through visualization can bring about new perspectives and reveal new relationships. From specific perspectives, the continuously changing landscape can show the connections of different fields, which one could ordinarily only discover after lengthy browsing in the hypertext environment. A denser interweaving of networks can cause fuzziness at different disciplines' borders, in such a way that separately-handled discourses transform into hub-like centres in virtual space. This landscape is appropriate for carrying out discursive analysis, but it is also well-suited to a simple search engine.

Pithamber R. Polsani

Network Learning

The ubiquity of information technology is profoundly altering the social formations that arose in the wake of the industrial revolution. These changes are result of 1) emergence of communication and computing technologies and 2) transformation of industrial appliances into information systems. These reconfigurations in the machines and societies – some visible and many invisible – are giving rise to a new Network Society whose key force of production is the information and the computer networks the means. For the first time in the history of human development the means of production and the forces of production are becoming one entity. Consequently, the network is emerging as the architecture for conducting business transactions, social interactions and individual communications. Education too is being displaced from its traditional confines of institutions to a generalized form of learning that can take place anytime and anyplace. In this regard, E-learning and M-learning have become the preferred means of characterizing digital mode of education wherein the information technologies play a decisive role. However, I believe that the terms E-learning and M-learning are too restrictive to adequately characterize the new forms of learning because they refer either to the delivery format of content (electronic) or the access devices (PDA). Because of "delivery-device" framework, E-learning and M-learning came to be thought as instances of traditional distance learning. This thinking has given rise to content and pedagogy for E-learning that is still informed by the traditional teacher–student paradigm. A more appropriate way to define the emerging educational process would be Network Learning or N-learning since both, E-learning as well as M-learning, are located in the global network of computers.

Network Learning can be defined as a form of education whose site of production, circulation and consumption is the network.

In this paper, my purpose is to offer theoretical formulations and practical mechanisms of Network Learning that mirror the flexible, adaptable and scalable conditions of the network. Furthermore, I will argue that knowledge (the content of learning) has undergone a conceptual change in the last fifty years resulting in performatively judged "knowledge-events" whose fundamental character is Flow. My argument here will focus on three critical issues pertinent to the topic under consideration: 1) Network Society, an emergent global social formation; 2) Performative Knowledge, the contemporary conditions of knowledge, and 3) Learning Objects, an efficient and flexible form of structuring content for N-Learning. As my argument progresses I will lay out a grid with four layers: Form, Condition, Criteria and Space. The grid will unfold in three stages and at each stage I will summarize the key elements of three critical issues and arrange them into the four layers of the grid. The objective of this exercise is 1) to demonstrate the affinity between the conditions of Network Society, Performative Knowledge and Learning Objects and 2) argue for the need to think about the structure and operation of N-learning in a radically new way.

Network Society

A commonly held misconception about computers and the internet is that they are tools. As a result of this general view about information technology it is positioned on the same level as other tools of instruction, such as overhead projectors, audio recorders, VCRs etc. A tool is an instrument or a vehicle for facilitating an action, which without the tool would require considerable effort and energy. Globally networked computers, on the other hand, have created a new space: the Information Sphere. Learning, knowledge explorations or skill acquisitions are actions performed with the help of intelligent software tools in the Information Sphere. Although I use the term "tool" to characterize software, it is unlike other instruments, which produce or facilitate actions other then the material they are made of. More adequate categorization would be to call software a collection of symbolic arguments. Unlike traditional tools, the symbolic assemblages (software) are applied to production of other symbolic groupings. Therefore, the knowledge production in the Information Sphere is the application of knowledge for further knowledge. Since this space – the site of production, circulation and consumption – is unique and radically new, the learning and knowledge actions cannot be identical or similar to the actions performed in the physical space. On the contrary, we have to create new notions of knowledge and learning.

The information sphere brought about by the information and communication technologies is emerging as a vital component of society, transforming it rapidly into a global Network Society wherein knowledge becomes the critical productive force. The final configuration of the Network Society is still unknown to us, but certain trajectories have been opened by information technology, and it is along these paths that society is traversing, opening lines of thought for us.

The globally connected network of computers is fast becoming the nervous system of an emerging social formation. The network increasingly mediates business transactions, social interactions, political organization, private pleasures and public entertainments. The architectonics of this network is rhizomic. Like the rhizome, the networked system of computers is a non-hierarchical space. In this space, each point is connected to the other with a multiplicity of connections; the connections have precedence over the points they connect. Because of this multiplicity of relations, the rhizomic network is indestructible. If a point ruptures, instead of collapsing or affecting the whole network, it will continue through other connections. Cartographically laid out, the network has many entry points and, like a map, can be read from any point or entered from any location. The unconstrained flexibility, unlimited scalability and the surfacely density gives the rhizomic network its attraction, enduring power and its capacity to diffuse into every aspect of human activity altering its very nature. Education as an important component for the well-being and growth of societies is permanently drawn into it. Therefore, educators have to urgently rethink questions such as, what is education? How is it produced? And, how is it transmitted? Because the very foundation of N-learning is a nonhierarchical and decentered rhizome, the content development, instructional design, and mechanisms of assessment have to be thought anew.

Historically the social space was linked to geographical space organized as territories-regions, nations and continents. The power and gender relations that brought in social, sexual and economic differentiations determined the internal order of these territorial spaces. The Network Society transcends national and regional boundaries deterritorialising them and reterritorialising them into Localities and Globalities. The major cause of this transformation is the penetration of the Information Sphere into all dimensions of life. The information space is a temporalized space, wherein the moments in time, measured as Global Real-Time, create differentiated time-bound spaces. Since the network erases the differentiation between here and there, institutions are being transformed from vertically integrated, spatially located, hierarchically organized structures into horizontally dispersed, independent modular units. The very culture and identity of individuals is being transformed from one that is linguistically and territorial constructed to one that is loosely defined by Localities and Globalities.

The lifeblood of rhizomic network is information. As the information space is a temporalized space whose basic state is motion, information is in constant flow. Continuously added, enhanced, transformed, exchanged and altered, information ceases to be a product to be consumed, instead it is characterized by the fluidity of Flows that are constantly circulated. The nodes of the network are the access points for information flows, and the access point is where information space is revealed in the interface. The Interface Space is the arena of performative actions of individuals and information alike. This Interspace comes into existence only for the duration the node is activated.

	Form	Condition	Criteria	Space
Network	A rhizome. Distributed as nodes and multiple connections.	Movement of information bits. Revealed in the interface and the interspace.	Efficiency: measured as shortest duration in time.	Global. Distributed and dispersed horizontally. Configuration changes depending on the number of nodes activated and bits of information exchanged.

Table 1. First Stage of the Grid

Performative Knowledge

Before the advent of the post-industrial age in the 1960s, Enlightenment and post-Enlightenment ideas determined the purpose and use of knowledge. The European Enlightenment defined the human being as a subject whose destiny is the realization of its full potentialities through reason. The goal of acquiring learning was the realization of spirit, life, and emancipation of humanity and the purpose of production of knowledge was the moral and spiritual guidance of a nation. Owing to this conceptualization of knowledge, universities were not expected to be responsive to society's needs. However, in the contemporary conceptualization of knowledge, its purpose is no longer to realize spirit or emancipate humanity but *to add value to human abilities expressed as labor*. Since learning has value, its valuation is determined by its utility and exchange. Thus, *the criterion for judging knowledge is its performance.*

The legitimacy of performative knowledge is no longer granted by the grand narratives of emancipation, but by the market. The market should be understood as a grouping of various forces such as public policy, industrial complexes, the financial sector, technology, business modeling, and so on. The character of the market at any given time is determined by the configuration of dominant forces that participate in it. The market, unlike the narratives of emancipation and speculative spirit, which are valid for long durations, is in a constant flux shifting rapidly from one configuration to the other. As a result, the knowledge requirements imposed by the market are also altering expeditiously. The only thing that is constant with the market is change. *Therefore, education should be redefined as preparedness for change, and the knowledge acquired through education, performative.*

The performative criterion has transformed *the knowledge space* into a flexible, adaptable and scalable experience. Removed from its traditional confines, knowledge is shaped under varied circumstances and situations. Situational knowledge is produced as modular "knowledge events" that come together from various contexts to form "knowledge programs" according to performatively determined programmatic objectives. Conversely, the knowledge event's ability to adapt to diverse situations determines its performative abilities, either enhancing or decreasing it.

The knowledge events arise in different contexts, in a chemistry laboratory under controlled experiment conditions, through the exchange of experiences between sales persons in a company or by aggregation of study tactics devised by a group of students. What is important under present social circumstances is that knowledge production has been expanding horizontally moving away from vertically integrated scholars and scholarship structure.

The knowledge programs are diverse knowledge events sequenced with programmatic objectives. The programmatic relations between events are determined by the performative criteria. The knowledge events that constitute the knowledge programs can be broken up into its constitutive elements and analyzed independently, on the other hand same knowledge events can be integrated into other knowledge programs. In this regard *the knowledge economy or the information society is not a stable structure with definitive functions, but a flexible condition where diverse programs can be developed using fragments of knowledge from different fields.* For example Keith Smith in his paper on knowledge economy identifies 32 knowledge and technological fields that are incorporated into fishing and fish farming industry, which is normally considered low technology industry. These fields include

> ...new materials and design concepts in ships, satellite communications, global positioning systems, safety systems, sonar technologies (linked to

> winch, trawl, and ship management systems), optical technologies for sorting fish, computer systems for real-time monitoring and weighing of catches. ... pond technologies (based on advanced materials and incorporating complex design knowledge), computer imaging and pattern recognition technologies for monitoring (including 3D measurements systems), nutrition technologies (often based on bio-technology and genetic research), sonars, robotics (in feeding systems), and so on.[1]

It is clearly evident from this example that constituent knowledge events of fishing and fish farming knowledge program are independent of each other, brought together through the performative criterion and they can be incorporated into other programs such as entertainment (3D imaging), travel (global positioning systems) networking (optical technologies) etc.

	Form	**Condition**	**Criteria**	**Space**
Network	A rhizome. Distributed as nodes and multiple connections.	Movement of information bits. Revealed in the interface and the interspace.	Efficiency: measured as shortest duration in time.	Global. Distributed and dispersed horizontally. Configuration changes depending on the number of nodes activated and bits of information exchanged.
Knowledge	Situational: Knowledge Events that arise in different contexts without an overarching direction of a metanarrative. Horizontally dispersed.	Flows: Knowledge Programs. Constituted by events that arise in diverse disciplines and contexts. They can be broken up into elements and analyzed independently of each other.	Performative: ability to adapt to diverse situations beyond the context of it initial production.	Flexible, adaptable and scalable. Conditioned by Flows, the topology changes with the intensity of flows and the performative capabilities.

Table 2. Second Stage of the Grid

[1] Keith Smith, *What is the "Knowledge Economy"? Knowledge Intensity and Distributed Knowledge Bases* (2002). Discussion Papers Series. Maastricht: UN University – INTECH, p. 20.

Learning Objects

As the market requirements of learning are changing constantly, performative knowledge cannot be transmitted en block; instead, it should be arranged into up-to-date knowledge banks that can be accessed by individual learners. The traditional educational system, which is established in a geographical space with physical assets and which relies on the transportation of its participants, will not be able to live up to these new tasks. N-learning that is driven by information and communication technologies, which are inherently flexible and effective, is the appropriate form of knowledge production and circulation for the new reality of the market.

The architecture of N-learning should be conceptualized with two guiding principles: modularity and the linkage system. The fundamental requirement for modular architecture and the linkage system is the separation of content from the instructional use of the content. The content should be created as discreet, self-standing modules that are predisposed for reuse in multiple contexts.[2] In this regard, we should borrow the notion of object and its structure from object oriented programming and adapt it creatively to the educational content. With the modular approach, we can bring greater efficiency into content development. The ideational value of the content should be well thought-out to adequately fulfill the requirements of performative knowledge, especially rapid adaptability to the changing configurations of market.

Content developers traditionally have conceived content from the point of view of its use. Since use is context and instruction specific, content intended for one particular use is generally invalid for other purposes. The Learning Object – organized content for pedagogical purpose – is a new way of thinking about content creation and its instructional use. However the success of this strategy rests on the rigorous separation of the Learning Object and its use for instructional purposes. Although sound pedagogical principles should inform the creation of a Learning Object, it should not be coded by any specific teaching methodology or instructional theory. A genuine reusability and optimum functionality of a Learning Object can be achieved only when the Learning Object attains a high level of abstraction. Abstraction provides the

[2] The Virtual Adaptive Learning Architecture being developed at Faculty Center for Instructional Innovation, University of Arizona, has taken this approach for creating content. The team is implementing a modular architecture and linkage system known as Learning Objects and Reusable Instructional Objects developed by this author.

Learning Object independence from use and strong performative ability, enabling it to join other Learning Objects for instructional intentions.

Viennese philosopher Ludwig Wittgenstein's idea about meaning of words and language-games can help us clarify the separation between the abstract Learning Object and its concrete use I am insisting on. According to Wittgenstein in *Philosophical Investigations*,[3] meaning of a word in a language is neither inherent to it nor is it derived from an object it stands for. Instead, the word becomes meaningful in its rule-governed use in a language. Varied uses of words and sentences are called language-games. Like games, language too is a rule bound activity. The rules of a game as well as language do not decide what move/usage will provide success, but instead what is permissible and what is correct. As a position has significance only in a game it belongs to, a word acquires its meaning only when used in a particular language-game according to the rules. Therefore a preposition is a move or a function in a language-game and it is meaningless without the whole system that supports it. The utterances in a language-game, like moves in a game, unfold as the game progresses and depends on the position of other players.

The Learning Object should be thought as a word or preposition and the usages of Learning Objects as language-games. Like a word, a Learning Object is abstract, but can be understood and shared among the users. Similarly, as individual words independently cannot produce meaning, the Learning Objects – self-standing and self-referential – in themselves are insufficient to generate significant instruction. Therefore, several learning objects have to be brought together in order to create an instructional situation. How many Learning Objects, how they are related, and for what purposes will be determined by the instructor's objectives, pedagogical methodology and instructional design theories. However, I would like to underscore the point once again that the efficacy of a Learning Object and its status as organized and sharable content depends on the degree of abstraction achieved through separation of content and its intended use.

Creating Learning Objects that conform to the conceptual definition advanced here requires that the structure of the Learning Object reflect the two basic foundational principles, Learning Intent and Reusability. This can be achieved by determining the granularity or the size of a Learning Object and its composition.

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[3] Ludwig Wittgenstein, *Philosophical Investigations*, transl by G.E.M. Anscombe, Oxford: Basil Blackwell, 1953.

	Form	Condition	Criteria	Space
Network	A rhizome. Distributed as nodes and multiple connections.	Movement of information bits. Revealed in the interface and the interspace.	Efficiency: measured as shortest duration in time.	Global. Distributed and dispersed horizontally. Configuration changes depending on the number of nodes activated and bits of information exchanged.
Knowledge	Situational: Knowledge Events that arise in different contexts without an overarching direction of a metanarrative. Horizontally dispersed.	Global. Distributed and dispersed horizontally. Configuration changes depending on the number of nodes activated and bits of information exchanged.	Performative: ability to adapt to diverse situations beyond the context of it initial production.	Flexible, adaptable and scalable. Conditioned by Flows, the topology changes with the intensity of flows and the performative capabilities.
Learning Object	Based on the principles of Learning and Reusability. A combination of elements, lend themselves for reuse in different instructional situations.	A sequenced set of Learning Object events. Can be arranged according to methodological or pedagogical considerations or be left to user choice	Reusability: Learning Object once created should be employable in diverse contexts. Intelligence to combine for instructional purposes.	A dynamic and highly interactive learning ecology that transforms and adapts to events and programs, and the exploration of knowledge by the learners.

Table 3. Third Stage of the Grid

Conclusion

Network Learning can emerge as the most adequate form of knowledge production, circulation and consumption for the Network Society provided that we establish it as an independent field by opening up its own space of operation, developing a coherent methodology and logical procedures for creating and delivering knowledge objects. As I have argued, the information sphere located in the global rhizomic network is the open space for N-Learning. The very structure, operation and methodological procedures, instead of being rigid hierarchical structures of traditional disciplines, should reflect the very topology of the network.

The Learning Objects are the most meaningful and effective way of creating content for N-learning. Unfortunately, the current definitions and practices of Learning Objects are confusing and arbitrary. As a result it is difficult to employ learning objects in a meaningful way. Therefore, a commonly accepted, accurate and functionally effective definition is necessary. The first step in this direction, as I have articulated in this paper, is to establish a concept of the Learning Object that clearly lays out the principle basis on which it is founded. Similarly, there is a need to re-engineer the design and development process of Learning Objects. In this regard the developers – programmers, academics, graphic designers, and multimedia experts – should embrace a multidisciplinary and cooperative model of development to create knowledge that is appropriate for the emergent Network Society.

The Learning Objects are only mechanism for structuring content, but they in themselves would not constitute learning environments. The N-learning environments include various objects that facilitate communications, interaction, mobility, creativity and engagements. In order to produce such knowledge ecologies we should think beyond web pages.

The web page has become synonymous with the web. The notion of a web page is a direct transposition of a printed page from a book or magazine to the digital format. Textual content drove the early iterations of HTML, the markup language for creating web pages. Although the current standardized versions of HTML incorporate various dynamic functions and external elements such as JavaScript, Flash animation, Shockwave, etc., the web page continues to be embedded in the framework of a printed page. Additionally the HTML merges the content and style in its representation resulting in a paradigm of "one fits all". Since the web is considered as an information source presented as pages, "search", "retrieve", "navigate" have become the major indexes of interaction with the information. The web page framework is extremely constraining for creating highly interactive and vibrant environments for knowledge exploration.

Learning is an active process of human agency, wherein the learner and information engage in an exploration through interaction resulting in an experience of knowledge and training. However, the learning agent cannot be left to his/her own devices or motivations. Even in the traditional instructional situations signing up for a course is not a sufficient condition for learning to actually unfold. A successful teacher initiates the learners in a path of exploration through various methods, that is, the instructor activates the agency in the learner. In N-learning the instructor is opaque, intervening indirectly through feedback via e-mail, bulletin boards etc. Therefore, the responsibility for activating the learning agency falls upon the environments themselves. In this regard the design becomes crucial because it becomes the agent that invites and provokes the learner into action, and the environment is an intelligent space that reacts, changes and adapts to the users as they progress through the learning ecology. This agency-endowed environment should have the capability to adapt, and engender a performative relation between the user and information, resulting in a transformation in the learner. We have to create active *agent-provocateur* learning environments, which instead of being simple objects of contemplation lying before the gaze of the viewer invite the viewer to think and act.

Marcelo Milrad

Mobile Learning: Challenges, Perspectives and Reality

Introduction

The use of information and communication technologies in education and training has undergone several paradigm shifts over the last three decades.[1] Very recently the notions of *e-learning* (learning supported by digital "electronic" tools and media) and *m-learning* (e-learning using mobile devices and wireless transmission) have emerged. Handheld devices are about to become one of the most promising technologies for supporting learning and particularly collaborative learning scenarios. These technologies give the possibility to move away from the stand-alone computer, thus allowing interaction with several devices and making information accessible through a wireless connection to a server. These technologies offer new opportunities for individuals who require mobile computer solutions that other devices cannot provide. Thus, many researchers as well as academic and industrial practitioners are currently exploring the potential of mobile and wireless devices for supporting learning. The challenges are manifold: adapting and appropriating the technology for learning in a way consistent with learning goals and principles, setting up and testing of prototypical applications and scenarios, developing specific software tools and architectures, among others.

As we move into the knowledge society, new interactive technologies provide us with both a challenge and an opportunity. The challenge is to find out how to construct and deploy highly supportive environments, which could be used to provide support for different kind of learning settings. The opportunity is to radically change the ways in which we aid the learning process in order to give students a much higher degree of individual support, and a much more flexible approach to the man-

[1] J. D. Bransford, A. L. Brown and R. R. Cocking (eds.), *How People Learn: Brain, Mind, Experience, and School*, Washington, D.C.: National Academy Press, (1999).

agement of their learning experiences. Bliss et al.[2] argue that the use of these new types of tools and interactive technologies makes possible to develop novel kinds of learning interactions within and across a variety of learning settings. However, it is not so clear how some of the more traditional sites of learning adapt to these changes.

The idea that new technologies will transform learning practices has not yet led to the collaborative ideal. The task of designing effective computer support along with appropriate pedagogy and social practices is simply much more complex than imagined.[3] According to Norris et al.[4] one of the main reasons that the potential of technology has not been realized in primary and secondary classrooms is due to insufficient computer and internet access. They suggest that the introduction of PDAs with wireless capabilities in educational settings may help to overcome this problem.

In the next sections, I will make an attempt to provide a broad perspective with regard to the field of mobile learning by integrating some key ideas from disciplines such as educational research, social science and engineering. My claim is that we need to develop a broad framework, which integrates all these views in order to discuss and to understand the impact of mobile and wireless technologies in education and their implications for the future of learning.

Current Pedagogical Approaches to Learning with Interactive Technologies

Current and emerging trends in education are increasingly moving towards learner-centred approaches.[5] In these, learning becomes an active process of discovery and participation based on self-motivation rather than on more passive acquaintance of facts and rules. The role of the teacher is coming more to be seen as mentor or guide, facilitating and playing an essential role in this process. From this perspective, learning can be considered as a dynamic process in which the learner actively "constructs" new knowledge as he or she is engaged and immersed in a learn-

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[2] J. Bliss, R. Säljö and P. Light (eds.), *Learning Sites: Social and Technological Resources for Learning*, Oxford: Pergamon/Elsevier, 1999.

[3] G. Stahl, "Contributions to a Theoretical Framework for CSCL", *Proceedings of CSCL 2002*, Boulder, CO: 2002.

[4] C. Norris, E. Soloway and T. Sullivan, "Examining 25 Years of Technology in Education", *Communications of the ACM*, vol. 45, no. 8 (2002), pp. 15–18.

[5] Bransford et al., *op. cit.*

ing activity. Furthermore, learners will also build understandings through the collaborative construction of an artifact or shareable product. The theory of constructivism is at the core of the movement to shift the center of instruction away from delivery in order to allow the learner to actively direct and choose a personal learning path.

An increasing amount of research has been documenting how new constructivist models may be used to reconceptualize curricula, teaching practices, and learning activities, and to effect significant and rich types of learning gains.[6] Many new constructivist models of learning utilize the affordances of new computational and communications technologies as part of learning environments in which learners engage in challenging problems, collaboration and creation of shared interaction.[7]

Social constructivism, an extension of the constructivist approach, argues that in addition to most knowledge being an interpretation of personal experiences it is also social in nature: knowledge is jointly constructed in interaction. Recent social constructivist perspectives[8] regard learning as enculturation, the process by which learners become collaborative meaning-makers among a group defined by common practices, language, use of tools, values, beliefs, and so on. Social constructivism asserts that a particularly effective way for knowledge-building communities to form and grow is through collaborative activities that involve not just the exchange of information, but the design and construction of meaningful artifacts.

There has also been a growing body of research on authentic and situated learning environments utilizing the problem-based approach to learning.[9] Problem-based learning (PBL) emphasizes solving authentic problems in authentic contexts. It is an approach where students are given a problem, replete with all the complexities typically found in real world situations, and work collaboratively to develop a solution. Problem-based learning provides students an opportunity to develop skills in problem definition and problem solving, to reflect on their own learning,

[6] Cognition and Technology Group at Vanderbilt, *The Jasper Project: Lessons in Curriculum, Instruction, Assessment, and Professional Development,* Mahwah, NJ: Lawrence Erlbaum Associates, 1997.

[7] P. Dillenbourg (ed.), *Collaborative Learning: Cognitive and Computational Approaches*, Oxford: Pergamon, 1999.

[8] D. Jonassen and S. Land, *Theoretical Foundations of Learning Environments,* Mahwah, NJ: Lawrence Erlbaum Associates, 2000.

[9] H. S. Barrows, *How to Design a Problem-Based Curriculum for the Preclinical Years,* New York: Springer-Verlag, 1985.

and develop a deep understanding of the content domain. This approach was developed in the fifties for medical education, and has since been used in various subject areas such as business, law, education, architecture and engineering. Most recently, there is a growing interest among educators to use problem-based learning in the K-12 setting, and a growing need for problem-based educational software to facilitate the development of higher order thinking skills via technology.

An underlying assumption of all these approaches is that most effective and meaningful uses of interactive technologies to support learning will not take place if technologies are used in traditional ways. According to Jonassen et al.,[10] meaningful learning will take place when these technologies allow learners to be engaged in the following activities:

- Knowledge construction
- Conversation
- Articulation
- Collaboration
- Authenticity
- Reflection

Wireless and Mobile Technologies in Education

In the past decade, the internet has spawned many innovations and services that stem from its interactive character. There are numerous indications that the ongoing process of adding mobility to interactivity will transform the role of the internet and pave the way for yet another set of innovations and services. The convergence of computing and communication is a process that is about to turn phones and mobile terminals into powerful multimedia units. The XML-based Synchronized Multimedia Integration Language (SMIL), for instance, is devised for the distribution of sophisticated multimedia content in a variety of devices, ranging from stand-alone computers to cellular phones.

Thanks to the convergence of telecommunications and data communication, future computer applications will rely on seamless wireless networking, and will thus be inherently mobile. This latest trend is now observable and a clear example is the convergence between two technologies that had developed separately during most of the nineties: wireless communication devices (pagers, mobile phones) and handheld de-

[10] D. Jonassen, K. Peck and B. Wilson, *Learning with Technology: A Constructivist Perspective*, Upper Saddle River, NJ: Prentice Hall, 1999.

vices (personal digital assistants, PDAs). Recently, a number of mobile phones and other wireless devices with PDA capabilities have been introduced; conversely, more and more handheld devices now come equipped with wireless capabilities.

Tablet PC is one of the major latest initiatives of computer's manufacturers. Task-specific tablet computers have existed before, but now a number of software developer houses are providing software-development kits (SDK) with general functionality for pen-based applications. It is possible to imagine that tablet PCs will replace laptop devices in the near future because of more natural interfaces and a more desirable form factor. The Tablet PC shares many qualities of the handheld and differs from it in its increased computational power, the larger and higher resolution display/touch surface.

All these new forms of interactive multimedia and communication offer new possibilities as to the way we learn, think, and communicate. The combination of handheld computing and wireless communication suggests enormous potential for education, especially given how familiar most young students already are with these technologies. However, and in spite of the widespread acceptance of the technology among teenagers and young people, mobile and wireless technologies represent a low percentage of those technologies used in the classrooms during lectures/ /educational activities. These devices are seldom used and in many cases their use in the classroom is forbidden.

To date most educational applications have been connected to the desktop, as they have relied on the processing power of that form factor. As we move these applications from the desktop to more ubiquitous and increasingly powerful portable devices, we could simply port existing tools to new emerging platforms. This change in form factor alone would provide advantages in price and accessibility to students. But the move from the desktop to the handheld computer provides other potential advantages, which make this an especially attractive platform for supporting learning. Klopfer et al.[11] have enumerated a number of features that make handhelds interesting for education. Those features, which are consistent with the pedagogical ideas presented in the previous section, are described below:

Portability: One can take the computer to different sites and move

[11] E. Klopfer, K. Squire and H. Jenkins, "Environmental Detectives: PDAs as a Window into a Virtual Simulated World", in M. Milrad, U. Hoppe, and Kinshuk (eds.), *Wireless and Mobile Technologies in Education*, Los Alamitos, CA: IEEE Computer Society, 2002, pp. 95–98.

around within a site. Mobile and wireless applications enable ubiquitous learning. The bounds of the classroom can now be extended to the limits of wireless networks.

Social interactivity: As mobile and wireless technologies enable peer-to-peer communication, students will have a way to interact directly with one another. Students can exchange data and collaborate with other people face to face.

Individuality: Can provide unique scaffolding that is customized to the individual's path of investigation.

Context sensitivity: Digital systems provide the ability to automatically log and aggregate usage, which can be used to design collaborative filtering systems, predictive user interfaces, etc. in the design of mobile applications.

Connectivity: Can connect handhelds to data collection devices, other handhelds, and to a common network that creates a true-shared environment

Merging digital and physical realms: In stationary settings, the digital and physical worlds are more or less separated (users "look into" and manipulate the digital world on the computer screen). In contrast, in mobile systems these realms may be combined. Sensors, smart rooms and ambient environments capture real-world information of users and devices and represent it in a format that is usable in the digital realm. Geographical information systems (GIS) are building on these and other properties to create many other new and innovative applications.

Educational Application of Mobile Devices

One of the major challenges for educational technologists and researchers is to find useful ways to implement and evaluate emergent technologies and innovative pedagogical ideas in educational settings. Gay et al.[12] have defined the term "mobility hierarchy" that refers to four different kinds of objectives motivating the use of educational application of mobile devices. These four categories range from the simple applications providing tools to achieve the objectives of "productivity" (calendars, contacts, schedule, etc.), as they call it level 1, to the most complex applications, which provide tools to achieve multiple objectives called "communication & collaboration" or level 4. An application at

[12] R. Gay, R. Rieger and T. Bennington, "Using Mobile Computing to Enhance Field Study", in Koschman, Hall and Myake (eds.), *CSCL 2: Carrying Forward the Conversation*, Lawrence Erlbaum, Mahwah: NJ: 2002, pp. 507–528.

this level will enable collaborative work and also will provide features for collecting and analyzing data. According to Pinkwart et al.[13] the currently available educational applications on PDAs can be categorized according to two main types of usage:

a) The PDA serving as an interface to a "main" desktop program to extend the use of the desktop application for specific scenarios. Here, the mobile device may in the extreme case just serve as a front end, e.g. for outdoor data input.

b) A stand-alone application running on the PDA, with or without connection to a central desktop application. This approach includes also several mobile applications allowing collaboration via direct communication between the devices.

Examples of the first category are "ImageMap" from SRI International or the "museum guide" of CILT.[14] In the case of "ImageMap", students who receive an image on their mobile device and have to answer a given question to it using annotation techniques use the PDA. Having done so, they send their annotations back to a server where all the different comments are gathered and displayed on a public screen, allowing teacher and students to discuss the answers. Similar to the case of "ImageMap", the mobile application "museum guide" is also essentially an interface for communication with a central server. It is used primarily for retrieving data and displaying information about a museum. The current location of a user can be detected and is considered for offering location-based information to the user. Applications and concepts illustrating the second category include "Geney" by EDGE Lab / CS Division and "PiCoMap" from the hi-ce group.[15] The goal of "Geney" is to collaboratively "engineer" a fish with a particular set of characteristics under restrictions coming from genetic rules. The students take different roles: one of them acts as a "manager" whose fish will be paired with one fish collaboratively constructed by the other students. During

[13] N. Pinkwart, Christian Schäfer, U. Hoppe, M. Milrad and J. Perez, "Lightweight Extensions of Collaborative Modeling Systems for Synchronous Use on PDAs", *JCAL: Journal of Computer Assisted Learning*, Special Issue on "Mobile and Wireless Technologies in Education", Fall 2003 (to appear).

[14] J. Roschelle and R. Pea, "A walk on the WILD side: How Wireless Handhelds may Change CSCL", *Proceedings of CSCL 2002* (Conference on Computer Support for Collaborative Learning), Boulder, January 2002.

[15] K. Luchini, Ch. Quintana, M. Curtis, R. Murphy, J. Krajcik, E. Soloway and D. Suthers, "Using Handhelds to Support Collaborative Learning", in Stahl (ed.), *Proceedings of CSCL 2002*, Hillsdale, NJ: Lawrence Erlbaum, 2002, pp. 704–705.

a so-called "what-if" mode, the view on the mobile applications differs according to the student's role: the manager sees a condensed overview whereas the other participants have a more detailed but restricted view of resulting characteristics. So, the students have to combine perspectives and collaborate to achieve optimal results.

With the "PiCoMap" application, students can illustrate a specific given problem using a graphical representation consisting of nodes with text input, and directed links. Having done so, they can exchange their developed models pair-wise. Afterwards, they annotate the ideas of the co-learner. The aim of this system is to lead students to a discussion about their different views and, finally, to a revision of their original ideas taking into account the result of the co-learners. Most of the mentioned tools use infrared connection as the channel to exchange information between mobile devices. The disadvantages of this approach are:

- it does not directly support continuous co-construction in shared workspaces (instead, only repeated "one-time" data upload or download is facilitated);
- it is (at least currently) quite restricted in terms of bandwidth.

While the second aspect is of limited relevance in usually not over-complex pedagogical scenarios (and might soon be overcome), the first disadvantage really restricts the spectrum of potential collaborative processes. The use of wireless LAN connections can solve this problem and thus offer more flexible ways to support collaborative work. Here, completely synchronized mobile applications are enabled for a variety of collaborative scenarios.

However, for applications built upon these technologies to be successful for children and the education community, research needs to understand what are the special needs of learners and instructors, as well as the kinds of collaboration, social interactions, guidance, and activities that need to be supported for learning. Moreover, the requirements for mobile learning applications will be very different from the stationary (primarily desktop-based) setting that has until recently been the dominating one in Human Computer Interaction.[16] In the next section I describe some of our research efforts underway within the field of wireless and mobile technologies in education.

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[16] A. Marcus and E. Chen, "Designing the PDA of the Future", *Interactions,* vol. 9, New York, NY: ACM Press, 2002, pp. 34–44.

Research Perspectives

We at *CeLeKT* have recently initiated a research effort to explore new design approaches and innovative uses of wireless and mobile technologies in a variety of collaborative educational settings. Our vision is not simply to provide novel mobile and wireless computational tools, but rather to explore new and varied educational activities that become available while applying innovative approaches for designing new technology to support learning.

Technical innovation in these areas is particularly characterized by using new types of interaction devices and new communication technologies such as hand-held and tablet computers, physical interfaces with smart interactive objects and wireless networks in ubiquitous computing environments. The envisaged and partially already existing research products are software components and architectures, which facilitate human–human communication in cooperative work scenarios as well as interactive and collaborative learning activities such as model building in groups. Our work is motivated by the following guiding questions:

1. *How can the use of wireless and mobile technologies provide new opportunities for learning and collaboration? (Design/Usability aspects.)*
2. *What might be an ideal configuration of a wireless computer for learning?*
3. *How should learning theories be incorporated into the design of the desired architecture?*
4. *How should ubiquitous computers and the contexts they mediate be designed to ensure the needs of learners are met?*
5. *What features and capabilities should the mobile computing systems provide for different learning and teaching activities?*
6. *Which evaluation methodologies are suitable for assessing the value added of new technologies in learning and work settings?*

From an engineering/design perspective, we base our technical developments on standard platforms and environments. Particularly, we use Java and Java extensions (RMI, JINI, Java Media Framework) for the processing mechanisms and XML (including SMIL, SVG, etc.) for data structuring, storage and data exchange. The big challenges still lie in the integration not only between software components in distributed environments, but also in the combination of software with new hardware and peripherals as well as the support for delivery on different types of devices. In this spirit, a special focus of our work is set on exploring and exploiting the potential of mobile/hand-held and wireless devices.

Over the last decades, we have seen qualitative changes in Information and Communication Technologies (ICT) at a very rapid pace. The paradigm of stand-alone personal computers that was introduced in the early 1980s as a successor of mainframes and timesharing systems, has been replaced by the networked computing paradigm. Now, there are indications from within the ICT community that future developments may no longer be centred around the explicit and dominant role of the computer. The new view of ICT is most sharply crystallized in the notion of the "Disappearing Computer". This particular topic is now also the theme of an ongoing European research initiative (http://www.disappearing-computer.net) at the crossroads of computer science, social sciences and innovative design.

Some years ago, the term ubiquitous computing [17] was defined as an attempt to create and design more "transparent" technologies to break away from the traditional desktop activity and moving computational power to the region of activity where the user is engaged. Weiser and Brown refer to designing computational objects in our surrounding/ /environment that become an integral and transparent part of our lives. These objects also are equipped with network capabilities and they help us to mediate our activities with or without awareness of their role. Donald Norman has propagated a similar vision in his book the *The Invisible Computer*.[18]

Weiser and Brown claim that such forms of ubiquitous computing will lead to a new age of "calm technology" which is characterized by having multiple computerized services around us in an implicit and unobtrusive way. This technology will no longer define the focus of our attention. Even the current notion of a "user" would be misleading if this vision were completely materialized. The point would no longer be the human–computer relationship but the availability of certain services located in the physical (and virtual) environment. Already today, we "see" multiple processors being invisibly embedded in many technical devices such as automobiles, dishwashers and other equipment in workplaces and homes. This should not be confounded with invisible computing in the envisaged sense. In these other applications, computers

[17] M. Weiser and J. S. Brown, "The Coming Age of Calm Technology", in P. J. Denning and R. M. Metcalfe (eds.), *Beyond Calculation – The Next Fifty Years of Computing*, New York: Copernicus (Springer), 1997.

[18] D. A. Norman, *The Invisible Computer,* Cambridge, MA: MIT Press, 1998.

essentially serve as controllers and regulators of processes within a device or between technical devices. The innovation that we are interested in has to do with information processing in which "the human is in the loop", i.e. with *interactive and collaborative* applications. Here, "explicit computing" is still predominant.

An early approach of how to adapt ubiquitous computing technology to the classroom has been described in Hoppe et al.[19] It featured a combination of new hardware devices, namely big interactive screens ("LiveBoards") and tablet displays for free-hand input, with a networked classroom environment in which typical patterns of information exchange in a classroom were supported by specific groupware functions. One of the basic ideas was the provision "electronic worksheets" which could be distributed and collected by the teacher and which could be used in synchronous cooperative mode between students or be shared through the LiveBoard. This type of scenario was called a "computer- integrated classroom" (CiC), reflecting the central idea of using computer and communication technologies to support interaction and information exchange in a face-to-face classroom. The CiC idea was put into practice in schools in the European long term research project "Networked Interactive Media In Schools" (NIMIS, 1998-2000).[20]

In this perspective, we pursue the following concrete projects:

- Development of ubiquitous computing techniques for informal information sharing (background technologies such as "electronic pinboards" with access through SMS, PDAs or tablet computers as input devices, communicating notepads between collaborators)
- Integration of location-awareness with other communication services, potentially on the physical level in order to support spatially contextualized information services and knowledge exchange

[19] H. U. Hoppe, N. Baloian, J. Zhao, "Computer Support for Teacher-Centered Classroom Interaction", *Proceedings of ICCE '93* (International Conference on Computers in Education), Taipeh, Taiwan, December 1993.

[20] Cf. H. U. Hoppe, A. Lingnau, I. Machado, A. Paiva, R. Prada and F. Tewissen, "Supporting Collaborative Activities in Computer-Integrated Classrooms – the NIMIS Approach", in Salgado, Antunes and Costa (eds.), *Proceedings of CRIWG 2000*, IEEE Press, 2000, pp. 94–101.

Computer Support for Collaborative Learning

Computer support for collaborative learning (CSCL) is the label for a rapidly growing community of researchers with a multidisciplinary background, which includes computer science, cognitive science, education as well as sociology and social psychology. Typical application fields are:

- Distance education and "virtual learning"
- Social aspects of learning communities
- Organizational and tool support for intellectual teamwork and knowledge management
- Development and evaluation of classroom collaboration tools
- Development and evaluation of collaborative tools for learning in the workplace

Within this broad framework of CSCL, our specific orientation will be focused on scenarios using mobile and wireless technologies. If these new mobile technologies are used to support active and/or collaborative forms of learning, the expected gain or added value is typically defined quite differently: Handheld computing devices allow for exploratory activities not bound to a special location, for example field trips, without losing the potential of taking electronic notes and retrieving information of various types.[21] Such notes, ranging from data collections and digital images to handwritten annotations, can be easily exchanged and downloaded. If combined with wireless transmission, these activities can be continuously monitored and coordinated between places. But even in classrooms and training settings with more or less fixed locations, the use of mobile and wireless technologies may lead to substantial changes in that small hand-held or embedded devices are no longer dominating the interaction in the same way as an "explicit" computer does. This can help us to bring the technology to the background and to set the focus more on inter-personal relations and on the task at hand.[22]

Our research efforts in this direction are oriented towards the exploration of new design approaches and innovative uses of wireless and mobile technologies in a variety of collaborative educational settings. These

[21] Gay et al., *op. cit.*

[22] J. Roschelle, C. Patton and R. Pea, "To Unlock the Learning Value of Wireless Mobile Devices, Understand Coupling", in M. Milrad, U. Hoppe, and Kinshuk (eds.), *Wireless and Mobile Technologies in Education*, Los Alamitos, CA: IEEE Computer Society, 2002, pp. 51–60.

efforts aim at investigating the challenges of designing and using mobile technology for:

- providing learners with new mobile computational tools to explore and share their knowledge with other peers;
- providing teachers with new communication channels to visualize students' ideas;
- fostering collaboration among students and among students and teachers.

The following concrete activities are in-line with this perspective:

- The use of new mobile devices to support academic study groups as in the C-Notes application[23]
- The use of wireless devices for data collection and visualisation in experimental settings in science museums[24]

Conclusions

As presented in this paper, wireless and mobile computing has the potential of enabling learners to share information, coordinate their tasks and conduct a number of educational activities in new ways. Efforts in this direction and applications of mobile and wireless technologies in education have been in used for almost 10 years.[25] However, due to a number of social, economical and educational factors, these technologies are just now being introduced to different educational arenas.

It is essential to remember that the introduction of new technological tools takes place into existing social environments having their patterns of interaction, own culture. These new tools, then, should be interpreted and used accordingly, but they can also have a major impact transform-

[23] M. Milrad, J. Perez and U. Hoppe, "C-Notes: Designing a Mobile and Wireless Application to Support Collaborative Knowledge Building", in M. Milrad, U. Hoppe, and Kinshuk (eds.), *Wireless and Mobile Technologies in Education*, Los Alamitos, CA: IEEE Computer Society, 2002, pp. 117–120.

[24] J. Gottdenker, M. Milrad, A. Wichmann, D. Jonassen, J. Strobel and J. Perez, "Exploring New Ways for Supporting Scientific Inquiry: Hands-On High-Tech Science Learning", in preparation.

[25] C. Wayne, "Wireless Coyote: A Computer-Supported Field Trip", *Communications of the ACM*, vol. 36, no. 5 (1993), Special issue on technology in K–12 education, New York, NY: ACM Press, pp. 57–59.

ing those cultures and practices. The mediation of mobile and wireless technologies and applications challenges traditional distinctions between "new learning environments" taking place anywhere/anytime to the notion of learning in the classroom, and it generates new learning and teaching activities and opportunities.

Such an understanding of the role of technology differs significantly from earlier suggestions to conceive computers as "dialogue partners". We see this new orientation as a consequence based on lessons learned from the limited success of past technology-centered approaches. A criticism of such earlier approaches to learning does indeed not exclude the use of the newest technology in the most creative and innovative ways. The point is that the learning environment, including such aspects as roles of learners and teachers, types of activities, and physical settings, should not be adapted to the available technology but instead, the technology should be designed for and adapted to the learning needs. And our hope is that better technology should adapt and serve better.

As we continue to conduct more research in this new field and to collect more empirical data, we will gain a richer understanding of the potential using mobile and wireless technologies for improving the design of technology-rich contexts for supporting learning and teaching. I would like to encourage all our colleagues in this area of research to continue this exploration so that we may ground theoretical conjectures regarding the potential of these contexts in empirical findings. More broadly, I hope that further research will help us to develop a richer theoretical framework for understanding the role of these new kinds of technologies and their implications for improving the level of education.

Louise Mifsud

Learning "2go": Pedagogical Challenges to Mobile Learning Technology in Education

Introduction

A retrospective look points towards the mobile direction of the evolution of technology: from desktop telephones to mobile telephones, from desktop computers to portable ("laptop") to mobile units. During the past few years mobile technology has become integrated in day-to-day activities. Hand-held computers appear to be part of a general movement towards mobile technology. Mobile telephony studies show that the personalised, mobile, accessible and social technology is widespread among children.[1] Figures for 1999 in Norway, for example, show that 68% of fifteen-year olds owned a mobile telephone, while almost 40% of thirteen year olds and 82% of twenty-year olds possessed a mobile telephone.[2]

Mobile computers offer new possibilities of tapping into different learning arenas, but whether these are realised as an enhancement of that which is already there, such as administrative roll taking programs, to reinforce existing practices to the exclusion of other routines, or to innovate practice, is still an open question. Mobile learning technologies also present challenges to the schools. One challenge is to *access* and *utilize* different learning arenas. Tyack and Cuban[3] compare schooling to "grammar", which has remained "remarkable stable over the decades". The example of the nineteenth-century teacher who can still feel at home in the classrooms of the twenty-first century is often quoted as an example. However the counterargument is that this same teacher would

[1] R. Ling and K. Thrane (eds.) *Sosiale konsekvenser av mobiltelefoni: proceedings fra et seminar om samfunn, barn og mobiltelefoni*, FoU [R & D] N 38/2000.

[2] R. Ling and P. Helmersen, "It Must Be Necessary, It Has to Cover a Need: The Adoption of Mobile Telephony among Pre-Adolescents and Adolescents", in R. Ling and K. Thrane, *op. cit.*

[3] D. Tyack and L. Cuban, *Tinkering Towards Utopia: A Century of Public School Reforms*, Cambridge, MA: Harvard University Press, 1995.

be shocked by what is expected of today's students, not only in the amount of knowledge that they are expected to learn but also in how it should be applied.[4] A question that arises is then: what role can hand-held technology have in education? What challenges do handhelds pose? Can mobile computers have a role in bridging different learning arenas? Or will an intruder role dominate? Can the "outside" be taken in and the "inside" taken out? Can there be a convergence between the learning in and out of school? Can anytime, anywhere learning be achieved? Is there room for an "anytime, anywhere learning" in the educational structure?

ICT in Education

It has often been argued that the fundamental task of the school is education. That education ideally provides perspectives and tools for participating in society, understanding society and shaping society. Further, that it should produce individuals who have a sound working knowledge base, who can use that knowledge when called upon to do so, and who are willing and able to continue the learning process after schooling.[5] Schools have often been criticised for having traditionally been slow to take on the technological challenge while information and communications technology has had a major impact on daily life, work and leisure.[6]

[4] J. M. Roschelle et al., "Changing How and What Children Learn in School with Computer-Based Technologies", *The Future of Children*, vol. 10, no. 2 (Fall/Winter 2000: *Children and Computer Technology* issue), http://www.futureofchildren.org/information2826/information_show.htm?doc_id=69809.

[5] D. Schuler as quoted in R. Dillemans et al. (eds.), *New Technologies for Learning: Contribution of ICT to Innovation in Education,* Leuven: Leuven University Press, 1998; T. Koschmann et al., "Computer-Supported Problem-Based Learning: A Principled Approach to the Use of Computers in Collaborative Learning", in T. Koschmann (ed.), *CSCL: Theory and Practice of an Emerging Paradigm*, Mahwah, NJ: Lawrence Erlbaum Associates, 1996; *The Competence Reform in Norway*, Status October 2000, Oslo: KUF, http://www.dep.no/ufd/engelsk/education/competence-reform/014061-990031/index-dok000-b-n-a.html; *Læreplanverket for den 10-årige grunnskolen* (The Norwegian National Curriculum), Oslo: Kirke-, utdannings og forskningsdepartementet, 1996.

[6] M. Carnoy, *Sustaining the New Economy: Work, Family, and Community in the Information Age*, New York: Russell Sage Foundation, 2000; R. Dillemans et al., *op. cit.*; P. J. Casey, "Computing as Educational Innovation: A Model of Distributed Expertise", *Journal of Information Technology for Teacher Education*, vol. 5, no. 1–2 (1996); M. Castells, *The Rise of the Network Society*, Oxford: Blackwell, 1996.

Dillemans[7] points out that as new technologies become more and more embedded in our society, the educational system also will be affected. Soloway[8] argues that as long as computers are not ready-at-hand, they will not be used in a routine, day-in, day-out fashion and there will be little or no impact on basic education. Computer technology has been criticised for being segregated from aspects of children's lives, relegated to the "computer rooms" in schools making PCs anything but personal.[9] It has however been argued that flexible access to technology will provide tools to help children construct knowledge throughout their daily activities, making technology an integral part of daily learning.[10] On the other hand, it has often been suggested that access on its own will not fulfil the promise which many have meant lies in the use of ICT in school.[11] It has been argued that schools are an isolated unit and that computer technology can provide students with a tool for applying concepts in a variety of contexts, thereby breaking the artificial isolation of school subject matter form real-world situations.[12] While this view has been viewed with some scepticism,[13] despite the criticism of ICT in education it appears that ICT has pushed education to re-think its mission.

Handheld computers appear to become more ubiquitous in their use as digital "assistants" in the business world. Several research centres in the United States and Canada (for example Stanford Research Institute [SRI] and Simon Fraser University among others) are now focusing on handheld devices in education, and trying to learn from the past mistakes of ICT implementation into schools. Critiques have for example been based on the grounds that the rush for software comes after the buying of the hardware.[14] SRI, together with the Center for Tech-

[7] R. Dillemans et al., *op. cit.*

[8] E. Soloway et al., "Learning in the Palm of Your Hand", http://www.handheld.hice-dev.org/readyAtHand.htm, *Communications of the ACM*, June, 2001.

[9] *Ibid.*

[10] E. Soloway et al., *op. cit.*; K. M. Inkpen, "Designing Handheld Technologies for Kids", http://www.cs.sfu.ca/~inkpen/Papers/hcscw_inkpen.pdf (1999).

[11] J. Bransford, A. L. Brown and R. Cocking (eds.), *How People Learn: Brain, Mind, Experience, and School*, National Research Council, Washington DC: National Academy Press, 2000.

[12] J. M. Roschelle et al., *op. cit.*

[13] J. W. Schofield, *Computers and Classroom Culture*, Cambridge: Cambridge University Press, 1995; M. Apple, "Is the New Technology Part of the Solution or Part of the Problem in Education?", in J. Beynon and H. Mackay (eds.), *Technological Literacy and the Curriculum*, London: Falmer Press, 1992.

[14] E. Soloway et al., *op. cit.*

nology Learning and Palm Inc.[15] awarded a $2.3 million grant to schools and research hubs in order to increase activity on the PDA front,[16] and has also established an idea bank for innovative use of PDAs in education, the aim of which is to research and evaluate innovative uses of handheld computers.

Mobile Learning Technologies in Education

The difference between the learning that goes on in school and out has often been addressed.[17] The National Council of Research Report *How People Learn*[18] emphasises that bringing students and teachers in contact with the broader community can enhance their learning. In a study of secondary schools and upper secondary in Norway, initiated after the 1994 and 1997 reforms, secondary school students' experience of what goes on within the classroom has been described as characterised by boredom, that it is often regarded as meaningless, not inspiring and that the students want to go "out of the classroom and into the world".[19] The OECD report *Learning to Change: ICT in Schools*[20] illustrates that ICT has established a new complementarity between formal learning in school and informal learning outside. It has been suggested that one of the roles of mobile and personal media could be as "bridges" between the various arenas. This can be related to the challenges that school as an institution and the culture of the classroom face. While a "bridge" may allow a flow of information, communication and access, if there is a barrier at the one end of the bridge, the access to information and communication flows stops. An example is that of mobile telephony in classrooms, where their role can be regarded as that of an "intruder" in the classroom culture,[21] and as such a disturbance. This is a challenge that the school

[15] Palm Inc – PDA "makers". Palm OS – Palm Operating System.

[16] One of the research hubs that has received a grant from SRI is the Hi-CE, University of Michigan.

[17] J. Lave and E. Wenger, *Situated Learning: Legitimate Peripheral Participation*, Cambridge: Cambridge University Press, 1991; L. Resnick, "Learning in School and Out", *Educational Researcher*, vol. 16, no. 9 (1987), pp. 13–20.

[18] J. Bransford, A. L. Brown and R. Cocking (eds.), *How People Learn*.

[19] G. Grepperud (ed.), *Tre års kjedsomhet? Om å være elev i ungsomsskolen*. Oslo: Gyldendal Akademisk, 2000, p. 15.

[20] *Learning to Change: ICT in Schools*. OECD Report, 2001.

[21] L. Mifsud, "Alternative Learning Arenas – Pedagogical Challenges to Mobile Learning Technology in Education", in M. Milrad, U. Hoppe and Kinshuk (eds.), *Wireless and Mobile Technologies in Education*, Los Alamitos, CA: IEEE Computer Society, 2002.

has to take up. New types of mobile telephones and PDAs which offer several extra functions, such as the possibility to record both voice and image, can also appear to present a challenge to classroom culture if regarded as an intruder. One can say that one of the first challenges is to view the technology as a bridge between different learning arenas, and for teachers to take time to find out how to integrate them into their learning activities – a challenge lies in *utilising* mobile technologies in education. The Palm Education Pioneers (PEP) Report[22] also suggests that "it is important that teachers find time to research available software and peripherals, ... and take the time to *learn how to use them, as well as understand how to integrate* the handheld, software, and peripherals into their learning activities".[23]

PDAs have begun to make their appearance in Norwegian schools. The programs, so far, appear to have been limited to the administrative side of teaching, with a program, Classe[24] that enables teachers to take attendance, grades, etc. on a pocket PC.[25] In a preliminary evaluation of the program Classe as an administrative aid for teachers in upper secondary schools,[26] there appeared to be indications that the teachers, while seeing the potential in the PDA, were not sure of how to actually use it in a learning situation.

Wenger[27] points out that schools/classrooms are (institutions) based on the assumption that learning is an individual process and that it has a beginning and an end, and best when separated from the rest of our activities. Barab and Duffy[28] state that "being a participant in a community is an essential component of the educational process. A community of practice is described as a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities of practice ... an intrinsic condition for the existence

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[22] *PalmTM Education Pioneers Program: Final Evaluation Report*, http://palmgrants.sri.com/PEP_Final_Report.pdf (2002).

[23] *Ibid.*, p. 32, italics added.

[24] The program is developed by Pulsar Data, a Norwegian company, see http://www.pulsardata.no.

[25] Sentrum Videregående Skole – Norwegian School. Case study, posted October 2001, http://www.microsoft.com/resources/casestudies/CaseStudy.asp?CaseStudyID=13086.

[26] L. Mifsud, "HotSync – A Preliminary Study", Internal ITU-report, 2001, unpublished.

[27] E. Wenger, *Communities of Practice: Learning, Meaning and Identity,* Cambridge: Cambridge University Press, 1999.

[28] S. A. Barab and T. D. Duffy, "From Practice Fields to Communities of Practice", in S. M. Land and D. H. Jonassen (eds.), *Theoretical Foundations of Learning Environments*, Mahwah, NJ: Lawrence Erlbaum Associates, 2000.

of knowledge...”.[29] In collaborative learning the emphasis is on working in “collegial” roles. It has been argued that participants in a collaborative learning environment can learn from each other equally well as from the instructor or course material, and learning is not a static subject matter, but the process of participating itself.[30] Collaborative learning has been described as a creative process where one exchanges ideas, expands on them, changes, modifies or discards them together with peers.[31] A quick look at many of the programs being developed for PDAs appear to build on the principles of collaboration. For example, the Center for Highly Interactive Computing in Education at the University of Michigan, Hi-CE[32] has developed, and is researching, a collection of applications for the classroom – “the Cool Dozen” – based on Palm OS, along with instructions for each. One of the programs that Hi-CE is working on is for example PiCoMap, a concept-mapping programme. Students working on a topic can first work on their own, making out their own concept map. The concept map can then be beamed (exchange of information through an infrared port). The programmes also include an offline browser (Fling-It),[33] a scrapbook maker (Go ‘n tell) that can be used together with a camera to create a story illustrated with pictures among other programmes. Using Hi-CE as an example, the programs mentioned above appear to build on collaboration-principles. However, as Resnick[34] points out, the dominant form of learning, performance and judging in school is individual – success or failure at tasks are independent of what other students do, despite group activities.

One can also look at the worries that some teachers have expressed at PDA implementation in their classrooms: PDAs might be used for things other than school related work, such as playing games, pranks, e-mailing friends in and out of school or cheating on tests.[35] These worries are also reflected in the final Palm Education Pioneers Report where inappropriate use of handhelds is mentioned as one of the drawbacks,

[29] Lave and Wenger, *op. cit.*

[30] Wenger, *Communities of Practice.*

[31] D. Rowntree, “Teaching and Learning Online: A Correspondence Education for the 21st Century?”, *British Journal of Education Technology*, vol. 26, no. 3 (1995), pp. 205–215.

[32] See http://www.handheld.hice-dev.org.

[33] One can download information from the internet to the PDA and this is available offline, anywhere, at any time.

[34] L. B. Resnick, “Learning in School and Out”, *Educational Researcher*, vol. 16, no. 9 (1987), pp. 13–20.

[35] A. Trotter, “Handheld Computing: New Best Tech Tool Or Just a Fad?”, *Education Week on the Web*, 2001, http://www.edweek.org/ew/newstory.cfm?slug=04palm.h21.

and where "games played during class time, downloading inappropriate materials and inappropriate use of beaming, passing notes, cheating on tests and "copying" by handing in assignments beamed from other students" are mentioned as examples of worries.[36] One can relate these worries to the challenges that schools face when implementing PDAs – challenges to timetable, curriculum, assessment, testing... the backbone of the structure, and "grammar", of school. Consequently, one can argue whether the existing structure changes and in which way – and whether different learning arenas, and a "learning2go", have a place in the existing structure. This also begs the question as to whether there is place in the school for what the students learn in the different learning arenas.

While the size of mobile computers or PDAs can be seen as a strength, it also appears to be their weakness. At the moment PDAs have relatively limited computational power and the screen is small, which leads to obvious limitations and challenges in what can be shown. However, PDAs cannot be perceived as mini-laptops, their function appears to point in the direction of a different use. For example, conclusions from the Knowmobile project propose that PDAs should be regarded as "*potential gateways*" rather than personal digital assistants.[37] PDAs have the advantage of being mobile (as opposed to portable). They have the advantage of being ready-to-hand, relatively cheap, mobile and, with the latest technologies, such as Bluetooth and iMode,[38] moving towards being fully wireless. The arguments for handhelds in education are many. They are personal, they are accessible and flexible and allow for collaborative solutions. With a "HotSync" plug in (connecting the handheld device to a computer for synchronising purposes), students can upload data files. It has also been pointed out that handhelds have the advantage of *immediacy*[39] and a *just-in-time* (JIT) access to knowledge and learning.[40] Attach a probe and the possibilities in science subjects appear to be many. Imagiprobe[41] has included sensors, which can be attached to the handheld device and which can, for example, measure the PH value of water, where the values are automatically

[36] *PalmTM Education Pioneers Program: Final Evaluation Report*, p. 17.

[37] K. Lundby, "Knowmobile Conclusions", in K. Lundby (ed.), *Knowmobile*, InterMedia Report, no. 5, 2002, University of Oslo.

[38] The Japanese wireless, mobile system appears to be highly successful and operational

[39] J. M. Roschelle et al., *op. cit.*

[40] K. Lundby, *op. cit.*

[41] Cf. http://www.imagiworks.com/Pages/Products/ImagiProbe.html.

entered into the PDA. Students can then beam the values over to each other for further collaboration. PDAs can be taken outside, to playgrounds, walks, malls ... wherever the "students" want to be. In a set of scenarios by Soloway et al.[42] the starting point is that the child learning something at school, and something "outside", makes the child link the two together and "inquire" further into the subject. The scenarios look at possible uses of mobile, handheld computers in different learning contexts, from a child who decides that she wants to measure the relationship between the amount of noise her school bus makes and acceleration, to a couple of friends wanting to find out what the optimal conditions for growing flowers in their garden are. These scenarios point in the direction that a learning arena[43] need not necessarily be enclosed within the school boundaries, using technology to "springboard" from one learning arena to the other seamlessly, when *needed* and in *context* – learning "2go".

Closing Reflections – Learning2go

Koschmann[44] asks a question which he views as fundamental to learning, namely: *"if we had the power to change instructional practice through the introduction of new technologies, what sorts of changes would we really like to see?"*. In addition to focusing on change in instructional practice, it is also essential to focus on change in learning practices and teaching practices. The PEP Report points out: teachers report that the use of handhelds "changed or will change their instructional planning..."[45]

Building further on Koschmann's question – what kind of changes in education would we like to see, if we had the power to make these changes? – this is how we can summarize the situation: Mobile computers offer new possibilities, possibilities of tapping into different learning

[42] E. Soloway et al., "Science in the Palms of Their Hands", *Log On Education: Communications of the ACM*, vol. 42, no 8 (August 1999).

[43] For the purpose of this paper, I define *arena* as a sphere of activity and *environment* as surroundings in which a person operates, and as such I take as my starting point an environment as that which can stimulate an arena (cf. *The Oxford Concise English Dictionary*, 1999 edition).

[44] T. Koschmann, "Tools of Termlessness: Technology, Educational Reform and Deweyan Inquiry", to appear in T. O'Shea (ed.), *Virtual Learning Environments*, Mahwah, NJ: Lawrence Erlbaum Associates, cf. http://edaff.siumed.edu/tk/articles/UNESCO.pdf (downloaded 21 September 2001).

[45] *PalmTM Education Pioneers Program: Final Evaluation Report.*

arenas, but whether these are realized as an enhancement of that which is already there, such as administrative roll taking programs, or to the exclusion of other routines is still a question. Mobile learning technologies present a challenge to the school – a challenge to access and utilize different learning arenas.

Studies into PDAs might eventually show results similar to those in mobile telephony, and applied to education. Can mobile computers have a role in bridging different learning arenas together? Or will the intruder role dominate? Can the "outside" be taken in and the "inside" taken out? There also appears to be the need for studies into strategies needed in order to see these changes through, and how the institutions approach the changes, whether, for example, these changes are realized through the already existing structure. Strategies for implementation – that teachers need to be familiar with the technology itself, and to be able to experiment with it before using it in a learning situation. Research in mobility needs to focus on these questions: How can anytime, anywhere learning be achieved? Is there room for an "anytime, anywhere learning" in the educational structure? There is the need for more research into the contribution of different learning arenas to the school and classroom arena and vice versa.

Andrea Kárpáti

Digital Didactics for Mobile Learning

This paper will describe if and how computerization of Hungarian classrooms resulted in changes of teaching style and content. In the 1980s, during the first wave of computerization of classrooms, traditional, frontal methods were used to introduce computer skills. The medium did not change the message. In the nineties, however, innovation projects were launched to introduce new types of (on-line) learning environments to harmonise current educational philosophy with teaching practice. Major paradigms in the field of learning and instruction today are *constructivism, situationism*, and *collaborative learning*. Learners are encouraged to *construct their own knowledge* (instead of copying it from an authority be it a book or a teacher), *in realistic situations* (instead of merely decontextualised, formal situations such as the classroom), together *with others* (instead of on their own). The paper will discuss how these theories are being realized in Hungarian school-based teaching projects aimed at mobilising the frontally taught classroom "audience" with the help of information and communication technologies (generally accepted abbreviation to be used in this paper: ICTs) and offers suggestions about the potential use of mobile communication devices in public education.

"Computerization" of Hungarian Education and Its Immediate Effect on Teaching

The first intensive phase of hardware development in Hungary occurred between 1995 and 1997, when the World Bank and PHARE launched their big ICTs projects in the country.[1] International grants

[1] By the end of 1997, in the 901 Hungarian secondary schools there were 4975 independent and 12420 networked computers with 1906 of them connected to the Internet. There were 1.5 computer laboratories per secondary school in average and one per school had an Internet access. Results of ICTs-related knowledge and skills of the first intensive phase of computerisation of Hungarian schools: Andrea Kárpáti, "ICT and the Quality of Learning at Hungarian Schools: Results of the OECD Study", to appear in Carolyne Dowling (ed.), *ICT and the Quality of Learning*, Amsterdam: Kluwer, 2003.

from PHARE, EU-Socrates Project, the British Know How Fund and the World Bank were the major sponsors of projects preceding the "Sulinet age": the massive computerization campaign launched in 1997.[2] These pioneer projects resulted in a profound modernization of vocational education and introduced ICT in higher education through the establishment of a range of distance education centres all around the country. Private funding has also been important from the start – primarily the George Soros Foundation-Budapest that excellently allocated and monitored grants to reach about 600 schools in all and more than 5000 teachers.

Thus, the Hungarian Schoolnet project could build on previous results: hundreds of secondary schools that already had an expertise in using ICT both for education and intra- or extra-school communication purposes. Between 1997–1999, the Ministry of Education initiated a massive computerization movement. This 3 billion HUF (cca 500.000 USD) was allocated to connect *all secondary schools* (about 700 in number), *30% of primary schools* (400 in all) *and one educational institute per county* (22 in all) to the internet. By the end of 2002, the plan was accomplished. Present plans include the *integration of all primary schools* in a broadband Schoolnet network by 2004 with the simultaneous donation of a PC laboratory and software kit for multimedia development and basic office applications. Members of the Hungarian Schoolnet receive free, 24-hour internet connection (mostly ISDN, but speed was doubled in 2002 to reach 120 kbit/sec and will be increased substantially later this year). The Schoolnet Office employs teams of subject specialists with a special interest in ICT applications who create a weekly updated, authentic content-rich web site: http://www.sulinet.hu that features columns for all compulsory school disciplines. Content ranges from learning games to translated articles from professional journals, lesson plans, teaching resources and links to both scientifically and educationally reliable web sites. The Association of Teachers of ICT, with more than 800 members, is a major promoter of innovation and research (http://www.isze.hu).

At present, Hungarian schools are in the upper medium range of the European countries in terms of infrastructure, internet access and number of teachers trained. Unfortunately, funds for upgrading and maintenance are scarce and the employment of local system operators rare. Educational software in Hungarian, adapted to the needs of our curriculum is difficult to find. Present national ICT in education efforts are there-

[2] The Hungarian Schoolnet – called "*Sulinet*" in Hungarian, a kind of nickname using the kid name for school.

fore focused *on content development* (e-Content Project) and the design and implementation of *ICT enriched, collaborative learning environments* ("The School of the Future" Project). Both enterprises are co-ordinated by the Hungarian Schoolnet Office, sponsored jointly by the Ministry of Education and the Ministry of Informatics and Communication. Funds are being allocated on an application basis.

Even the first phase of the computerization movement, characterised by a focus on infrastructure and connectivity, lead to a more or less acceptable learning environment in about 400 primary and secondary schools whose staff belongs to the *Innovators and First Adapters* of computer technology in Hungary.[3] When describing them in a recent OECD study,[4] we found that the diffusion pattern by Rogers[5] was applicable in countries with a wide variety of cultures and financial means as well as in Hungary. Rogers divides potential adopters into five categories, based upon socio-economic status, communication behaviours, and personality values. This diffusion pattern includes a small group of Innovators (the first 2.5% to adopt), a larger group of Early Adopters (the next 13.5% to adopt), an even larger group of Early Majority (the next 34%), with the rest distributed among the remainder groups of Late Adopters and laggards. National researcher teams did not provide such quantitative definitions, only general trends described in the model were verified. Contrary to our expectations, *best educational users* – those who were most competent in the use of ICT for teaching and self-guided studies – turned out to be middle-aged professionals who were experienced in the practice of teaching and knew how to harmonise new methods with traditional ones. Young teachers were often afraid of entering "the road less travelled" and often too preoccupied with the chores of teaching and

[3] ICT infrastucture and use are being constantly monitored by international surveys (IEA-SITES, PISA) and national educational assessment projects (MONITOR). Some studies that focused on ICT school culture and student/teacher skills, competencies and use patterns: *MONITOR 1999 – Evaluation of Educational Achievement*, Budapest: National Institute for Public Education, 2000 (in Hungarian); Márta Turcsányi-Szabó and Géza Ambruszter, "The Past, Present and Future of ICT in Education – the Hungarian Image", *International Journal of Continuing Engineering Education and Life-Long Learning* (in print).

[4] Richard Venezky and Cassandra Davis, *Quo Vademus? The Transformation of Schooling in a Networked World: Draft Executive Summary of the OECD project "ICT and the Quality of Learning"*, Paris: OECD, 2001, unpublished manuscript; Richard Venezky and Andrea Kárpáti (eds.), *Case Studies on ICT and Educational Change from the OECD Project "ICT and the Quality of Learning"*, special issue of *International Journal of Education, Communication and Information*, 2003, in print.

[5] Everett Rogers, *Diffusion of Innovation*, New York: Free Press, 1995.

the intricate process of fitting into a school staff.[6] Similar findings were reported by the EMILE project team, another European study on school culture that monitored average institutions.[7]

Assessment seems to be a key concept in Hungarian educational computing. Screening change is not just an exciting opportunity for mapping new territories of human cognition but also a unique chance to monitor the effects on teaching and learning of a teaching aid students are fascinated by. These studies focus on the following issues: formation and change of attitudes of teachers and students towards computer-based communication and information processing at school, structure and content of computer usage in an educational setting versus home use, internet in education as a public forum and knowledge base, accessibility and level of computer literacy in different school types and socio-cultural/geographical settings and teachers and educational multimedia – thematic and didactic preferences, patterns of use/adaptation/development.

There are no large scale research projects that investigate the *potential use of mobile communication devices in public education*, but the need for their integration is evident. The penetration of mobile phones among Hungarian youth is high and constantly rising – thus, a potential "teaching aid" becomes increasingly available that teachers and educational researchers may no longer ignore. Some suggestions about their inclusion in the educational process will be given at the end of this paper.

The Second Phase of ICT Culture: Emergence of New Educational Paradigms

From the late 1990s, in most leading ICT-employing countries, infrastructure development had been gradually replaced by research on methodology and effective digital forms of teaching content. New types of learning environments were developed that went far beyond the first and most popular application of computer technology in the classroom: illustration of frontal presentations. Dominant educational trends in the field of teaching and learning are *constructivism* (learnign based on previ-

[6] Péter Fehér, "The Road Less Travelled: ICT Culture of Hungarian Village Schools", *Ninth EARLI Conference*, Fribourg: 2000, http://www.mek.iif.hu/porta/szint/tarsad/pedagog/infoktat/road.

[7] Serge Pouts-Lajus and Marielle Riché-Magnier, "New Educational Technologies: An Opportunity to Rethink Educational Relationships", 2000, http://www.ote.fr. For Hungarian results see Andrea Kárpáti, "Report of the Hungarian Case Studies of the EMILE Project", 2000, full English online version available at the project web site: www.emile.eu.org.

ous experiences and subsequent knowledge construction by students), *situationism* (creating authentic learning problems in life-like settings), and *collaborative learning* (encouragement of pair and group work to solve complex projects and tasks.). "... learners are encouraged to construct their own knowledge (instead of copying it from an authority be it a book or a teacher), in realistic situations (instead of merely decontextualised, formal situations such as the classroom), together with others (instead of on their own)."[8]

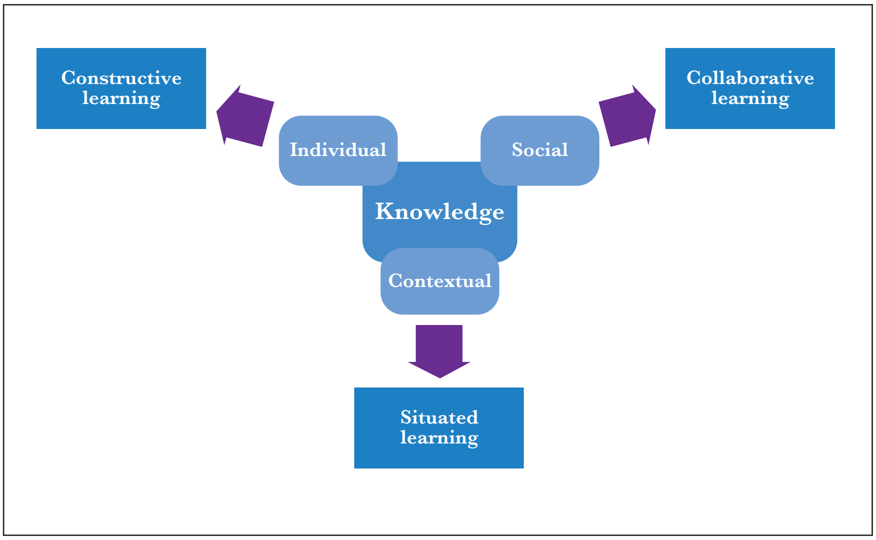
New approaches to education seem to have one common feature: the *empowerment of the learner* and the profound change in teacher roles, values and practices. Teachers are required to leave the pulpit and no longer be "a sage on the stage" but instead "a guide on the side". For example, if we contrast *discovery learning* with traditional, frontal teaching practices, we realise that the two models are so different that a learning environment developed to serve one will not suit the other. Thus, not only educational practices but also the whole array of teaching-learning aids has to be replaced.

Teaching-learning process	Discovery Learning	Frontal Eucation
Teacher activities	Orientation	Planning
	Monitoring	Guiding
	Mentoring	Modelling learning methods
	Authentic assessment	Formal assessment of knowledge transmitted
Student activities	Hypothesis generation, experiment design	Listening to instructions, performance of prescribed task
	Collaborative learning	Individual learning
	Cognitive apprenticeship	Master–disciple relationship
Joint teacher and student activities	Data interpretation	Guided dialogue about knowledge presented by teacher
	Evaluation of working process	
	Evaluation of hypothesis	

Table 1: Comparison of a new and a traditional educational model: discovery learning and frontal education

[8] Ton de Jong, "Knowledge Construction and Sharing with Media Based Applications", *Journal of Educational Research*, vol. 21, no. 1 (2001).

These new sets of activities involve a *re-interpretation of knowledge* to be transmitted through education. It is no longer perceived as an embodiment of external, objectivistic "truth", but as *individually constructed* and thus potentially different between learners. These individual knowledge states are being examined, structured, verified and modified in the process of education, with the mentoring help of the teacher. Knowledge has a strong social character and has to be applicable in real life, modifiable at will in the process of life-long learning and not restricted to a set of "output criteria" of centrally regulated curricula as it had been customary in the first two decades of public schooling. The chart below provides an overview of changes in views on knowledge and related trends in learning and instruction.



New views on knowledge and related forms of learning.[9]

ICTs play a major role in implementing the new trends in education. Construction of knowledge is greatly supported by digital environments such as hypertexts, concept mapping, simulation, and modelling tools.[10]

[9] Ton de Jong, *op. cit.*

[10] T. de Jong, W. R. van Joolingen, J. Swaak, K. Veermans, R. Limbach, S. King and D. Gureghian, "Self-Directed Learning in Simulation-Based Discovery Environments", *Journal of Computer Assisted Learning* 14 (1998), pp. 235–246.

Collaborative learning is not only supported but actually occurs in an internet based learning environment such as Knowledge Forum, an interactive classroom environment for knowledge construction, management and sharing, (http://kf.oise.utoronto.ca), or Belvedere, an environment for group learning (http://lilt.ics.hawaii.edu/belvedere). MOVELEX (www.violasoft.hu) is an adaptive testing environment that helps learners assess knowledge gained and train insufficient skills.

Simulations are perhaps the best examples of how science and technology education can benefit from ICTs. Complex virtual laboratories enable students to model a system or a process, change values of input variables and observe values of output variables. (Cf. Co-Lab, http://www.colab.nl). Computer games with an educational scenario have an underlying learning theory and content model. Learners, while at play, understand the model inherent in the simulation, set goals, observe rules and constraints, and engage in a real-life competition using "real life" computer tools also employed in the world of work for solving similar tasks. The complexity of the environment, the motivating element of surprise and the emotional involvement created through role playing all contribute to the authentic learning experience.

Adventure games are also very popular among educators and learners because they utilise action game-like effects and thus create a stimulating discovery learning environment. They generally have no underlying theoretical model. Player-learners collect information, make choices, get involved in competitive tasks, recall information, and observe the goal, rules and constraints of the environment. Situatedness and close relationship with reality make these games complex enough to motivate through surprise effects and new challenges. The involvement of the learner is increased through role play and identification with combating characters. A good example for educational adventures is the still unpublished KM Quest Game, where the domain targeted is business management. A team of players has the role of knowledge manager in a virtual company called Coltec. The task of the players is to analyse the knowledge household, decide on knowledge management interventions and observe their effects.

"Digital Didactics" for Mobile Learning?

Most contemporary educational paradigms outlined above could benefit from the introduction of mobile learning devices as educational tools. In order to predict the chances of the educational utilization of mobile devices, it seems important to see how teachers make use of already available, desktop PC technology. A recent survey commissioned by CERI, the educational research institute of OECD, entitled "*ICT and the Quality of Learning*", 1999–2001, offers data from 23 countries about teachers' ICT skills, attitudes and practices. The major aim of this extensive study was to investigate if and how ICTs resulted in changes in the quality of teaching and learning in public education. As part of the project, *school based case studies* were executed that evaluated the functioning of schools incorporating ICT in their education, internal and external communication and management. Here we summarise two problem areas of computer-generated educational innovation: *effectiveness* of new educational methods and *teachers and/or technology as a catalyst or supporter of reforms*.

"Technology is a strong catalyst for educational innovation and improvement, especially when the World Wide Web is involved. The rival hypothesis is that where true school-wide improvement is found, technology served only as an additional resource and not as a catalyst, that the forces that drove the improvements also drove the application of technology to specific educational problems."[11] The summary of findings of this part of the OECD study clearly indicates that infrastructure and student competence do not contribute to the success of the reforms as much as teacher attitudes, motivation and competence. Almost all of the school-based case studies showed reform-oriented educational institutions with dedicated and highly trained staff to be the first to engage in computer-related educational reforms. These schools were considered cutting-edge, innovative institutions already before ICT had been introduced in their country and continued to do good work through an effective and intensive use of computer technology in teaching and communication. Infrastructure was helpful and student support often needed but by far not instrumental. Most innovative efforts produced a diffusion pattern characterised by Rogers as "classic" for educational innovations.

In Hungary, results seemed to suggest a different pattern. Here, ICT infrastructure at schools plays a very important part in the initiation of educational reforms. Students who were considered individual receptors of teacher-generated information are now encouraged to construct their own knowledge and engage in creative, discovery based inquiry in realistic situations in teams.[12] Hungarian education that had been geared towards instruction in high quality abstract knowledge needed a strong

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[11] Richard Venezky and Cassandra Davis, *op. cit.*, p. 10.

[12] For a detailed description of the Hungarian educational system cf. Gábor Halász, Erika Garami, Péter Havas, Irén Vágó, "The Development of the Hungarian Education-

impetus – indeed *a new teaching–learning platform* – to alter classic views on teaching and learning. Apparently, in Hungary, computers actually acted as *Trojan horses* – smuggling an army of new methods into the fortresses of perhaps the most traditional public sector of Hungary: education. Though by far not practised by all schools in Hungary, those institutions that are sufficiently equipped have been much more motivated to upgrade their teaching culture than those who were left out of the computerization campaign. We discovered a *direct connection between the level of infrastructure and the innovative quality of teaching and learning* in the schools observed.[13]

Technology acted as an initiator of the reforms – but was it really a catalyst? Did it significantly contribute to the realization of innovative ideas and teaching–learning methods? Providing means is one aspect – another issue is the role of ICT in keeping up high level, innovative education. Here, our results approach those of other OECD countries more closely. Those Hungarian schools that had been innovative before the introduction of computers – for example, the first bilingual secondary school (www.karinthy.hu) or the first privately owned educational institution (www.akg.hu) – made a better use of the potentials of educational computing. Another group of schools in our sample, however – the tiny village primary school named after John von Neumann (www.enjai.sulinet.hu) or another primary school in a small town in a developing industrial area (www.almasi.mako.hu) initiated educational reforms clearly after the introduction of computer technology, inspired by its potentials. Therefore, we do not exclude the possibility of technology as a catalyst for better education although agree that a kernel innovation effort must be present at a school to be successful in making full use of the potentials of ICT.[14]

ICT did not change teaching styles but it definitely altered learning styles and created a new working relationship between teachers as learners to students as teachers. Teachers use the internet for learning more extensively but students are more advanced. Thus, knowledge manage-

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al System", http://www.oki.hu/article.asp?Code=english-art-bie.html; Gábor Halász, *Schooling for Tomorrow*, Budapest: OKI, 2001; on ICT-related developments see Andrea Kárpáti, "ICT in Hungarian Education: Who/What is inside the Trojan Horse of Education?", *International Journal of Educational Theory, Research And Practice* 2 (2000), pp. 23–30.

[13] Andrea Kárpáti, "ICT in Hungarian Public Education – An Overview", *Journal of Educational Multimedia and Hypermedia*, 2003, in print.

[14] Andrea Kárpáti, "ICT Culture in Hungarian Schools – results of the OECD Study from a Central European Perspective", *IFIP SEC III Conference Abstracts*, Dortmund: University of Dortmund, CD-ROM publication, 2002.

ment competency of educators may be enhanced by the technical competency of students. *In the area of mobile learning, these differing strengths and weaknesses may also create a mutually beneficial synergy.* In Table 2, we summarise a range of teaching–learning situations and mobile applications that may contribute to their success.

Teaching-learning activity	ITC-based activity	Mobile device option
Registration, organization and administration	Distance learning environment	WAP environments, automatic SMS dispatch systems
Collecting and arranging knowledge	Internet and CD-ROM-based search	WAP text search, mobile internet search
Co-operation, team work	E-mail, chat, discussion forum, teleconference	Voice communication, (in pairs or in conference), SMS, MMS
Consultation, mentoring	E-mail, chat	Voice communication in pairs, SMS, MMS
Setting tasks and supervision	E-mail	SMS, MMS
Discovery learning, individual knowledge construction	Virtual adventure and game environment	Collective games
Documentation	Digital image and text	Voice and text messaging, MMS
Evaluation and testing	Whiteboard, digital testing environment	Innovative solutions are needed.

Table 2: Mobile devices for education – some methodological options

Are PC-based and mobile communication options always compatible? Of course not. E-mail and SMS/MMS may serve similar functions at task setting, organization, mentoring, motivating, giving brief feedback, and record keeping of actions taken, but SMS and MMS fall short when it comes to correction, analysis, testing, and detailed evaluation of student work. On the other hand, the flexible use of mobile devices makes them an asset on field trips, or at project work carried out in a variety of in- and outdoor environments.

To quote just one example for the efficient integration of "stable", traditional and flexible, mobile devices, here is a school management tool developed to make use of mobile messaging functions that are, in some cases, quicker and more efficient than paper-based or even e-mail communication devices. More than 200 Hungarian schools have subscribed for the digital report book service (www.suli.info.hu) that sends an SMS stating the notes of their children gained any given school day. This software is run by school administrators who enter marks received by students at the end of each school day. The system in turn sends SMS messages to subscribing parents about the results of their child. This system may be undesirable not only for students but also for teachers whose mark giving strategies are less than professional or who do not regularly record notes, but parents and school principals praise the immediacy of information provided. *ICTs integrated with mobile communication devices may make schools more transparent* and empower parents to act as customers rather than victims of the educational system.

Mobile communication may have huge potentials as parts of *distance learning environments*. These platforms usually lack flexible person-to-person communication options. Integration of PC-based and mobile applications may substantially enrich these facilities and would contribute to authentic learning for students having little access to their mostly virtual alma mater. (Assessment of distance education environments reveal deficiencies and may offer ideas for co-operation: www.virtual-learning.at or www.c2t2.ca/landonline.)

Present situation (2002)	**Predicted situation (2020)**
Educational potentials restricted by technology	“Hardware is no longer hard”
Teacher-centred environment	Student-centred environment
Access unequal	(Reasonably) equal access
Medium = hidden curriculum	Customizable teaching and learning
Learning in educational institutions	Regional and national networks. Mobile learning outside school: at home, at work
Digital divide	Global networks – mobile communication. ICT against learning handicaps
Multiple national and international standards	Global standards

Table 3 : Research and development trends: Connecting the Future, Global Summit of Online Knowledge Networks, Adelaide 2002 [15]

[15] *Connecting the Future: Global Summit of Online Knowledge Networks*, Adelaide, 2002, http://www.educationau.edu.au/globalsummit/papers.htm.

Educational researchers with a futurist perspective (cf. "The School of the Future", a UNESCO project,[16] and NASA's The Classroom of the Future Project[17]) predict a paradigm shift towards learner-centred education. In the school of the future, presence and distance education will be mixed and the customisable teaching content will be available on demand. Individualised assignments with teacher scaffolding will replace most of frontal lecturing. If this will be the case, mobile mentoring may be an invaluable asset. If GSM companies continue to widen their downloadable information options, the handheld phone or PDA may be used as an ever-present tool to access knowledge. Homework that requires little text and few images will be submitted through SMS and MMS to automatic distribution and monitoring facilities that give instant SMS feedback pre-programmed by teachers.

> Education systems are under pressure on two main fronts. First, to adapt to changes in society, which, as it becomes a learning society, has rising expectations for education. This includes the implications of lifelong learning; if schools create the required learner that society needs they will need to be provide more flexible, individual and learner-driven learning offers. Second, the school as a "house of knowledge" is increasingly facing competition from other knowledge sources, including information and entertainment, and from enterprises that define themselves as knowledge producers and mediators.[18]

The new object of study, therefore, is "the *personalized classroom*: a learner-centred environment preparing young people to take their place in the information society. It integrates people, tools and resources, offering the learner of compulsory schooling age access to customised *networked learning* (n-learning) anywhere anytime through the *networked school* – a school without walls." According to ERNIST, the international ICTs expert network of the European Schoolnet (http://www.eun.org/ernist), three phases can be discerned in building educational computer networks in Europe. In the first phase, infrastructure was the key issue, in the second, developing ICTs broadband connectivity was in focus. In

[16] D. Passey and B. Samways, (eds.), *Information Technology: Supporting Change Through Teacher Education*, London: Chapman and Hall, 1997.

[17] P. A. Carlson, L. Ruberg, T. Johnson, J. Kraus, A. Sowd, "Collaborations for Learning: The Experience of NASA's Classroom of the Future", *Technological Horizons in Education Journal* 25 (1998), pp. 50–53.

[18] *ICT: Policy Challenges in Education*, Paris: OECD, 2002, p. 5.

the third phase, however, the transformation of the school as a teaching–learning institution is targeted. Mobile communication should occupy in this phase a similarly important place as it does in "real life", outside the school building.

The THINK Study of the European Schoolnet, (http://www.eun.org /eun.org2/eun/en/Insight_Policy/content.cfm?ov=19103&lang=en) identified 4 scenarios:

Scenario 1: ICT strengthens the centralised regulation of schooling. This scenario develops in a political context marked by a generally held view that schooling needs to change and improve significantly in order to further the economic prosperity and well being of the nation and the individual.

Scenario 2: ICT supports the creation of schools as "learning organizations". There is a shared political sense about the general direction of change in education that is needed to ensure future prosperity and well being for both public and private lives.

Scenario 3: Citizenship at the Centre: ICT supports the emergence of schools as core nodes in their communities. This, the most radical of the scenarios, develops in a national context marked by generous economic investment, historically high levels of public confidence in the state school system and a tradition of de-centralised responsibility for curriculum planning, assessment and accreditation of learning.

Scenario 4: ICT fails to deliver: technology melts down. This scenario is designed to identify and discuss indicators that, in five years time, could acts as signals of the fact that a school system is failing to gain the expected benefits from ICT and that the public school system is in trouble.

It is hoped that a more optimistic scenario will be realised. Educational research and innovation heads towards the first three scenarios. The classroom of the future, according to one of the world leaders in educational computing, the ICT Learning Laboratory of the Singapore National institute of Education (http://www1.moe.edu.sg/iteducation) will be based on completely wireless communication with hand-held, palm-top and laptop devices integrated in the learning process as equals. Research on how these tools make education more personal, more effective and more exciting is perhaps the next big challenge for educational researchers who should soon turn from more or less reluctant users to partners in the development of mobile communication devices.

Andy Stone
Graham Alsop
Chris Tompsett

Grounded Theory as a Means of User-Centred Design and Evaluation of Mobile Learning Systems

Introduction

The Learning Technology Research Group (LTRG) is currently engaged in the use of Grounded Theory as a methodology for studying students' uses of learning management systems (LMS). The rationale for selecting Grounded Theory as the methodology, and initial findings can be found in other publications.[1] We are also actively involved in research into the effective use of mobile technologies in supporting our students, to complement use of LMS and other technologies in use at Kingston.[2]

This paper begins with an introduction to Grounded Theory, by providing an overview of the process involved, and then explaining how a theory is developed. We then draw upon some of the initial findings from the LMS study to demonstrate the potential application of mobile learning systems to complement LMS use, and other research undertaken elsewhere, to illustrate the basis for which we feel this approach can be used to inform the design and evaluation of our mobile learning systems.

The following two sections are a synthesis of work documented elsewhere,[3] with some further elaboration of certain points, based on feed-

[1] Cf. e.g. Graham Alsop and Chris Tompsett, "Grounded Theory as an Approach to Studying Students' uses of Learning Management Systems", *Association for Learning Technology Journal*, vol. 10, no. 2 (2002), pp. 63–76; Graham Alsop and Chris Tompsett, "A Grounded Theory Investigation of Students' Perceptions of Learning Management Systems", in *Proceedings of the 9th International Symposium on Improving Student Learning, 2001*, Oxford: 2002, pp. 112–124.

[2] Andy Stone, Graham Alsop, Jonathan Briggs, Chris Tompsett, "M-Learning as a Means of Supporting Learners: Tomorrow's Technologies Are Already Here, How Can We Most Effectively Use Them in The E-Learning Age?", in P*roceedings of the Networked Learning Conference*, Sheffield, UK, 2002; Andy Stone, "Mobile Telephony and Learning: Nuisance or Potential Enhancement?", in *Proceedings of ISTAS'02*, IEEE, Raleigh, USA, 2002, pp. 262–266.

[3] See the papers referred to in note 1.

back obtained from the presentation of this paper at the Budapest 2002 m-learning conference. There are some important points which are key to this approach which ought to be made as clear as possible for the interested researcher, who may be new to this technique.

Grounded Theory – An Overview of the Process Involved

The Grounded Theory method requires that the full research process is grounded in the data that is collected. It is accepted that the researcher is inherently bound up in the process of the research, and thus will not be external to the data collection and subsequent interpretation of it. This is the case with many qualitative methods. In grounded theory, the data collection and interpretation processes take place on a cyclical basis. The initial low-level data analysis provides a basis for simple levels of interpretation. This then provides a basis for subsequent rounds of reinterpretation of the existing data, and where possible the collection of further data.

In addition to being a cyclical process, this process requires a number of iterations, which is focussed on the viewpoint and perspective of the subject. However, it is accepted that the researchers cannot approach a subject without their own endogenous bias (i.e. their personal views). Throughout the whole process, there is an implication that the results obtained will be dependent on the implicit involvement of the researcher – however, this can be managed by taking care to record the process of interpretation itself. In this way, the researchers' initial interests, subsequent comments and possible interpretations are treated not just as information external to the analysis, *but are considered and recorded as data within the project itself*. This is where the strength of the methodology lies – in the "suppleness" which its process and data contains.

There is a possibility that different researchers might not agree on results; such differences can be regarded as a logical consequence of a constructivist epistemology. The validity of any resulting "theory" can be justified by the fact that this process allows other researchers to review an explicit "audit trail" containing the researchers' contextual "baggage" that they have brought to the project, as well as the analysis they have undertaken on the raw data. This allows a "step-by-step" sequence of interpretation, recognizing that the individual bias and interpretation would not necessarily be identical.

The extent to which the researchers have shared the same values and frameworks during the process of their work may determine the extent to which different researchers would accept the same conclusions – providing these different researchers have made explicit their own interests, and these perspectives are clearly stated in any work they may undertake with the data, their outputs would make explicit their own (otherwise implicit) value judgements they have thus imposed by interacting with the data.

Grounded Theory – How a Theory is Developed

As with the process, the development of a theory is a cyclical phenomenon: existing data is used to build a theory. As this develops, the depth of interpretation will increase, as will the coverage of the developing theory across the individual subjects. The first stage is to generate a catalogue of the terms and concepts used by the subjects, known as "open coding". The catalogue generated by the open coding process is then used to generate what is known as an "axial model".[4] This is defined as a time-sequenced framework that establishes the interrelationships between the concepts within the open coding. The axial model develops the interpretation of the subjects' perception of the problems that were being solved: e.g. the conditions controlling what was possible; the choices that were open to them; and their assessment of what was and was not successful.

Once the axial model appears effectively structure the data collected, it is then summarized by the "core category" – the identification of a single bounding concept. This core category encompasses a framework within which all the subject's perceptions can be included. In practice, there is a constant cycle between the last two stages; the eventual intent being for a theory to be developed whereby the core category can provide a summary that allows all the data to be interpreted within the axial model – and thus the core category itself.

The validation of these last two stages of the process is achieved using a recursive process known as "theoretical sampling", where concepts and issues that are already relevant in the current axial model are used to search for new cases to be integrated into it. It is entirely possible for the newly gathered data to introduce new concepts or variables that will enrich the open coding stage of the process, increase the complexity of and change the axial model, or perhaps even result in a redefinition of the core category. When this process comes to an end, a process of uncertain length, the research is considered to be complete and the model

[4] A. L. Strauss and J. Corbin, *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*, Newbury Park, CA: Sage, 1990, p. 96.

is said to have reached "theoretical saturation".

The outline of the process might suggest that existing literature in the field is ignored, but this would be illogical if the theory is, itself, to have predictive value. Concepts and models from literature are treated here as frameworks that have been created by other stakeholders outside the immediate focus of the research. There is no direct implication that they should apply to the conceptual framework used by subjects. Existing literature is treated as a further source of material to be used in developing theoretical saturation. Awareness of possible frameworks from the literature, termed "theoretical sensitivity", allows possible issues to suggest areas for data collection, as long as there is sufficient evidence from what has been collected already.

How Grounded Theory Research in Learning Management Systems Can Justify Use of the Same Technique in Mobile Learning

Some of the findings from the Grounded Theory research relating to Learning Management Systems (LMS) have a direct bearing on two particular issues critical to the justification of the adoption of mobile learning – time and location: "'Time management' was established as a focus within a core phenomena of a 'network of beliefs'... For many, travelling is a significant element of unproductive time... releasing time ... offers the potential for improving student learning... remote access is seen as a fundamental transformation of the student experience."[5]

These issues have also been identified in research undertaken elsewhere, by Lee and Perry,[6] who assert that time (particularly work time) "is itself made mobile ... freed from the constraints of location and resources ... and this is supported and made possible by new (mobile) technology". We feel that such observations are consistent with the notions of complementary media and complexity, as referred to elsewhere,[7] and provide a reasonable basis for using Grounded Theory to inform the design and evaluation of mobile learning systems.

[5] Alsop and Tompsett, "A Grounded Theory Investigation...".

[6] H. Lee and M. Perry, "Contextualising Virtuality: Polychronicity and Multipresence", in *Proceedings of the International Conference on Spacing and Timing: Rethinking Globalization & Standardization*, Palermo, Italy, 1-3 November 2001.

[7] Andy Stone, Graham Alsop, Jonathan Briggs, Chris Tompsett, *op. cit.*

A Brief Comment on Overcoming Possible Negative Perceptions of Mobile Telephones by Decision-Makers and Other Key Stakeholders

It should be evident that for any trial, let alone a rollout to a full service, to succeed, involvement and motivation will be required from all parties concerned. For example, alert systems and interactive applications may be used in any location, including places where the irresponsible use of mobiles is regarded as a distraction and nuisance (for example, libraries). Informal discussions with librarians, teachers, and other stakeholders have already flagged this as a potentially significant issue. Such individuals may also be key decision-makers in the deployment of service trials – if they have an overall negative perception of mobile telephones in general, this may delay, or even block important development work.

Current (general) perceptions of mobiles are still negative in some quarters – examples of this, based on both anecdotal evidence and literature, have been reviewed elsewhere.[8] This may impede acceptance of mobiles as "valid" or appropriate technologies to be used in education, in the minds of some, although we propose the adoption of a "carrot and stick" approach when introducing useful services to students, conditional upon adherence to agreed guidelines for responsible usage of mobile telephones in quiet areas, for example.[9] By adopting a Grounded Theory approach, we will also be able to identify if this is an issue early on in our trials, which will be an invaluable evaluation tool.

Conclusions

This study is a "work in progress", and we are currently engaged in the process of interviewing students across Kingston University, and coding the results. It has been acknowledged elsewhere that there is value in producing less definitive results, rather than a complete theory in many more months' time.[10] Even at this early stage, some interesting initial observations have emerged.

It should be noted that whilst we were interested in how students use mobile phones to collaborate, we felt it would be instructive to frame a

[8] Stone, *op. cit.*

[9] *Ibid.*

[10] Martin Oliver, "An Introduction to the Evaluation of Learning Technology", *Educational Technology and Society*, vol. 3, no. 4 (2000), pp. 20–30.

question which did not explicitly refer to mobile devices. From informal interviews, we expected SMS to feature in the responses, but in order to neutralise our own endogenous bias, we asked students to describe best and worst experiences of using communication to work collaboratively.

In the data collected, two technologies were mentioned in nearly equal proportion: SMS as we had expected, but also the use of Instant Messaging (IM) software. Whilst this is not a truly "mobile" technology, students can work collaboratively at more than one location, enabling some form of mobility for the group. Furthermore, since the time of the data gathering process, there have been announcements of next generations of mobile phones containing IM software.

The second point is that students use these tools to plan face-to-face meetings, supporting our hypothesis that notions of complementary media and complexity are consistent with the notion of time becoming mobile as outlined above. Finally, the examples given were for both work and social purposes, hinting at self-management of the "work/life balance". These three factors will be instructive in further research into developing the most effective m-learning applications in the future.

Attila Krajcsi

Mobile Learning in Mathematics

Computer technology provides advanced solutions, and is mobile in two senses: high performance computers are small enough to take anywhere and can be connected to a network almost everywhere. Therefore, computer technology is ready for mobile learning. However, writing truly intelligent and interactive programs still eludes us, because cognitive science still lacks complex models of understanding and high-level problem solving. Therefore, cognitive science is not ready for mobile learning. Still, cognitive science can help educational specialists and software makers a lot with building effective software and using it intelligently. Five techniques used in applications where cognitive science has an essential contribution shall be reviewed.

Introduction

Cognitive psychology or cognitive science can help in building effective educational software. This review will discuss five frequently used techniques in programs and show how psychological knowledge can improve their effectiveness. Despite the good examples, it is important to point out that education still lacks truly intelligent systems. The first section will reflect on the role of computer technology. Next we will take a look of some frequently used techniques and how cognitive science can improve their usefulness. Finally we will take into consideration the limitations of cognitive science in helping to create educational software, and show that the main reason for the failure to build intelligent systems is that cognitive science lacks models of understanding and complex problem solving. Most of the examples come from the field of mathematical cognition, because cognitive science can reveal many details about the underlying processes in mathematical problem solving, and much software has been dedicated to these ends.

Technological Possibilities

The hardware industry has advanced technology for making effective computers. Small-sized notebooks have almost the same abilities as desktop computers. Recently introduced tablet PCs might be the next generation of this technology, and PDAs are small and fast booting computers with a long battery life. These computers are mobile in the sense that they are lightweight, can be taken anywhere, and they are smart enough to run almost any program that can be run on desktop computers. On the other hand, these computers are mobile in another sense: they can be connected to a network. Mobile phones as modems or built-in modems can be devices used for these purposes. *Computer technology is ready for mobile learning.*

But we are still lacking effective mobile educational applications. One answer might be that mobile technology is still young and has had no time to develop mature applications. Though this is true, the problem may be more general. We still need effective educational software not just in mobile learning, but in general. Computers are advanced enough for more complex programs, but programmers don't know how to create these. I would like to give some examples of how cognitive science can help in improving applications and what the limitations today are. My conclusion will be that *the limitations are not technological, but psychological or cognitive.*

Techniques Used in Educational Software

This section will introduce the five most frequently used educational programs, and show how cognitive science can help make them more powerful. This will be the brighter side of the story. The next chapter will show what the limitations of today's theories are.

1. Textbooks

Most educational programs are simple textbooks, even if they use new tools such as hyperlinks and multimedia that are unavailable in traditional paper-based textbooks. However, the use of these new tools is not a trivial issue. Our example will be hyperlinks.

Some years ago, when hyperlinks began to spread, supporters claimed that hyperlinks were extremely useful in texts because they imitate the associative nature of human thinking.[1] Now on the one hand it is true that human thinking is associative, for example in case of the mental lexicon.[2] Words are ordered in a mental network based on similar meanings, subsets, synonyms, antonyms, etc. But on the other hand there are many cases where knowledge is not organized in an associative way, but in a way that is more structural and hierarchical. For example, when we are trying to understand a story we use "scripts" to build a representation.[3] Scripts are special kinds of hierarchical schemas with slots to fill. Every time we hear a narrative, we try to find a matching script for that story. We try to fill the empty slots, otherwise we can use assumed default values even without hearing about the details. For example, there can be a general schema for going to a restaurant. Someone might tell us that he's gone to an elegant restaurant, ordered something and met an old friend whom he hasn't seen for a long time. Though he hasn't talked about the payment, we still suppose that he paid at the end of the dinner because the restaurant script would predict this detail as a default value.

Thus it is not true that in general human thinking is associative: often we do not use associative representations. We do not use such representations when we are browsing the web. Some years ago when the first webpages appeared, authors put hyperlinks anywhere throughout the text. But recently, popular websites haven't been following this tradition; rather, they put hyperlinks below the main text. (There are frequently some other links that can be found at the side of the page, these links however are usually not connected closely to the content of the text, but to the content of the website generally.) What can be the reason for this? One explanation may be a technical one: with the usual dynamic database technology, it is easier to make links at the end of webpages than put them into the text. Actually, mid-text links can be built easily with today's technology even with a dynamic webpage, and some websites in fact use that solution. Another suggestion might be that the website makers do not want visitors to go to another website too quickly, and

[1] Two illustrative examples of this view are Nataša Hoić-Božić, *Hypermedia Supported Education*, Chapter 2.1.1, http://top.pefri.hr/mr/ch2_1_1.htm, and Kristin Roijen, "Education by Server-Based Instruction: Impacts on the Library", http://www.bokis.is/iod 2001/papers/Roijen_paper.doc.

[2] See for some introductory reviews: Lawrence W. Barsalou, *Cognitive Psychology*, Hillsdale: Lawrence Erlbaum Associates, 1992, and Steven Pinker, *The Language Instinct*, New York: HarperCollins, 1994.

[3] Roger C. Schank, *Dynamic Memory Revisited*, Cambridge: Cambridge University Press, 1999.

want to make them stay on their advertising place as long as possible. This may be true, but there's a cognitive reason as well. Jumping from the middle of a text while processing it (and filling the empty slots of scripts) can decrease later performance in understanding or remembering. A solution might be that suggested links should be placed at the end of the text with a short reference to the exact issue they can give extra information about. So first one can read, process, understand and store the text before looking for any extra information.

Other better-known examples could be given regarding how psychological research can help determine what kind of fonts are comfortable to read, where to put advertisements to attract attention, what kind of sitemap to use to find information easily, etc.[4]

2. Aiding Tool

There is a strong debate on the issue of whether calculators should be used in solving mathematical problems at school. This section will give three examples where calculators can be useful.

When solving a problem, we use a short-term storage system where information can be temporarily stored and manipulated. This kind of memory, called working memory – as a kind of temporary working place or desk – has a limited capacity, so we can not work on an unlimited amount of problems at the same time. This system is used at many stages of solving arithmetical tasks, such as understanding word problems, arithmetical computation, planning the solution, etc.

Many tasks need several steps, though the capacity of working memory narrows down the possibilities. From the viewpoint of education (and psychology) we can give some subtasks preference: usually we think that understanding the task and complex situations are more important in education than mechanical calculation. For this reason, if we want to emphasize the priority of understanding and other complex processes in education, it would be better not to load working memory with extra subtasks like mechanical computation. Experimental evidence shows that loading several subcomponents of working memory can damage the performance of arithmetical tasks.[5]

[4] For some illustrative examples see these journals: *Computers in Human Behavior*, http://www.elsevier.nl/locate/comphumbeh; *International Journal of Human–Computer Studies*, http://www.academicpress.com/ijhcs; *CyberPsychology and Behavior*, http://www.liebertpub.com/CPB/default1.asp.

[5] For the role of central executive see Mark H. Ashcraft, "The Relationships among

Another example of reasonable calculator use in education involves the choice between different strategies. The mind tries to find the most economical solution for a task every time. For instance, one can add a number several ways. In fact, children choose between these strategies.[6] Let's suppose the task is to find the sum of 3 and 4. The youngest children count in the following way. First they count to 3: one-two-three, and then add four: four-five-six-seven. Older children know that they don't have to count up the first number, but can start from 3 directly: three, and then add four: four-five-six-seven. Still older children know that it is easier to start with the bigger number; it is quicker to start with four. Four, and then add 3: five-six-seven. The oldest children know that $4 + 3 = 7$ by rote learning, because they have met with this problem so many times that they don't have to count anymore, i.e. they have learnt the fact. In adults, there can be a similar kind of decision based on whether they calculate the result or know it by rote learning. Each kind of solution has some advantages and disadvantages as well: rote learned facts can be recalled fast, with relatively small effort and recall does not need much working memory capacity. On the other hand, rote learning first needs some investment: we have to learn every fact, which is an expensive process in the economy of the brain. Calculation needs some learning as well, but these processes are more general: once you have learnt how to add two numbers, then you can add any two numbers no matter how big these numbers are. However, calculation is slower and needs more working memory capacity. With these parameters, decision depends on frequency: if you run frequently into a specific task, it is better to learn the exact facts and use rote learning. On the other hand, if you rarely meet a specific problem, the process of calculation could be a better choice. In a time when every mobile phone, PDA and many other tools contain a calculator, the role of the calculation process should be emphasized more strongly.

The third example deals with a quite frequent arithmetical disability called dyscalculia. People with this problem have a very weak number sense and can barely learn the easiest calculation processes, facts (like features of the multiplication table) or even to write down Arabic numer-

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Working Memory, Math Anxiety, and Performance", *Journal of Experimental Psychology: General*, vol. 130, no. 2 (2001), pp. 224–237. For the role of phonological looping and spatial-visual sketchpads see Alan Baddeley, *Human Memory: Theory and Practice*, Hove: Psychology Press, 1997.

[6] Robert S. Siegler, "Strategic Development", *Trends in Cognitive Sciences*, vol. 3, no. 11, 1999, pp. 430–435.

als or count to a small numeral like five. Many surveys show that approximately 5% of children have this special disability.[7] These people have everyday problems with telling the time or doing the shopping. Calculators can be an aid for people with dyscalculia and other solutions should be found with more specialized applications on PDAs or smart phones.

3. Experimenting

Several pedagogical and psychological schools emphasize the role of understanding, construction, and personal experiences in the process of learning. Computers can be artificial environments with many experimenting possibilities that would otherwise be hard to implement. One famous example in mathematics is the *LOGO* implementation of *MicroWorlds*.[8] With this easy-to-learn program language and programming environment, children can explore and discover artificial settings on their own. (See Figure 1 for two examples.)

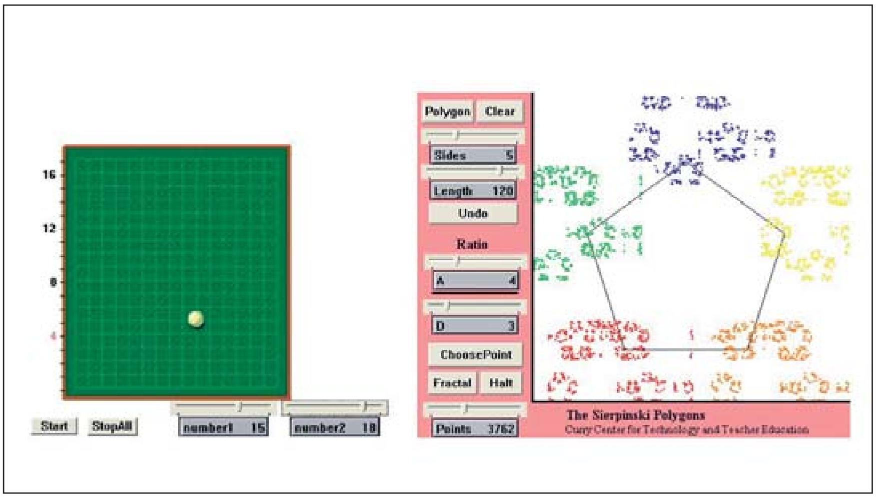

Figure 1. MicroWorlds tasks[9]

[7] Ruth S. Shalev and Varda Gross-Tsur, "Developmental Dyscalculia", *Pediatric Neurology*, vol. 24, no. 5 (2001), pp. 337–342.

[8] For a downloadable demo and non-technical descriptions see the website of MicroWorlds: http://www.microworlds.com.

[9] Several mathematical (and other) tasks can be found in the MicroWorlds library: http://www.microworlds.com/library/index.html.

The activity of the children and the non-direct attitude represented by teachers are important values in the view of constructivist educational theorists. The computer environment has a special role: MicroWorlds is not a program that teaches knowledge directly, but rather an environment where children can explore a world that otherwise could be hard to implement.

4. Programmed Learning

With the advent of computers one of the first applications in education was programmed learning. This technique was inspired by behaviourism, a school in psychology at the beginning of the 20th century which stated that human beings are simple machines connecting stimuli and responses with simple reflexes. One important learning mechanism is operant conditioning, where good answers (or responses) for specific stimuli are rewarded and bad answers are punished. All we have to do is to give rewards and punishments to the student and anything can be taught.[10] The programs that believed in this idea used a quite simple and

Figure 2. Programmed learning examples

[10] Watson's classic paper is available online: John B. Watson, "Psychology as the Behaviorist Views It" (1913), http://psychclassics.yorku.ca/Watson/views.htm.

easily-programmable structure: first we have to give some information that should be learnt (for example, a text about an historical event, etc.), then we have to ask some questions. If the students answer correctly, we can go on with the next topic. But if they fail, we can present the previous material again, or give extra information or more details about the topic of difficulty.

The idea was quite simple and easy to implement, but the problem is that it didn't work. Educational practice did not verify this theory: though students can mechanically answer the questions, they do not understand what they have learnt and cannot use the information. Nowadays we envisage a more complex learning theory, and many models emphasize the role of understanding and complex processing. Does this mean that rote learning is unnecessary? Not really. In the *Aiding Tool* section we have seen that rote learning sometimes can be useful (by recalling arithmetical facts); recent theories are justified to lay stress on the role of meaningless verbal rote learning.

Dehaene's Triple Code Model[11] states that we use three different kinds of representations when we solve simple arithmetical tasks. Each module uses different kinds of representations, different inputs and outputs, and can solve different typical tasks. The localization of these modules can be seen in Figure 3. Magnitude representation can be imagined as a mental number line. The closer two numbers are to each other, the more similar the representations of them are. This magnitude representation can be used for rough comparisons of two sets, or for approximate calculations (e.g. 15 + 26 is around 40 vs. 70). The verbal system

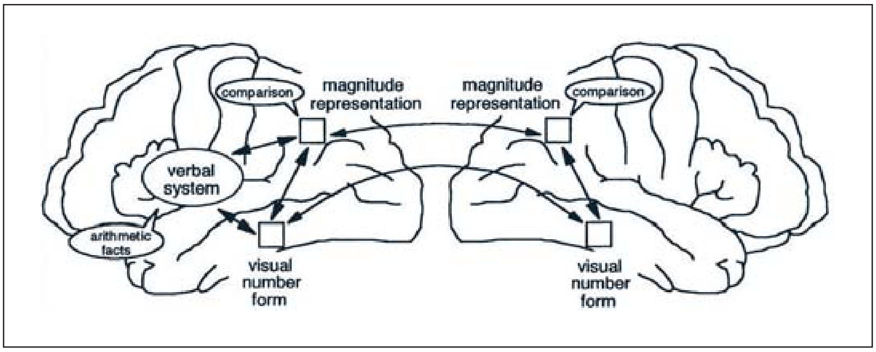

Figure 3. The localization of the Triple Code Model hypothesis

[11] Stanislas Dehaene, "Précis of *The Number Sense*", *Mind and Language*, vol. 16, no. 1 (2001), pp. 16–36.

uses (not too surprisingly) verbal representations, and can be used for exact calculations and the rote learning of various facts (e.g. the features of the multiplication table or determining the exact result of 6 + 5). The visual number form uses Arabic numerals and is used for operations such as calculations in writing or for storing the parity of a number.

To show the role of the verbal and magnitude representation, Spelke and Tsivkin devised an elegant series of experiments.[12] Russian and English bilinguals had to practice some exact large addition (e.g. 56 + 47 = 103 vs. 113) and approximate logarithm and cube root tasks (cube root of 29 is approximately 3 vs. 4). The tasks were displayed to them in written textual form: to one group in English, to the other in Russian. After learning the task in one of their languages, they were asked again to solve it, both in the language the learning took place, and in the other language (e. g. if the learning took place in English, they had to solve it both in English and in Russian). Exact large addition was slower when changing the language, which can be seen as evidence for using a language-dependent representation for storing these facts with translation requiring extra time. But approximate logarithm and cube root tasks are as fast in the new language as in the old one, which suggests that a language-independent representation is applied to the task regardless of which language is used.

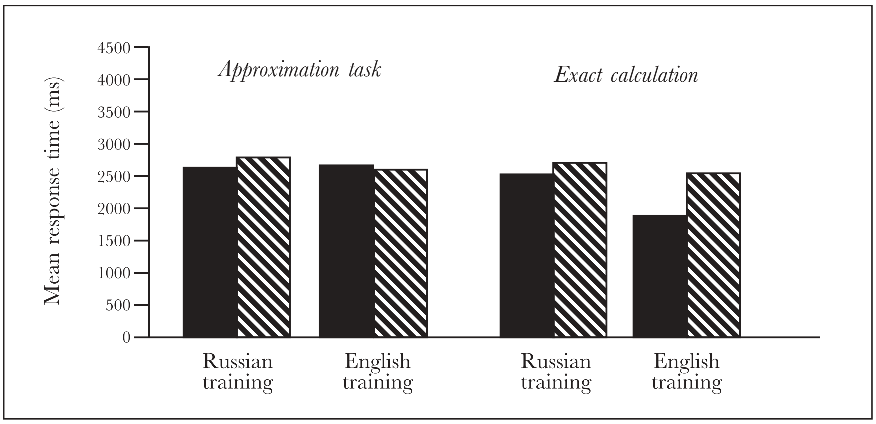

Figure 4. Mean reaction time for learned facts in the original language (solid bar) and in the new language (striped bar)[13]

[12] Elizabeth S. Spelke and Sanna Tsivkin, "Language and Number: A Bilingual Training Study", *Cognition* 78 (2001), pp. 45–88.

[13] After Spelke and Tsivkin, *op. cit.*, p. 55.

These results suggest that exact facts are stored verbally as a kind of poem and though understanding is important, some meaningless knowledge (which can be combined with meaningful elements) can be useful in mathematical education, and mechanical programmed learning can be useful in practicing these facts.

5. Intelligent Tutors

All the techniques mentioned above are not really interactive or intelligent. There is an excellent example of how cognitive research can help to create brand new technologies for educational purposes. First we have to understand a short description of a simplified architecture of the ACT-R theory proposed by John Anderson. It has two simple parts (see Figure 5): working memory and long-term memory. Working memory is a kind of working place with limited capacity. Long-term memory keeps two kinds of information: declarative knowledge and procedural knowledge. For our purpose, it is enough to understand the role of procedural knowledge. This knowledge covers well practiced rules that can be used in specific situations. The next example will show how it works.

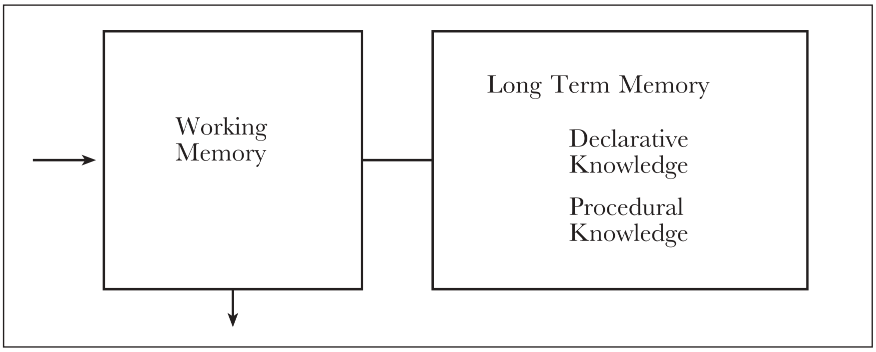

Figure 5. Simplified architecture for understanding ACT-R

In the *Balance problem*, the subject has to tell if the left or the right side of a balance will go down (see Figure 6). One has to take into consideration the weights, the distances and sometimes the torque. Let us suppose that typically those who are able to solve the problem perfectly in any combination have some procedural rules in their heads as can be seen in Table 1 (Ignoring for now the cardinal problem of how we can know that these rules really are in someone's head.) Every procedural rule has a condition (after the IF) part and an action (after the THEN) part.

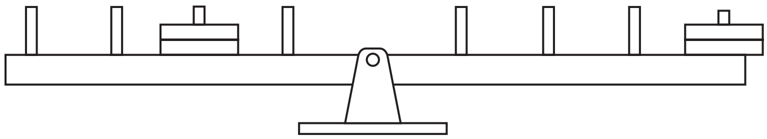

Figure 6. Balance problem

P1	**IF weight equal THEN say „Balance"**
P2	**IF X side greater weight THEN say "X down"**
P3	**IF same weight AND X side greater distance THEN say "X down"**
P4	**IF X side more weight AND X side less distance THEN compute torque: t1=w1 x d1; t2= w2 x d2**
P5	**IF X side more wight AND X more distance THEN say "X down"**
P6	**IF same torque THEN say „Balance"**
P7	**IF X side greater torque THEN say "X Down"**

Table 1. Production rules that can solve the Balance problem[14]

The system will check if the condition part of any rule is satisfied in the current situation and then executes the action part of the satisfying rule. (There may be situations where several rules can satisfy the actual situation, but there are processes that can solve the problem of choosing only one rule.) Table 2 shows some cycles of the working system. The first column shows the number of the cycle, the second column shows the actual content of working memory (the situation that can be seen by the subject or the result of some computations) and the third column shows the rule with a condition part that satisfies the actual situation (the content of the working memory) and with an action part that will be processed as the result of the cycle.

[14] After John T. Bruer, *Schools for Thought*, Cambridge, MA: MIT Press, 1993. Bruer's presentation here is based on a 1985 paper by Robert Siegler.

Cycle	Working Memory	Production
1	Left: weight=5, distance=3; Right: weight=4, distance=4	P4: IF X side greater weight AND X side smaller distance THEN computer torque
2	Left: torque=15; Right: torque=16	P7: IF X side greater torque THEN say "X down"
3	Say: "right side down"; no match	Stop

Table 2. Working of a production system[15]

Though the ACT-R architecture and the way of processing rules, as well as the content of working memory are quite simple, they are extremely powerful. With some methods (not discussed here), the rules used for solving a problem by a typical person can be found and built into a computer, and these programs can be used for education. *Cognitive Tutor*[16] is an example of such a program. Figure 7 shows a screenshot. The program shows the task (in the *Scenario* window) and will get input from the user (in the *Worksheet* and *Solver* windows). At the same time, there is an artificial expert system running in the background, a production system discussed above and a special comparison module that tries to match the partial results of the user and the partial results of the inner expert system. With this comparison, the matching module can follow what the solver is trying to do to get the result, whether they are on the right track or not, or if they are trying to do something regarded as ruled out. When the comparison module thinks that the solver is going the wrong way and will not find the solution, it can give some hints.

[15] After Bruer, *op. cit.*

[16] For more information on this software see the website of Carnegie Learning: http://www.carnegielearning.com.

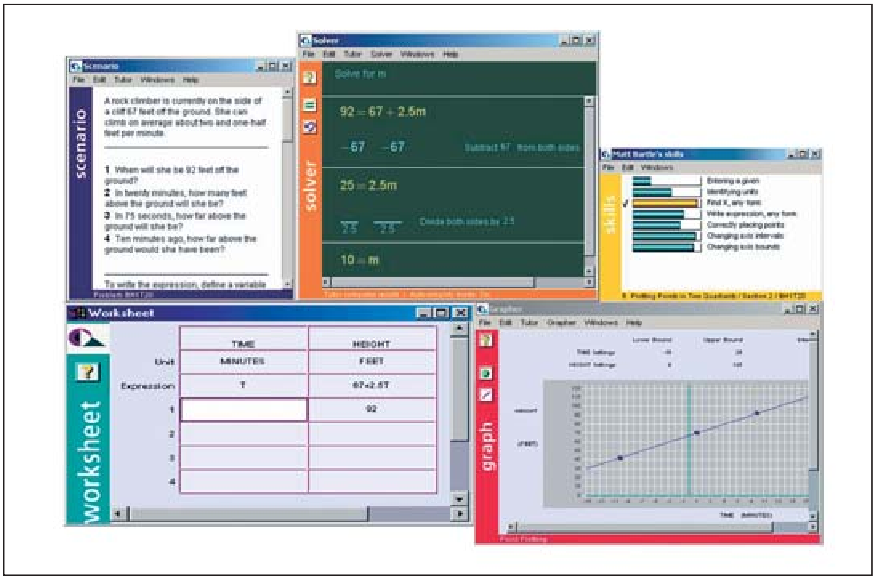

Figure 7. Screenshot from Cognitive Tutor [17]

This method is really interactive and intelligent in the sense that it knows and as it were understands what the problem solver is doing.

Limitations of Cognitive Science

The psychological models and statements mentioned up to this point are not too complex, except the ACT-R system, in the sense that they do not try to represent complex structures of understanding. All the discussed psychological models are useful enough to help make more effective applications, but are not powerful enough to build really intelligent and interactive programs (again except the ACT-R model, but it too still has its limitations).

Clearly, one cannot build intelligent and interactive software without knowing what is going on in the problem solver's or student's head. The best solution we have found so far uses an artificial model of the student. So the key question is whether cognitive science can give an account of what we do when trying to understand complex situation or solve high-level problems.

[17] From the website of Carnegie Learning: http://www.carnegielearning.com.

Scripts are quite a sophisticated conception and one of the best ideas how to build complex representation of a complicated situation, but they still are not able to model high-level understanding. Working memory theory and multiple strategies are useful in explaining how calculators can be used, but they do not help make computers a real helper and they are just teaching aids. Constructivism can be a good theoretical framework to find efficient educational methods and tools, but it is not specific enough to make computer programs. Programmed learning is a simple tool and modern cognitive research can establish circumstances where it can be usable, but it can only be applied to simple mechanical knowledge. (Actually, we still do not know how the brain can memorize a poem or a new word, but functionally this is not a mystery and can be modelled easily.)

Because cognitive science cannot give an account of how humans understand complex situations and solve high-level problems, it cannot establish a model for building computer systems. The main obstacle to creating valuable applications is not technological, but cognitive. The point is that hardware might enable the making of more intelligent programs, but because of a lack of psychological knowledge, programmers do not know how to create such programs. So computer technology is ready for mobile learning, but cognitive science is not.

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Supporting Observation Tasks in a Primary School with the Help of Mobile Devices

A Pilot of the Digital Learning Project

Introduction

The Digital Learning project is financed by TEKES (the National Technology Agency in Finland) – and implemented partly at the University of Tampere, Finland. As part of this project, a primary school pilot that utilizes mobile devices (Nokia Communicator 9210) and digital camera has been conducted. In other pilots we have focused on learning that happens at work or at leisure time. Based on findings in this and other pilots we will create innovative future mobile learning scenarios for schools and corporate use.

The goal of the Digital Learning project is to explore innovative future learning practices, which are related to mobility and the new forms of both studying and working from a pedagogical perspective. We see mobility as mobility of the terminal and relative non-alignment of activities from time and place. The research work is aiming to facilitate the development of mobile learning and its evaluation. For this purpose we have developed the components of a mobile learning evaluation model. One special area of interest is to test and evaluate mobility in a primary school environment. In the first stage of the exploratory primary school pilot the main research question was: *What kind of challenges and possibilities can mobile devices bring to the learning process in primary school?* Our hypothesis was that mobile devices can help in making the learning process more meaningful.

The aim of this article is (1) to identify what we count as mobile learning, (2) to present an evaluation framework for mobile learning created in the research process and (3) to introduce a primary school pilot of the Digital Learning project and to describe its preliminary results and the future work. This article's perspective is educational and it does not focus on mobile devices' technical details or comparison.

Mobility and Collaboration Models

Mobile technology has not been widely used in learning situations or in teaching.[1] Actually, mobile devices are relatively new devices in this area of research. That is perhaps the reason why there are only few models available to indicate how mobile devices and related (wireless) network services can be used in learning situations. Several research projects are however going on or are beginning. Many research groups are seeking for answers how these little devices can be used in learning and teaching processes in a meaningful way but few research results have been reported so far.

Luff and Heath[2] discover three types of mobility: micro mobility, local mobility and remote mobility. Micro mobility is the way in which the artefact may by mobilised and manipulated for various purposes around a relatively circumscribed, or "at hand" domain. Local mobility is more scattered: for instance, walking between classrooms, floors and different buildings of the school area at a local site. Remote mobility is when remote users interact with each other using technology.[3]

Another CSCW originated approach is presented by Churchill and Wakeford.[4] Their approach takes into account the fact that information need varies in different situations and the needs to be connected (levels of mobility) are related to this information need. According to Churchill and Wakeford tight mobility is the need for real time synchrony while on the move. Tight mobility is also highly collaborative. Loose mobility indicates the requirement of asynchronously accessing documents on the move. Loose mobility is not collaborative at the ground level of working practices, but it can be seen as a highly co-operative process.

An example of tight mobility in a primary school could be an on-line negotiation with a partner school or commenting online materials by text messages with a partner school. Loose mobility in a primary school could mean a possibility to access some co-operative exercises from a shared WWW page on class excursion trips.

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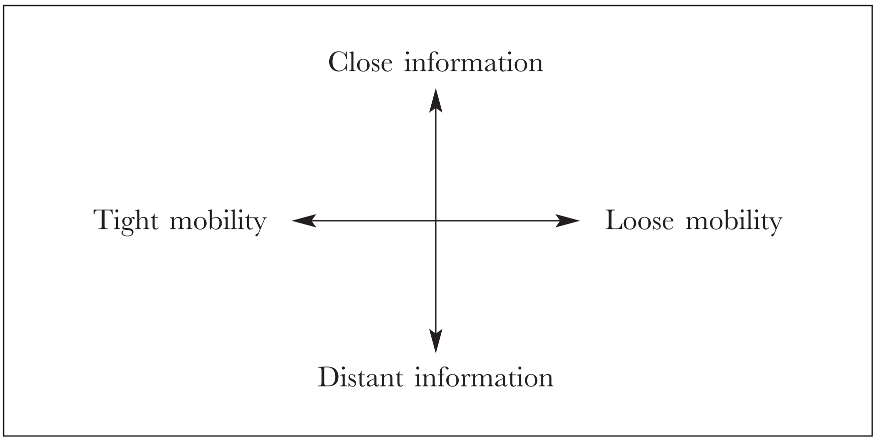
[1] D. Keegan, "The future of learning: From eLearning to mLearning", http://learning.ericsson.net/leonardo/book.html, 2002.

[2] P. Luff and C. Heath, "Mobility in Collaboration", *CSCW* 1998, pp. 305–314.

[3] H. Fagrell, F. Ljungberg and M. Bergquist, "Exploring Support for Knowledge Management in Mobile Work", Viktoria Institute, Gothenburg, 2000, http://www.viktoria.se/groups/mi2/results/papers/mobiservice.pdf.

[4] E. F. Churchill and N. Wakeford, "Framing Mobile Collaborations and Mobile Technologies" in B. Brown, N. Green and R. Harper (eds.), *Wireless World: Social and Interactional Aspects of the Mobile Age*, London: Springer, 2002.

Close information is the kind of information that can be gathered through mobile technologies and other sources. At a school level it presents the kind of information that is accessible through mobile devices in a mobile situation. Distant information is information that is difficult to access with the help of mobile devices. This kind of information could be for example some books or maps that are only available in a school library and not in a digital form or digital materials that are inaccessible with mobile devices or networks. In a school context these levels of mobility and also the mobile devices vary when moving from one situation or subject to another.



Accessibility challenges in mobile settings

(After Churchill and Wakeford)

Accessibility Challenges in Mobile Settings

The diagram above indicates a challenge to change working procedures and collaboration activities based on each situation. For mobile learning evaluation purposes the model of Churchill and Wakeford[5] is interesting: how to provide learner support for these different and ever changing learning contexts?

The concept of mobility concerns learning, work and leisure time. Therefore the different aspects of mobility should be understood broader than just from the perspective of learning. The original meaning of the

[5] *Ibid.*

concept "mobility" has changed or at least it does not fully represent the learning that takes place with the help of mobile devices. Mobility and mobile concepts characterize well mobile technology, but when connected to learning the new concept might be a misleading one if it is used without additional definition. The concept of mobile learning is often defined as learning that simply takes place with the help of the mobile devices.[6] As such it does not necessarily capture the nature of the learning that takes place with mobile devices and network-based services. A device that supports learning can be freely moved, but in the learning events the learner is mostly stationary, even though he/she is using a mobile device. Therefore although the device is mobile and portable, the learning as an event remains immobile.

The confusion in the use of the concept can be compared to the earlier debates whether the new society structure being founded on the new communication technology should be called "knowledge society" or "information society".[7] In other words is the key element knowledge or information? Castells[8] has taken this further and called the new society informational in order to indicate that the social attributes of information generation and processing go beyond the impact of information technologies and the information itself. A similar conceptual strategy should be applied here. Can learning with the help of mobile devices be called mobile learning, or is there a danger that the concept "mobile learning" provides a narrow and technically defined utopian picture of the learning that takes place with the help of mobile devices?

Lifelong Learning Dimensions of Mobile Learning

Usually mobile devices are relatively small and light, available almost everywhere and used personally. The user may build his/her own portfolio or a diary through the personalisation of mobile learning software. When it comes to learning situations, a mobile device can help in building one's own learning history.

When mobile devices are personal there is a possibility to use them for

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[6] C. Quinn, "mLearning: Mobile, Wireless and In-Your-Pocket Learning", *Line Zine Magazine*, http://www.linezine.com/2.1/features/cqmmwiyp.htm, 2000.

[7] I. Niiniluoto, *Informaatio, tieto ja yhteiskunta: filosofinen käsiteanalyysi* [Information, Knowledge and Society: A Philosophical Analysis of Concepts], Helsinki: Edita, 1996.

[8] M. Castells, "Flows, Networks and Identities: A Critical Theory of the Informational Society" in M. Castells et al., *Critical Education in the New Information Age*, Lanham, MD: Rowman & Littlefield, 1999.

personal time and task management continuously. If the devices are not personal pupils have to share them with others. Lifelong learning is an important approach and it broadens the perspective of mobile learning.

The table from Sharples describes the relationship of lifelong learning and new mobile technology. It brings out some interesting notions about the continuity aspect in learning. Our perspective on lifelong learning in this pilot project is to see mobile learning as a persistent activity, which requires a long-range use of mobile devices. Drake[9] has pointed out that learning must be a life-long process, but it also needs to be seen as a life-wide and life-deep process to fully support the preparation for life.

In order to reach a lifelong learning effect in the mobile learning area and in learning situations taking place with the help of mobile devices, the devices have to be personal and they require long-range use. When the device is personal and works as a tool for life-wide and flexible learning, the goals of lifelong learning can be aspired. In a primary school this means teaching children to appreciate life-wide learning in order to prepare the ground for effective lifelong learning in the future.

Lifelong Learning	**New Mobile Technology**
Individualized	Personal
Learner centred	User centred
Situated	Mobile
Collaborative	Networked
Ubiquitous	Ubiquitous
Lifelong	Durable

The Design of Personal Mobile Technologies for Lifelong Learning[10]

[9] C. Drake, "Values Education and Life-Wide Learning", paper for the 16th Annual Conference of the Hong Kong Educational Research Association, 1999, http://www.livingvalues.net/pdf/lvlearning.pdf.

[10] M. Sharples, "The Design of Personal Mobile Technologies for Lifelong Learning", *Computers and Education* 34 (2000), pp. 177–193, http://www.eee.bham.ac.uk/sharplem/Papers/handler%20comped.pdf.

Evaluation Framework for Mobile Learning

From the premises that were described earlier we have set out to develop an evaluation model to broaden the view of mobile learning. Our approach to learning is that it should be considered more broadly than just from an institutional point of view. Learning can also take place without previous learning material, when learners themselves can collaboratively construct the knowledge from their own experiences.[11] Therefore experiences and making observations in authentic learning contexts have been a special interest in our research.

Earlier research project reports and literature indicate that the use of mobile devices can be divided into at least three different groups:

- The use of mobile devices in formal teaching and learning processes.[12]
- The use of mobile devices in different everyday life situations where they can help to enhance ones life quality.[13]
- The use of mobile devices to make our everyday life more experiential and multifaceted.[14]

As mobile devices are a pervasive medium they can help to combine work, studying and leisure in a meaningful way.[15] Bringing this pervasiveness to a primary school might enable continuity between institutionalised learning and learning from real world phenomena outside the school hours. Thus mobile learning components have been developed especially to take note of flexible[16] and informal learning practices (learning at work and in leisure time).

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[11] M. Ahonen, A. Syvänen and H. Turunen, "Supporting Observation Tasks in Primary School with the Help of Mobile Devices", http://21st.century.phil-inst.hu/m-learning _conference/Turunen/turunen_abst.htm, 2002.

[12] M. Regan, "In Search of the Learning Bubble", http://studio.tellme.com/newsletter /dialed20001102.html, 2000.

[13] See e.g. C. Greeno, R. Wing and S. Shiffman, "Binge Antecedents in Obese Women With and Without Binge Eating Disorder", *Journal of Consulting and Clinical Psychology*, vol. 68, no. 1 (2000), pp. 95–102.

[14] See e.g.: *Digital Content for Global Mobile Service: Final Report*, European Commission, Directorate-General Information Society, 2002.

[15] M. Ahonen, B. Joyce, M. Leino and H. Turunen, "Mobile Learning – A Different Viewpoint", in H. Kynäslahti and P. Seppälä (eds.), *Mobile Learning*, Helsinki: IT-Press, 2003.

[16] B. Collis and J. Moonen, *Flexible Learning in a Digital World: Experiences and Expectations*, London: Kogan Page, 2001.

There are certain challenges in evaluating mobility and usability itself. In mobile use context there cannot exist any controlled laboratory environment. This differs quite a lot from traditional e-learning and CBT evaluation schemes,[17] where the action takes place around computers in a certain room or space. With mobile learning the environmental elements like noise, weather and network coverage create the preliminary evaluation challenges for the actual learning. Also as a learning process mobile learning is a highly fragmented experience.[18] Therefore, our evaluation framework aims at taking these disruptive effects into account.

This implies designing mobile learning devices where all usability risks should be taken into consideration. Especially with mobile devices and their interfaces all usability factors are crucial. When testing a WWW page the context and environment is of second interest. But when testing a mobile solution's usability the context is the factor. Lindroth and Nilsson[19] claim that it is quite difficult to test mobile devices' usability with traditional usability test methods. Designers should therefore be aware that the devices are meant to be use in real mobile situations. These situations can mean, for instance, walking in the rain with the mobile device in hand.

From these approaches we have derived the components as follows:

1. Continuity and adaptability between learning contexts – how to support spontaneous learning?
2. Learning as a personal process – are the mobile learning products taken personally?
3. Contextuality in learning – is the context of learning better recognized in the learning process?
4. Accessibility – what is the adequate skill level for mobile learning?
5. Support for time and learning management – how to support learners' self-monitoring and regulatory processes?
6. Flexible interaction – how to enhance communication between peer-learners?

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[17] T. C. Reeves, "Evaluating What Really Matters in Computer-Based Education", in M. Wild and D. Kirkpatrick (eds.), *Computer Education: New Perspectives*, MASTEC, 1994, pp. 219–246.

[18] M. Regan, *op.cit.*

[19] T. Lindroth and S. Nilsson, "Contextual Usability: Rigour Meets Relevance When Usability Goes Mobile", http://ecis2001.fov.uni-mb.si/doctoral/Students/ECIS-DC_LindrothNilsson.pdf, 2001.

These components are currently being sharpened by interviewing mobile learning experts. Later the components of m-learning will be operationalized into an on-line self-rating questionnaire adopted for two target groups representing Finnish comprehensive school students (N=90) and adult learners (N=50) who have real m-learning experiences. The components will be later utilized for developing evaluation methods for m-learning materials and environments. They also give approaches for building m-learning learner profiles, applications and materials.

The Use of Mobile Devices in the Primary School Pilot

Children's use of mobile phones is common in Finland, but can the use of these devices be meaningful in the school context? We have found that children are relatively interested in mobile devices and this interest can be utilized in many innovative ways. According to Sharples[20] children "saw the value of possessing a device that could give them control over their learning". From teachers' and the school's perspective the challenge in the reported pilot is to integrate the use of mobile devices and services to curriculum and daily tasks.

In intentional, formal learning situations mobile devices have been especially used in contexts where the learning content can easily be divided into small meaningful pieces such that when one part is learned the learner can easily connect it to a part of the whole learning content. According to Regan[21] those contents can be, for example, learning different languages or the grammar of a certain language. Mobile devices can help the learner to revise the facts that have been taught. With the help of a mobile device a learner can complete little quizzes or a group of learners can partake in a group work in the field. In the classroom the group can later analyse their findings from the field. A mobile device thus earns its place in authentic learning situations.

The use of different kinds of PDA devices, for example Palm, Handspring or iPaq are being researched today in learning environments. However, there are only few research projects focusing on the use of the Nokia Communicator-type of mobile devices in learning. One of those has been the Finnish LIVE-project, being also the first Finnish research

[20] M. Sharples, "Disruptive Devices: Mobile Technology for Conversational Learning", *International Journal of Continuing Engineering Education and Lifelong Learning*, vol. 12, nos. 5–6 (2003), pp. 504–520, http://www.eee.bham.ac.uk/sharplem/Papers/ijceell.pdf.

[21] M. Regan, *op.cit.*

project on mobile learning.[22]

The pilot research has been done in a little primary school in Southern Finland. There have been approximately 22 pupils in the class. When the pilot started, the pupils were 11 years old, and today they are in the 6th grade, that is 12 years old. The class has one teacher whose own interest for new learning technology has been a great advantage to the whole pilot. It is essential that the persons who are involved in a research project be committed to the work. The teacher's bright and imaginative ideas have helped the research group's work a lot.

The pilot school has approximately ten computers. According to Soloway[23] children are not using computers in primary schools. If we compare the amount of computers in the pilot school to the numbers that Soloway[24] quotes we can consider it as a rather normal level. It can be asked whether the computers actually provide support to the continuing learning process and teaching if the student can use them only e. g. a couple times a week in school. This is what Soloway[25] points out too, and in the same article mobile devices are introduced as a solution for the needs of the continuing learning process.

Pedagogical Solutions

In the beginning of the pilot it was important that the teacher got to know the research area and that she understood what one can do with those devices. After she learned to use the devices it was time to train the pupils to use them. The teacher wrote instructions to aid the children in their own language, instead of using ordinary consumer (adult) oriented mobile device handbooks. The class also used a web-based training and drilling environment to get acquainted with the interface of the Nokia Communicator 9210. In the first stages of using mobile devices children performed short writing and recording exercises together with the researchers. The exercises were made in small groups because the amount of mobile devices was limited. The researchers took part in

[22] A. Rönkä and J. Sariola, "Mobiiliopiskelu opettajankoulutuksessa - LIVE-projekti" [Mobile Learning in Teacher Education – the LIVE Project], in P. Seppälä (ed.), *Mobiili opiskelu – joustavasti liikkeessä*, Helsinki: The Educational Centre for ICT of the University of Helsinki, 2002, pp. 82–94.

[23] E. Soloway, "Supporting Science Inquiry in K-12 Using Palm Computers: A Palm Manifesto", http://www.pdaed.com/features/palmmanifesto.xml, 2001.

[24] *Ibid.*

[25] *Ibid.*

the observations and exercises occasionally. Also a technical assistant was needed. He for example installed the needed software on the computers and guided the teacher and the class in using a digital camera. According to the teacher the charm of a new device did not last long, while from time to time some of the children indeed saw it only as a funny gadget.

The main research question in this primary school pilot was: What kind of challenges and possibilities can mobile devices bring to the learning process in primary school? Our hypothesis has been that mobile devices can support pedagogically meaningful learning. In the pilot the inquiry learning method has been used. What is essential in the inquiry learning method is that it engages pupils to reflect on their own thoughts and actions. In the inquiry learning method the goal is not just to find the right answer. The pupils learn to criticize certain facts and their understanding develops within a collaborative group work.[26]

Inquiry learning has been used in primary schools in science education for a while now. In inquiry learning constructing a meaning from the experience is crucial. This requires reflection, conversations and comparisons of findings with others, interpretation of data and observations, and the application of new conceptions to other contexts.[27] In our pilot, mobile devices have had a role in the meaning construction process and elaboration of observations into online presentations. We wanted to find out how learners act when they construct their own experiences and observations to create understanding. The model proved itself suitable for carrying out learning with mobile devices in a primary school context in a problem-based manner.

Challenges in Using the Mobile Devices

According to our findings mobile devices can be usefully employed both in formal and informal learning processes and especially in supporting observation tasks. The device is easy to carry and rather easy to use. Today there are a lot of different mobile devices on the market and the user interfaces have become more and more friendly. Every child in the class learned to use the device. However, children did not own the

[26] K. Hakkarainen, K. Lonka and L. Lipponen, *Tutkiva oppiminen* [Inquiry learning], Porvoo: WS Bookwell Oy, 1999.

[27] "Inquiry: Thoughts, Views, and Strategies for the K-5 Classroom", *Foundations - A Monograph for Professionals in Science, Mathematics, and Technology Education* 2 (2000), http://www.nsf.gov/pubs/2000/nsf99148/htmstart.htm.

Communicator. Because the devices are not personal, the earlier view about lifelong learning by Sharples[28] is difficult to realize in a class with just a few, non-personal mobile devices. In this kind of context, informal learning does not necessarily emerge or it is difficult to measure.

During the pilot the teacher noticed that children's patience towards the devices varied a lot. Children often wanted to use the mobile devices only for entertainment purposes. But the enthusiasm towards mobile learning diminished slightly when the learning activities and tasks demanded more information processing. This was also in part due to the lack of proper learning software for mobile devices and supporting network-based mobile learning environment.

Structured knowledge processing and knowledge sharing through mobile devices was sometimes difficult. The teacher thus pointed out that a certain and important aspect in using mobile devices in learning process is to make children understand that using mobile devices really can help their learning processes.

All the children in the class learned to use the devices well and there were no clear differences in the skills. Usually the best way to share issues with co-learners in the class is oral introduction. However, for some pupils this can be difficult. There are children who are very talented in writing and others who are very talented in speaking and performing, but these different skills could not be well taken into consideration in the mobile learning process in our research pilot.

According to the teacher, learning and working with mobile devices demanded editor skills from the children. She argues that even for adults it can be difficult to make a report on a certain issue in on-the-go situation. Some mobile learning environments could possibly bring help to these problems. With this kind of an environment or software pupils could become more self-guided learners.

Other Findings

An edutainment-element would be useful in teaching and learning but at this moment there are no devices or methods for that kind of an action in mobile learning environments. At a primary school level the learning process has to be also very much guided by adults. If a group of children perform a certain task by themselves it is not always clear that the elements they seek and find are informative and educational enough.

[28] M. Sharples, "Disruptive Devices".

At first children had difficulties to understand that even very modest, simple observations were important for the whole learning process. It is essential to understand that informing co-learners for example of the fact that "not all leaves are fallen from the trees outside our school environment" is an important issue. The teacher points out that children sometimes lift their informative goals too high. They sometimes think that the facts they observe have to be really complex and strange ones. This reflects the effect of information overflow in today's information society and how important it is to learn to acknowledge different sources and structures of knowledge. It is interesting to ponder what mobile learning might bring to this situation.

We cannot expect too much self-guidance from the children. However, a small independence in observation tasks is needed. One challenge in this pilot has been to teach children to work independently. Besides self-guidance, co-operative skills become very important when working with mobile devices. Children have to learn to discuss and solve shared problems. The effective collaborative learning with the help of a new mobile medium requires the comprehension of the device as a meaningful learning tool. Children should also solve situations where someone wants to do something differently than another. Writing and reading skills also become emphasized when working with mobile devices. This might change when in the future pictures can be used in a more complex way in the learning process.

One interesting method of learning with the help of mobile devices according to the teacher could be making mind-maps at the same time as a pupil is observing a certain piece of interest. Future development of mobile learning applications like Picomaps[29] can help pupils figure out each other's different knowledge and observation structures.

According to this pilot's results mobile learning and observations tasks give the richest experience to the group that is outdoors, doing an observation task. But the co-operation between the observation group and the group in the class is not yet very complex. The demands for the observation group become very high because they should in fact act as teachers who through writing and talking can deliver an observed phenomenon to another group. Working with mobile devices can still be a nightmare to a shy pupil. And the mobile device will not necessarily make the process easier.

Considering the mobile learning evaluation framework, described earlier, from the teacher's point of view it became clear that adaptabil-

[29] Cf. Soloway, *op. cit.*

ity/continuity is an important aspect in mobile learning. Children should understand that they can learn everywhere and they can utilise the knowledge acquired in other contexts than school as well. According to the teacher this also means seeing learning as a personal process. Children should learn to appreciate the knowledge they gained from their hobbies and everyday activities. The mobile device at its best is a device with which you can share and deliver information when moving from one context to another. It also became clear that many things can be done with mobile devices, and that with the help of a shared WWW environment it is possible to work co-operatively at home.

Conclusions

The main result of the pilot at this stage is that the use of mobile devices in the learning process has to be designed very carefully. The possibility to use a mobile device in a real distance situation is crucial for this research. In our future research children will have the network connection available which makes it possible to accomplish real mobile tasks outside the school environment. This gives us a new chance to test our mobile learning evaluation framework further.

Based on our pilot findings we see that mobile technology can be well utilised in supporting differentiation because it is a rather flexible and motivating medium. Since pupils' experiences and abilities vary, the teacher has a lot of work to tailor lessons to meet everybody's needs. With the help of mobile devices it is possible for a learner to review again the issues that have been taught earlier.

To sum up, we suggest that schools – in case they see mobility in the school context meaningful – should have a far-reaching educational strategy to utilise mobile devices in learning. Also, those devices should be personal and closely linked to daily tasks and activities. The teacher of the pilot class wisely remarked that it would be a fine addition if children could use the devices from the early years of school all the way to the high school level. This would bring real lifelong learning, and continuing effect, to the learning process.

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Anju Relan
Susan Baillie

Invigorating Clinical Education via Handheld Computing:

Examining Possibilities with Individualized Interactive Applications

Introduction

Handheld computing devices are now an indispensable tool among physicians to facilitate a variety of functions related to clinical practice.[1] A recent study[2] revealed that 67.3% of the Family Practice Residency Programs used personal digital assistants or PDAs individually or as a group, of which 30% were required to do so. While creative uses of this technology have been noted among residents and practicing clinicians,[3] relatively few applications have emerged to empower medical students' learning environment.[4] This state persists in spite of the assertion that the apprenticeship practices of senior medical students are particularly well suited for a reliance on mobile computing to enhance clinical rea-

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[1] M. Tschopp, C. Lovis, A. Geissbuhler, "Understanding Usage Patterns of Handheld Computers in Clinical Practice", *Proceedings of the American Medical Informatics Association Symposium*, 2002, pp. 806–809; A. E. Carroll, S. Saluja, P. Tarczy-Hornoch, "The Implementation of a Personal Digital Assistant (PDA) Based Patient Record and Charting System: Lessons Learned", *Proceedings of the American Medical Informatics Association Symposium*, 2002, pp. 111–115; S. B. Bird, R. S. Zarum, F. P. Renzi, "Emergency Medicine Resident Patient Care Documentation Using a Hand-Held Computerized Device", *Academic Emergency Medicine*, vol. 8, no. 12 (2001), pp. 1200–1203; S. E. Lapinsky, J. Weshler, S. Mehta, M. Varkul, D. Hallett, T. E. Stewart, "Handheld Computers in Critical Care", *Critical Care*, vol. 5 no. 4 (2001), pp. 227–231.

[2] D. F. Criswell and M. L. Parchman, "Handheld Computer Use in US Family Practice Residency Programs", *Journal of American Medical Informatics Association*, vol. 9, no. 1 (2002), pp. 80–86.

[3] E. J. Hammond and B.P. Sweeney, "Electronic Data Collection by Trainee Anaesthetists Using Palm Top Computers", *European Journal of Anesthesiology*, vol. 17, no. 2 (2000), pp. 91–98; S. Fischer, S. E. Lapinsky, J. Weshler, F. Howard, L. E. Rotstein, Z. Cohen, T. E. Stewart, "Surgical Procedure Logging with Use of a Hand-Held Computer", *Canadian Journal of Surgery*, vol. 45, no. 5 (2002), pp. 345–350.

[4] D. J. Bower, C. J. Bertling and The Advanced Education Group, Medical College of Wisconsin, "Using Palm Pilots as a Teaching Tool during a Primary Care Clerkship", *Academic Medicine*, vol. 75, no. 5 (2000), pp. 541–2.

soning, self-assessment and self-monitoring.[5] While a plethora of free and modestly priced commercial applications are available for clinicians, such as patient trackers, drug references, decision making systems, medical calculators, textbooks to facilitate clinical practice,[6] we believe that successful implementation of this technology with medical students lies in individualized, interactive applications developed to solve existing problems, especially those related to a decentralized educational environment during clinical clerkships. To this end, we describe the process of design, development and implementation of a complex set of applications which allow students to document their clinical experiences, formally known as the UCLA PDA Patient Log. While some medical schools have implemented similar systems in individual departments and programs,[7] our approach is unique in that it is a system-wide program featuring a customized PDA Log for all clerkships, making it possible, among other functions, to compare student data across clerkships. Clinical faculty in various subspecialties use this tool for prescribing appropriate patient encounters for students, provide increased feedback, and reconceptualize the clerkship curriculum, leading to an overall improvement in their ambulatory experiences.

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[5] R. Rosenberg, "Handhelds to be Harvard Medical Students' First Assist", *The Boston Globe*, May 7, 2001.

[6] G. Rao, "Introduction of Handheld Computing to a Family Practice Residency Program", *Journal of the American Board of Family Practice*, vol. 15, no. 2 (2002), pp. 118–122.

[7] P. A. Carney, C. F. Pipas, M. S. Eliassen, S. C. Mengshol, L. H. Fall, K. E. Schifferdecker, A. L. Olson, D. A. Peltier, D. W. Nierenberg, "An Analysis of Students' Clinical Experiences in an Integrated Primary Care Clerkship", *Academic Medicine*, vol. 77, no. 7 (2002), pp. 681–687; C. F. Pipas, P. A. Carney, M. S. Eliassen, S. C. Mengshol, L. H. Fall, A. L. Olson, K. E. Schifferdecker, M. T. Russell, D. A. Peltier, D. W. Nierenberg, "Development of a Handheld Computer Documentation System to Enhance an Integrated Primary Care Clerkship", *Academic Medicine*, vol. 77, no. 7 (2002), pp. 600–9; W. Sumner 2nd., "Student Documentation of Multiple Diagnoses in Family Practice Patients Using a Handheld Student Encounter Log", *Proceedings of the American Medical Informatics Association Symposium*, 2001, pp. 687–690; S. Speedie, J. Pacala, G. Vercellotti, I. Harris, X. Zhou, "PDA Support for Outpatient Clinical Clerkships: Mobile Computing for Medical Education", *Proceedings of the American Medical Informatics Association Symposium*, 2001, pp. 632–636; M. B. Schmidts, "OSCE Logistics – Handheld Computers Replace Checklists and Provide Automated Feedback", *Medical Education*, vol. 34, no. 11 (2000), pp. 957–958; A. L. Helwig, C. Flynn, "Using Palm-Top Computers to Improve Students' Evidence-Based Decision Making", *Academic Medicine*, vol. 75, no. 3 (1998), pp. 603–4; T. S. Alderson, N. T. Oswald, "Clinical Experience of Medical Students in Primary Care: Use of an Electronic Log in Monitoring Experience and in Guiding Education in the Cambridge Community Based Clinical Course", *Medical Education*, vol. 33, no. 6 (1999), pp. 429–433.

Problem Identification

The need to monitor students' clinical apprenticeship experiences more effectively than is currently practiced has been documented in the medical education literature. Typically, the last two years of the medical school (of a total of four, in the USA) are spent in acquiring clinical expertise via "clerkships" in a variety of specialties. Clerkships can be likened to traditional apprenticeships where medical students are exposed to a patient population native to a socio-economic community. Increasingly such experiences have moved away from a hospital-based practice to community clinics. The following excerpt taken from the Goals and Objectives of the Family Medicine clerkship at the institution under discussion illustrates student expectations from clerkships:

- To demonstrate the ability to take an accurate, problem-focused patient history, including psychosocial and family issues.
- To demonstrate the ability to perform a complete, accurate physical examination appropriate to the patient's complaint.
- To demonstrate the ability to give a complete, accurate and organized case presentation of a patient encounter.
- To demonstrate the ability to write complete, accurate, organized and focused progress notes.
- To begin to develop a patient-centered management plan that incorporates the principles of preventive and ongoing care and health education.
- To demonstrate interpersonal skills that enable the development of patient rapport.
- To demonstrate the ability to research a patient problem in a systematic manner by utilizing relevant medical literature and expert resources.

The goal of medical education is to fulfill these objectives in a consistent manner for all students. However, in spite of inventive efforts to standardize this experience, attainment has been moderate. Students see patient problems that vary considerably in the nature of illness, seasonal variations, geographical location. As well, the type of feedback received by students in the same location itself may vary given the variety of clinical faculty or resident mentors they encounter. This variability has an impact of how clerkships are structured, monitored and evaluated, with a concomitant effect on student learning. Given the unregulated nature of clinical apprenticeship, it is not surprising that medical students are often left to make their own decisions, seek additional, relevant information and refine their clinical reasoning process independent of faculty modeling and feedback. Against this background, medical students are required to fulfill demanding goals attributed to subspecialty training. It is clear that the decentralized nature of clerkships in the training of medical students cannot lend itself to the attainment of these objectives in a consistent, predictable way.

Methods

The development of the UCLA PDA Patient Log has its roots in the amorphously organized clerkship experiences, and the consequent inability to monitor student learning in diverse geographical settings. An attempt to address these problems was made via the development of the Clinical Web Log, a web-based application to allow students to input patient problems observed during their clerkships. This was implemented with limited success by a single faculty member and abandoned on account of the inadequacy of the software to capture and retrieve data for individualized interaction with students. At this point, the emergence of PDAs as an effective clinical tool for physicians was rapidly gaining popularity, watched with interest by medical schools across USA as a possibility for enhancing medical education. A decision was made to require the purchase of a Palm OS based handheld computer for third year medical students by UCLA. The Clinical Web Log was reinvented to take advantage of the mobile technology now available to all medical students. It is important to note, that in addition to the Web Log, course objectives, calendars and student expectations were also made available as PDA compatible documents.

Objectives of the PDA Patient Log

The UCLA PDA Patient Log is a suite of applications designed to gather patient problem data, which can be retrieved by faculty and students for self-assessment, student feedback and clerkship restructuring. It is formatted to resemble a mini questionnaire on a PDA. The goal of this application is to improve the quality and consistency of students' learning in clerkships via documenting and examining the number and type of patient problems seen by students during their ambulatory experiences. The suite consists of six different applications modeled after a single template for nine mandatory clerkships: Family Medicine, Inpatient Medicine, Ambulatory Medicine, Surgery, Psychiatry, Neurology, Obstetrics and Gynecology and Radiology (see Figure 1). The first three clerkships share a common Patient Log. Questions on Radiology are embedded into all versions of the Patient Log.

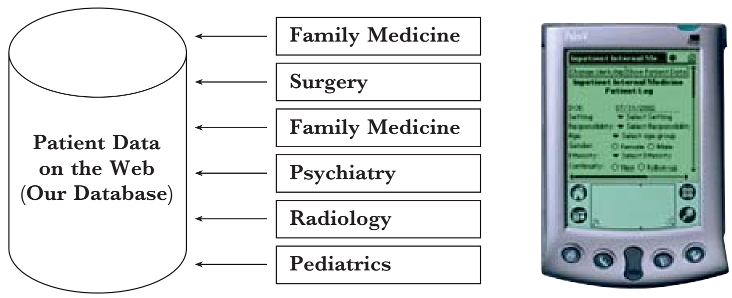

Figure 1. A Model of the UCLA PDA Patient Log

Capabilities of the PDA Patient Log System

The Patient Log was designed to elicit maximum compliance from faculty and students. The requirement to input data rested with the Clerkship Directors, who were more likely to use the application if the data retrieval was easy and information was readable and relevant. Students would find the data most useful if they could consolidate this patient information, and interact with it in multiple ways. To achieve these goals, the following capabilities were identified, with face-to-face meetings with potential users, to motivate participation in the implementation of the Patient Log.

Capabilities for faculty:
- Monitor student experiences
  - View each student's record on the Web
  - Automate checking of mandatory number of patients; report generated and emailed to faculty and students
  - Attach URLs and/or learning issues associated with predetermined cases
- Look at aggregate clerkship data
  - Search by all fields within specialty
  - Receive aggregate clerkship data weekly via email

Capabilities for students:
- View patient records by clerkship
- Comment on interesting /unique cases in a Notes field
- Mark cases for self and for sharing with peers/faculty
- Automate checking of mandatory number of records

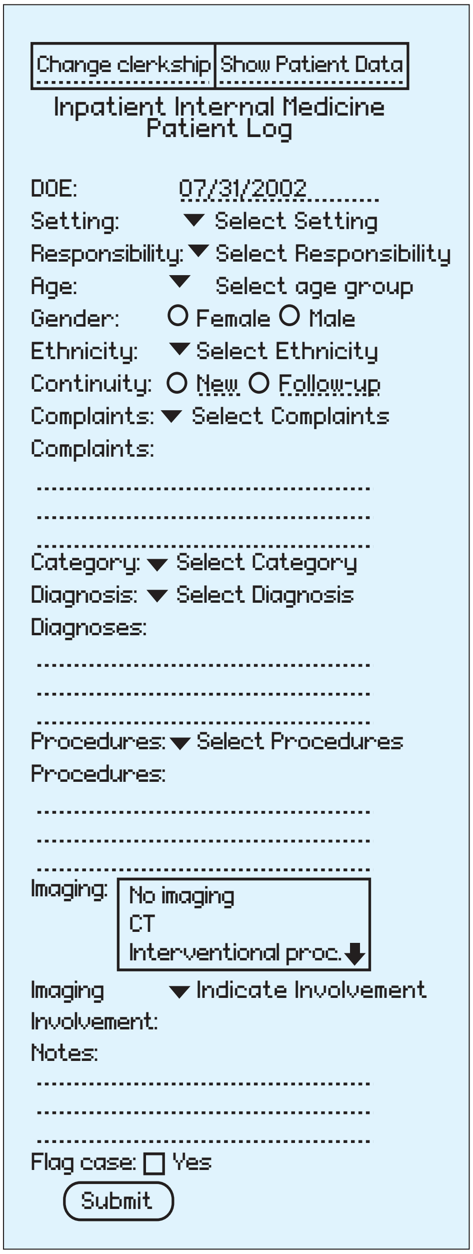

Figure 2. The PDA Patient Log (Internal Medicine) in its entirety

- Query within each clerkship, according to all fields, and marked cases, with learning issues
- Indicate if case should be transferred to the PDA

Structure of the PDA Patient Log

The application consists of three components: the PDA client which can be downloaded and allows data entry. This is an open-ended tool containing pull-down menus for patient demographics (in accordance with regulations for the patient privacy act), patient problems, radiological findings and a blank field for additional notes. The uniqueness of this Patient Log lies in customized versions of data entry for different specialties. Thus there is no single common log, but versions which are endemic to six specialties: Surgery, Pediatrics, Obstetrics and Gynecology, Family Medicine, Psychiatry and Neurology (see Figure 2 to view the Medicine Log in its entirety). An AvantGo server (http://www.AvantGo.com) serves as the mediating technology between the web based database where all patient data resides and the students' PDAs. This is the second, commercially available component of the application. Finally, a web based interface was developed to allow database entries to be retrieved in multiple ways: via search tools, predetermined reports comparing data across sites, and a graphical representation of these reports (see Figure 3 for a structure for data entry and retrieval). Faculty and student settings allowed for customizable options in viewing data. Figure 4 shows a report generated from the web, comparing ethnicities of patients seen across clinical sites in the Internal Medicine clerkship.

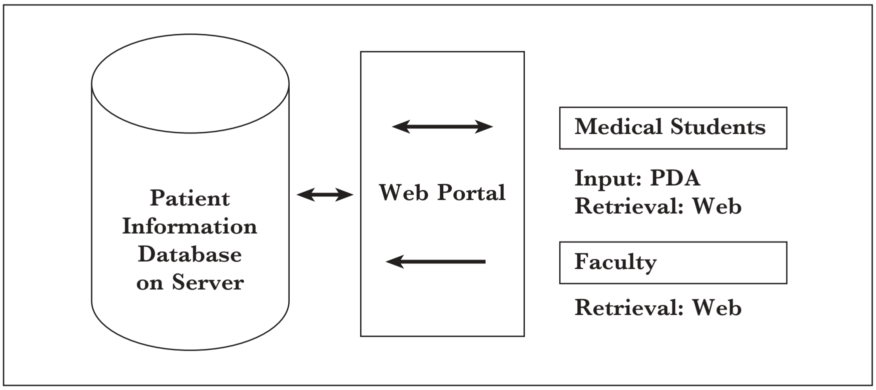

Figure 3. Data input and retrieval mechanism in the UCLA PDA Patient Log

FACULTY PAGES:

Inpatient Internal Medicine Clerkship Data Comparison

Home

I. STUDENT INDIVIDUAL REPORT

- **Browse All Students**
- **Search by Student Name**

	African-American	Asian	Caucasien	Latins	Mixed	Native American	Unspecified
Cedars-Sinai Medical Center	45	4	77	26	0	0	12
Harbor/UCLA Medical Center	44	13	32	71	5	0	7
Kaiser Sunset	23	11	36	26	3	0	0
King/Drew Medical Center	14	2	2	37	0	0	0
Olive View Medical Center	17	23	66	151	6	0	14
UCLA CHS	19	11	63	30	0	1	6
West Los Angeles VA	22	5	47	17	0	0	4
Total data:	184	69	323	358	14	1	43

Select 1 of the 2 following graphing options.
Total

Figure 4. A comparison of ethnicities seen in Internal Medicine Rotation among various clinics

Technical specifications

The entire application is created using web and database programming environments such as html, javascript, Cold Fusion (Macromedia, Inc.) and proprietary AvantGo server. An SQL database is utilized for data storage and retrieval.

Implementation Strategies

The School of Medicine decided to require implementation of the PDA Web log after considerable review of literature on PDA technology and discussion of use possibilities with clerkship directors and administrative faculty. Key issues in the discussion of adoption were the need for comparability and documentation of student experiences. With the increasing movement of student from hospital-based learning experience to learning in dispersed ambulatory settings, the PDA offered a management tool for program coordinators and a self-management instrument for students. A trial of the PDA Log was initiated the year before total implementation. Trial results enabled technological adjustments and further revisions of the log to better meet the needs of the separate clerkships. Adjustments were also made based on student feedback on the use in the trial period.

The trial results led to a decision for full implementation by all clerkships. To better secure successful implementation, several strategies were selected. First, meetings were set up with clerkship directors and individual teaching faculty to introduce them to the technology and potential uses and retrieval functions. They were given flexibility as to the diagnoses and procedures to be used in their log and how they would like the data reported. Non-technological faculty were given instruction on the multiple uses of the PDA. Instructional strategies for interactive uses of the data were discussed interactively with faculty. Examples included the following strategies:

- Recommend the number of patients students must enter per week
- Review cases on the PDA (oral exam, case presentation)
- Require exams/grade based on number of cases entered
- Use learning issues to promote feedback
- Review session on problems seen during clerkship

In a few cases, faculty were given a PDA for use with the web log. Second, students were given instruction on the PDA at the Introduction to the Clinical Years course prior to beginning the clerkships. They were given general instructions and a practice case, which allowed implementers to test for comparability of use among students. Students needing additional help were offered a PDA clinic at a variety of times during the orientation week. Additional instructions were also given to students at the orientation to each clerkship. Directors set forth their expectations of PDA use.

Success in implementation was facilitated by the active sponsorship of the instructional technology division as well as the medical education staff. Clerkship director promotion and requirement of active PDA use has greatly influenced numbers of entries in actual student patient logs. Late adopters of the PDA web log have now begun implementation after reviewing the successes of other clerkships in acquiring useful data on student experiences. It is interesting to note that faculty in different subspecialties used a variety of well differentiated strategies to implement the PDA Log corresponding with their teaching style and the needs of individual clerkships.

Students have adopted PDA use when required by clerkship directors. They have become more skilled in applying the easy to use log and find that it takes little time or effort. They vary in their ability to use the PDA in self-management and in their understanding of the utility of population information as a principle of disease prevention and behavioral change for specific populations groups. The educational staff of the medical school is addressing this and hopes to provide more instruction on this in the future. The PDA, however, has become an essential tool for most of the students with the student log just being one component. The idea of mobile computing and the use of handheld technology have been readily adopted by most students with only few exceptions.

Conclusion and Discussion

Handheld computing offers rich, untapped development opportunities in a variety of programming platforms. When used in conjunction with web-based and database technologies, the potential for creating powerful educational applications is limitless. Although development costs in terms of personnel and technology are substantial, these must be weighed against the long-term effects of successful PDA integration into the curriculum.

Our experience with development and integration of individualized applications such as the UCLA PDA Patient Log in medical education demonstrates that this is an effective strategy for ensuring successful diffusion of the PDA technology. Although the use of mobile computing in education is in its infancy, a few guidelines related to the development of customized mobile applications for this environment may be noteworthy, and are not markedly different from implementing other complex, system-wide, computer-based technologies, where research has been prolific. A strong needs assessment lays the foundation for creating applications which are based on an existing need; protocols for an appropriate needs assessment must be identified and implemented. All users of the system being developed must be involved in the design and repeated formative evaluation of the tool. A summative evaluation employing triangulation of methods must be conducted to further refine the tool and strategies of implementation. Support at all levels of the implementation must be available to the users. The design must take into account the attributes of the technology, ensuring that the mobile environment is exploiting these attributes. A strong development team is critical for analysis and use of the technical environment.

We have found that rich, open-ended applications such as the PDA Log may potentially spawn entirely new, reified ways of using this mobile technology. For example, one arena of clinical practice is the study of population medicine as a preventive and diagnostic tool.[8] The PDA Patient Log provides access to patient data within a local practice environment, which students can use to view trends, and use these patterns in prevention, diagnosis and prescription. Faculty have used the PDA Log in surprisingly creative ways; it is possible that students have generated unique strategies for self-monitoring of their clerkship experiences.

The PDA Patient Log project is presently undergoing a comprehensive evaluation. Based on this data, we intend to calibrate the PDA Patient Log to accommodate faculty and student concerns. We will also disseminate ways in which the system is being used by all faculty so that a cross-pollination of ideas occurs via faculty development. We hope that successful implementation of the PDA Patient Log will generate other PDA-based, individualized applications fulfilling critical needs and objectives of medical education.[9]

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[8] D. Fox, "The Relevance of Population Health to Academic Medicine," *Academic Medicine*, vol. 76, no. 1 (2001), pp. 6–7; A. Howe, K. Billingham, C. Walters, "Helping Tomorrow's Doctors to Gain a Population Health Perspective – Good News for Community Stakeholders", *Medical Education*, vol. 36, no. 4 (2002), pp. 325–333; T. Lyndal, C. Rufus, "Self-Directed Learning in Population Health: A Clinically Relevant Approach for Medical Students", *American Journal of Preventive Medicine*, vol. 22, no. 1 (2002), pp. 59–65.

[9] The authors appreciate the painstaking effort invested by Zhen Gu and Katherine Wigan in developing the UCLA PDA Patient Log.

Eleni Malliou et al.*

The AD-HOC Project: E-Learning Anytime, Anyplace

The AD-HOC project[1] aims at the development of an innovative, advanced, multimedia language learning tool for European travellers who on location are willing to acquire certain language skills, in order to communicate with locals in the destination country. The main outcome of the project will be the AD-HOC system comprising three levels: content, service provision and learning environment. By creating mappings between content and services using database technology and metadata, the system will maximize reusability of existing content. By decoupling the learning environment from educational services, the system will achieve personalization, localization, contextualization, adaptability and ease of maintenance. By utilizing wireless networking users are placed at the centre of an ambient, always available, device-independent educational environment. This paper presents the basic principles of the AD-HOC system and the current status of its development.

Introduction

The AD-HOC project's[2] innovative application allows travellers (for business, leisure or educational purposes) to access the web through advanced new communication applications (PDA applications, GPRS and UMTS). These new applications allow for fast transfer of data (text, sound, picture and video) through the mobile device (phone, palmtop) of the user. The AD-HOC system will serve users regardless of time and location. An on-line manual, acting as an on-line tutor, will also be developed in order to support self-directed ad-hoc learning.

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[*] Co-authored by Savvas Stavros and Sofoklis A. Sotiriou (*Ellinogermaniki Agogi, Research and Development Department, Pallini*), and by Antonis Miliarakis and Manolis Startakis (*FORTHnet S.A., Research and Development Department, Heraklion, Crete*).

[1] The AD-HOC project is a European cooperation project (2000-2002), co-financed from the European Commission, DG Education and Culture.

[2] See www.ellinogermaniki.gr/ep/ad-hoc.

The system aims to present linguistic content embedded in its cultural context furthering the understanding of Europe's cultural and multilingual diversity. It has been proven that mutual understanding in the communication process depends not only on linguistic competence but also on the awareness and perception of cultural behaviour, cultural differences and similarities. Most often it is the need and wish to communicate in a foreign country that motivates individuals to learn a foreign language, or at least to acquire specific limited language skills, but usually in travel situations no learning tools are available, and back home a lack of time and appropriate learning material deters individuals from foreign language studies. Increasing mobility of individuals, either for business, training or educational purposes, indicates the need for innovative, flexible, fast retrievable and user-friendly language learning tools, catering for the needs of the modern "mobile" European, who does not have the time or inclination for in-depth involvement but requires immediate limited information.

The AD-HOC project's objectives are to encourage linguistic diversity throughout the EU and support "life-long learning" by motivating and aiding individuals to learn languages at any time and in any place, developing an innovative language learning tool which serves the specific needs of travellers through:

- The presentation of authentic communication and real-life situations within a cultural context.
- Its ad-hoc availability during travel.
- The offer of different, basic levels, including a survival level.
- The choice of thematic fields for the acquisition of foreign language skills required for specific situations and specific purposes (business travel, travelling of young people, etc).
- The choice of acquiring only partial competencies, e.g. oral comprehension and expression.

The application of new technology in the AD-HOC project supports the pedagogical method of autonomous self-directed learning[3] and allows

[3] A. Aviram, "Personal Autonomy and the Flexible School", *International Review of Education*, vol. 39, no. 5 (1993), pp. 419–433.

for a self-directed acquisition of language skills to meet users' individual communication needs.

Usability Issues

Handheld devices have become very popular information devices for millions of users. Many applications have already been developed for public agencies, commercial companies,[4] even for university courses.[5]

A key problem for handheld devices is usability: the screens are too small, they don't have keyboards only scribble pads, and the available speech recognition programs do not really work.

The small glass displays of the current handheld devices essentially limits how much information can be presented at one time. Lack of screen space is not a problem that can easily be improved with technological advances; the screen must fit on the device and the device must be small; screen space will always be in short supply. A second usability problem is the fact that presenting dynamic information on devices with small displays is difficult. Techniques for large displays again do not generalize well to small ones.

Given these limitations, "mobilizing" existing PC-based e-learning applications can result in a frustrating or nearly unusable mobile service. The solution lays in taking a different approach to how information is streamlined and targeted to the user. The first step toward this solution is to integrate a user-centered investigation into the e-learning system's development cycle.

According to the 1998 ISO 9241 standard for usability[6] the following parameters must be included in the system: usefulness, functionality, learnability, memorability, effectiveness, efficiency and desirability. Even with such a checklist, it is still very easy for a designer to make a tool which is quite unusable. This is partially because design is not sequential process – design decisions affect which people can use a tool, thus requiring the original design to be rethought; and partially because

[4] J. Fleischman, "Going Mobile: New Technologies in Education", *Converge Magazine*, May 2001, www.convergemag.com; J. R. Anderson, L. M. Reder and H. A. Simon, "Situated Learning and Education", *Educational Researcher*, vol. 25, no. 4 (1996), pp. 5–11.

[5] K. Zreik (ed.), *LEARNING'S W.W.W., Web Based Learning, Wireless Based Learning, Web Mining*. Proceedings of CAPS'3. Paris: Europia, 2000.

[6] G. Castelli, "Universal Mobile Telecommunications System: Terminals and Applications", in G. Riva (ed.), *Communications Through Virtual Technology*, Amsterdam: IOS Press, 2001.

designers are not the potential users, and are driven by other forces, e.g. a love for technology. Nevertheless there is hope. There will come a time when the design of a system is no longer driven by technological advances, but will instead be influenced by the users who have higher expectations of usability while taking basic performance for granted. The methodological approach of the AD-HOC project plays a fundamental role in the development of such a system: user-centered design[7] and a scenario-based design[8] are means for assuring that the final system is appropriate to the user and to the context of use.

The AD-HOC system will fulfil the following general requirements:

- Interactivity: it should provide means of communication between learners and teachers. It should allow for feedback by teachers that will be accessible to learners.
- Interdisciplinary: Content should be presented in an interdisciplinary way incorporating information from different disciplines, thus promoting the idea of informal learning.
- Unobtrusiveness: so that the student can capture situations and retrieve knowledge without technology obtruding on the situation.
- Availability: its functions should be available anywhere and it should provide seamless communication inside and outside buildings.
- Adaptability: it should adapt to the learners' evolving skills and knowledge.
- Usefulness: it should be suited to everyday needs for communication, reference, and learning.
- Suitability: Content should correspond to the specific learning needs of users, e.g. content for the same subject should be presented in several ways, and provided according to the specific users' individual profile.
- Easy to use: it should be intuitively easy to use, even by users with no computer experience.

[7] D. Norman, *The Invisible Computer*, Cambridge, MA: The MIT Press, 1999.

[8] G. Ringland, *Scenario Planning: Managing for the Future*, Chichester: John Wiley & Sons, 1998.

Technical Description of the AD-HOC System

The aim of the AD-HOC project is to develop a device-independent platform that will make internet services available with GSM and UMTS terminals. At the time of access the user will inform the service provider of her/his terminal characteristics (display dimensions, computing capacity, graphic processing capacity, etc.), and the provider will transmit the required information, adapting representation to the indicated characteristics. Consequently the same information will be presented in different ways, according to whether access is from a desktop computer or from a mobile terminal. The AD-HOC platform will have the capability to specify information and represent it graphically, to integrate profile and service management, while it will allow for fast application development through a visual programming environment.

Another important objective of the AD-HOC project is to develop and evaluate communication patterns and possible infrastructures for interconnected embedded technologies among devices. Communication between devices can take place by using RF technologies like Bluetooth or 802.11b. The utilization of Bluetooth seems to be a good option, due to low power and cost, with data as well as speech transmission capabilities, although there are some important open issues. Problems like the integration of Bluetooth devices in embedded systems with restricted memory capabilities, and successive devices management, have to be researched and dealt with.

The platform services will be delivered via an advanced user-interface, where the user will have to log in. The first major component of the user-interface will be the Personal Learner's apprentice: This is the core software agent of the system and the main part of the user-interface. It is responsible for interacting with the user, and will:

- manage the user–system dialogue
- support students in declaring their goals, by using each user's personal ontology and the domain ontology
- perform skills gap analysis by matching the user profile and personal ontology against the domain ontology
- pro-actively suggest content to the student, based on his/her profile and ontology, the domain ontology and the available educational modules
- attend to users' queries about content, and suggest modules that meet his/her declared needs, based on the available educational modules

- decompose the user queries and goals into sub-goals to be met by the system and then co-operate with the response planner in order to compile a list of suggestions
- monitor the correct delivery of courses and record user's learning behaviour in order to update his/her profile
- optimize the delivery of content with respect to momentary network availability and device capabilities

Based on user's model and profile, this agent will synthesize "on the fly" the user interface for the particular educational session, using frames that combine interaction templates with aspects of context. By decomposing the user-interface into dialogue description, content, layout and device capabilities, the system will support flexibility, adaptability of interaction, while taking into account linguistic and cultural preferences of the users.

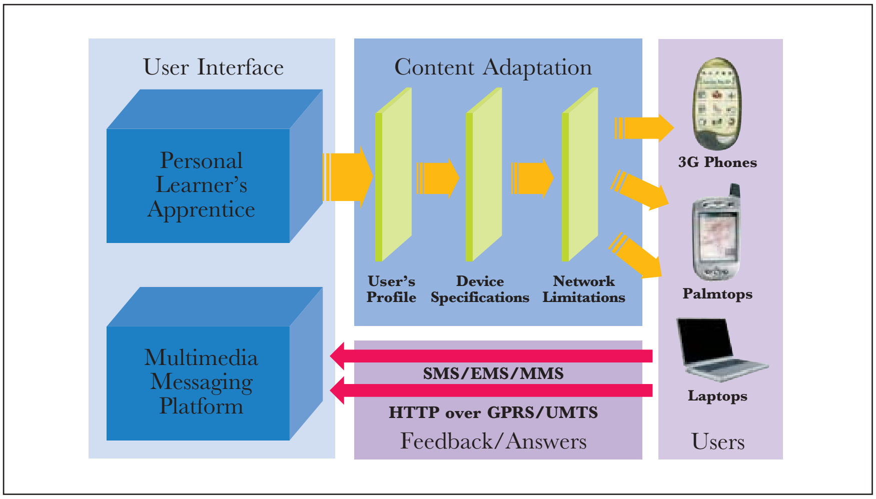

Figure 1:
The platform services will be delivered to the user via an advanced user-interface. The main components of the user-interface will be the Personal Learner's apprentice and the Multimedia Messaging Platform

A Multimedia Messaging Platform (MMP) will be developed that will provide two-way communication. The MMP will be the second major component of the user-interface. A web-based application will provide the interface for delivery of multimedia messages. A web server will be used to collect user responses either through the web or directly from the mobile network. Learning material can be delivered to learners using this platform and questions or feedback can be collected from them. Collaboration among learners will be enhanced by a service that allows for easy and immediate exchange of information. Transmission of quality photographs, sound and video will be possible enabling instant, high quality collaboration among the users.

Educational Content

Educational content is what the AD-HOC system actually delivers to its users. The project is developing a generic software platform for storing, retrieving and dynamically synthesizing educational modules to meet each learner's goals. To achieve this, content will be broken into small, independent multimedia educational modules. These will be stored and retrieved using a database management system. Content modules will present domain topics in many different formats. Meta-data will be used to describe the modules. An international standard (or near-standard) such as the IEEE P1484 will be adopted. Aspects describing the use of meta-data include the format of module and other technical aspects, its language, its technology requirements, its duration, its role in learning, pre-requisite knowledge or modules, etc. A set of software modules will then be used to dynamically synthesize a course, according the user's profile and language, and the learner's goals. The system will:

- decompose a query issued by the learner into educational sub-goals, or perform an analysis of his/her skills profile
- retrieve the appropriate educational modules from the database
- synthesize the modules into a Personalized Virtual Document (PVD) based on a methodology that will be developed during the project. The methodology will take into account the user's context of learning, his/her personal ontology and his/her goals, and will implement an appropriate instructional strategy

When applying this methodology for course synthesis, the system will come up with a range of educational modules for the learner to select, depending on the constraints set by the learner. These may include educational objectives, duration, delivery platform, etc.

The approach, that will be adopted in the framework of the project, is to use scenario-based design methods[9] as a means of defining suitable educational applications of mobile technology. Scenario building is one of the partnership's main design techniques to explore new forms of interaction in which the physical environment is able to react to human behavior, using handheld devices as a mediator. In the framework of the AD-HOC project a series of scenarios will be developed describing different situations. Language will be presented through written text, audio and, where applicable, through animations or video. The language modules will be divided into limited sub-modules to help the learner in the fast access to the specific language patterns he/she is looking for. The learner will receive choices for links to little scenes, cultural context, grammar explanations and to interactive exercises, also to similar language content/scenes/cultural context in other languages. The interactive exercises will allow for voice recognition and will offer the option for correction and reply. In this way the learner will be able to create a live dialogue or even use the device as assistant during his/her communication with another user.

Current Status

So far we have focused on two axes: PDAs' multimedia capabilities and short-range wireless communications technologies.

Using Embedded Visual Tools like Embedded Visual Basic 3.0 and Embedded Visual C++ we are developing and testing applications from scratch that will take full advantage not only of device mobility, but full exploitation of all multimedia capabilities, i.e., the downloading and reproduction of audio and video files.

Moreover, we are not only examining mobile internet connectivity, but are extensively researching different download methods. In these methods the content is pushed to the PDA whenever the user "syncs" the device with the AD-HOC system. Another programming challenge on which we are working is the availability of "device-to-device" networking using Bluetooth. There is already under development a Bluetooth wireless LAN for testing wireless communications and downloads using some exemplary AD-HOC scenarios.

The piloting of the application is taking place in repeated cycles of learner-centered trials in Greece, Italy, Austria and Germany. Each cycle includes the design, the development, the trials and the evaluation,

[9] G. Ringland, *op. cit.*

which is the input for the next cycle in the student-centered product's development approach. The in-situ trials are not only meant for evaluation purposes but involve both students and teachers offering them the chance to provide feedback to the project and its technical and pedagogical aspects.

Conclusions – Future Work

The AD-HOC partnership considers that the challenge for the future generation of educational systems at the dawn of the third millennium is to develop didactic environments for mobile phones and mobile computers as the availability of mobile devices spreads to a billion users. The mobile telephone is becoming a trusted, personal device with internet access, smart card usage, and a range of possibilities for keeping the learner in touch with the institution's student support services, in contact with learning materials and fellow students, while at home, at work, or traveling.

During the application an extensive usability evaluation will provide guidelines as to the human–computer interaction and the psychological contents required for the development of the final version of the AD-HOC system. The consortium aims to investigate the impact handheld technology has on end users' experience of wireless e-learning applications.

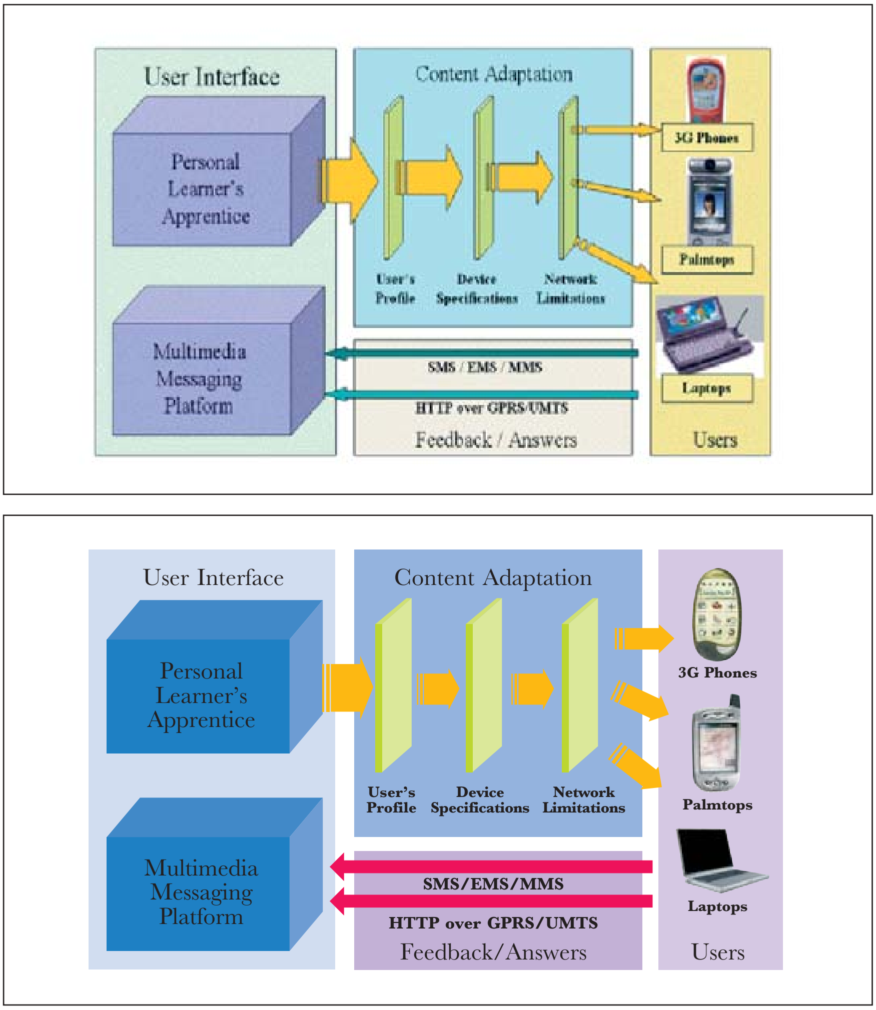

Figure 1:
The platform services will be delivered to the user via an advanced user-interface. The main components of the user-interface will be the Personal Learner's apprentice and the Multimedia Messaging Platform

Karin Drda-Kühn

VERTIKULT

Mobile Technologies Offer New Opportunities for Safeguarding Performance and Quality of Cultural Work

VERTIKULT is an innovative German research and application project with a three year timeframe at the interface between culture and the arts and the new information and communication technologies. The target is to offer those working in cultural activities an internet-supported platform – an "internet portal" – as an innovative working tool for project work. Via the portal, services can be offered and accepted. Two aspects are new here: this is the first time that such a portal is available in the cultural field covering a complete state, and also further functions will be offered to support the work organisation in projects.

VERTIKULT was developed on the background that a fundamental change is taking place in our society. Its economic and social structure is evolving into a society characterised by knowledge and services. The cultural field is no exception here. The notable features of this change are more intensive competition, continuous qualification needs in handling the new information and communication technologies, the changing roles of men and women in the world of work and the replacement of fixed organisational forms by flexible contracts and time-frame structures.

The realisation of projects within a limited time period will definitely characterise the future of cultural work. Even today, in many cultural institutions, such temporary project work is already part of day-to-day routine. VERTIKULT offers an instrument with which these changing requirements can be mastered and used productively.

The Initial Situation

On the one hand, in an increasingly flexible employment market, the cultural field can be considered as playing a pioneering role in the transformation of work. This is because the new occupational circumstances which are currently being established in the European employment market are "typical for cultural work: project work, short term employment, part-time or small-income jobs, multiple jobs, high rates of self-employed persons and patchwork careers".[1]

However, on the other hand, one can by no means claim that the new information and communication technologies (ICT) are being adequately exploited in the cultural field. We can already say that the self-employed persons in the cultural field are on their way towards exploiting the possibilities of ICT; however cultural institutions – particularly those in public ownership – are just beginning to learn what possibilities are available.

Therefore, it becomes all the more important to present a differentiated picture of the user requirements in such a heterogeneous field as culture. The state of research on user prerequisites and applications of new media and telecommunications in the cultural field is very limited to say the least. Apart from one or two isolated publications, currently, neither a sound data base nor a research approach appear to exist with regard to the question as to why the new media have not imposed themselves in the cultural field in the same way as in other areas where they are now taken for granted.

Research work increased over the last ten years only concerning the aspect of "the culture industry and employment"; the central role played by ICT is stressed here. The catchwords here are "economisation of culture" and "culturalisation of the economy".[2]

To sum up one can say: Over the last years, researchers have published numerous problem descriptions and, in a series of studies, repeatedly demonstrated the necessity for the implementation of new technologies – even demanding this. In the German speaking region, the the literature on this subject is just as extended, complex, and inconclusive, as are the various efforts in this field made by the individual German states. A characteristic feature is that there are studies on individual aspects but hardly any comparable data (neither at the level of the indi-

[1] IFA – Institut für Arbeitsmarktbetreuung und -forschung, *Informations- und Kommunikationstechnologien – Auswirkungen auf Beschäftigung und Qualifizierung – Endbericht* [Information and Communication Technologies – Impacts on Employment and Qualifications – final report], part 4: *Kultur / Kulturwirtschaft* [Culture / Culture Economy], Vienna: IFA, 2000, p. 106.

[2] See the following study: MKW GmbH, *Exploitation and Development of the Job Potential in the Cultural Sectors in the Age of Digitalisation*. Commissioned by the European Commission (DG Employment and Social Affairs), Munich: MKW, 2001.

vidual German states nor at the federal level).[3]

We are confronted with a similar situation at the European level with regard to research and data. This is all the more incomprehensible because the EU Commission itself states that the number of jobs in the cultural field within the EU member countries amounts to about 3.5 million – which nevertheless would correspond to a share of 2% of all employment.[4]

Even though the number of internet connections has grown continuously over the last years and the demand for internet services is also increasing, the cultural field is certainly not characterised by a particularly innovative approach here. The "digital gap" between users and those who only use the internet in a very limited manner or even refuse to have anything to do with it (onliner – nonliner) also exists in the cultural field as well as in other walks of life and occupations.

However, today, one can definitely say that the new information and communications technology is changing the nature of occupations in the cultural field wherever it is used, experimented with or employed as an additional working tool. Here, one must agree with Zimmermann /Schulz who came to the simple but likewise correct conclusion: "that the changes are less marked concerning the actual cultural work itself and that they are all the greater when mediation and utilisation work is concerned".[5] This is where VERTIKULT is implemented.

[3] Five recent studies reflect the current research situation: Kultursenator Bremen (ed.), *Neue Medien und Telekommunikation – Studie über die Auswirkungen auf den Kulturbereich*, Bremen: 2000; IFA, *Informations- und Kommunikationstechnologien* (cf. note 1); *Frauen in der Kultur – Zwei Untersuchungen des Deutschen Kulturrats*. Bonn: Deutscher Kulturrat, 1995; MEDIACULT (ed.), "Frauen in Kultur- und Medienberufen in Österreich" (research project *Women in Arts and Media Professions – European Comparisons*, co-financed by General Directorate V of the European Commission, Vienna: 2000 (the data can be considered as reflecting the general European trends); O. Zimmermann and G. Schulz, *Kulturelle Bildung in der Wissensgesellschaft – Zukunft der Kulturberufe*. Commissioned by Deutscher Kulturrat e.V., Berlin–Bonn, 2002. In this context reference should be made to the "Status Report on New Ways to Work in the Information Society – a report about the status of eWork-Developments in Europe" (2000, supported by the European Commission within the scope of the IST program). Here, one also finds the evidence for the relevance of a gender-specific access for IT solutions. In Germany, the percentage of women working in individual areas of the cultural field is as high as 72% therefore the VERTIKULT project will specifically take this factor into account.

[4] *Working paper for the Commission: "Culture, Cultural Economy and Employment"*, Brussels: European Commission, 1998.

[5] O. Zimmermann and G. Schulz, *op. cit.*, p. 62

The VERTIKULT Background

What characterises the field where VERTIKULT is positioned?

- The cultural field is a work and service environment which is dominated by two types of employment: (a) regular positions, principally in public institutions, and (b) to a much greater extent, free-lance experts who offer their services temporally and project-related.
- The standard ("regular jobs") working relationships are proving to be increasingly difficult for the organisation of (principally public) cultural work: The fact is that there are more and more tasks which are limited both in scale and time and for which standard work organisation methods are too inflexible. Of course the demand remains for highly qualified experts with a solid academic background but today these candidates must be able to provide further skills as well. They must have competence in:

  – information management = obtaining information from many different sources also using new technologies;
  – communication capability = interdisciplinary working within changing conditions of time, place and personnel;
  – team capability = cooperation with experts from different disciplines.

- For these forms of working, there are no adequate institutionalised structures to bring together clients and employees under the new requirements. There is also a lack of scenarios which display the possible chances open to previously marginalised groups (handicapped persons, mothers and fathers who wish to organise their work around the needs of their children) in the employment market who are apparently in an increasingly insecure and incalculable starting position.
- In some respects, the cultural field lags behind in the use of new technologies. These are often only used as aids and not incorporated in the work organisation and work requisition. One significant indicator: in contrast to a host of other working areas, there is no internet employment broker for the cultural field.

VERTIKULT takes effect exactly at the point where the value of using new technologies is most obvious: in work structuring. This is where there are chances for employment development, for a more humane organisation of the world of work and an improvement of competitive edge of the (small) companies and persons involved. The focus is placed on questions and problems in a "virtual enterprise", i.e. a working situation without traditional work forms such as a fixed work location and defined working hours. The necessary qualifications and skills, aspects of social and cultural integration in the enterprises involved as well as questions of motivation to perform self-reliant working are taken into consideration.

Why Is an Internet Portal Necessary?

The latest technology can support new working requirements and types of activity – starting with telework, via flexible organisation concepts right up to technically controlled networks and information flows. An internet portal allows the exploitation of the new technologies for the safeguarding of working performance and quality in cultural activities. It opens up new working opportunities for those actively involved in cultural work and thus enriches the cultural landscape.

VERTIKULT appeals to all involved in cultural activities and the arts in public and private institutions as well as all persons who provide services within the scope of cultural activities. Those people who are only interested in part-time or temporary activities are also a target group – for example men and women with young families. The requirements of handicapped people will also be taken into account.

The portal will offer to these culturally creative professionals new opportunities by bringing together employers and employees in the cultural field. It will make a contribution to transparency in the contract award process of publicly funded projects. It will include both offers and requests for temporary services. It will simplify and support the search by employers for qualified contractors. It will provide those searching for work with access to contracts and tasks suitable for their skills. It will allow the users to actively contribute to the changing processes in the world of work and permit them to improve their own qualifications.

How Can Cultural Institutions Profit from VERTIKULT?

An example:

For an exhibition project, a museum is searching for a curator who must have specialist experience in order to perform this specific task. A corresponding job description is entered in the VERTIKULT *databank. At the same time, using the qualification profiles and CVs already stored in the databank, a search can be made for a suitably qualified expert and contact can be made to request an offer for the proposed project.*

What does this mean for the future working of cultural institutions? Cultural institutions are obliged to treat the available resources as time and cost efficiently as possible. VERTIKULT supports these efforts free-of-charge – particularly in the project work. It will be possible to carry out the tasks at hand electronically, independent of time and place, and with a clearly reduced administrative input and cost savings.

How Can Persons Working in the Cultural Field Benefit from VERTIKULT?

An example:

A free-lance restorer of works of art is obliged to take on project-related temporary tasks or an art historian with young children wishes to know what tasks are available which are independent of time and place and thus compatible with family obligations. Both persons can enter their qualification profiles (anonymously) in the VERTIKULT *databank. At the same time, using the search functions, they can consult the databank for offers of work which correspond with their qualifications and interests.*

What does this mean for the future work prospects of professionals in cultural activities? Every qualifications profile which is entered into the databank – free of charge – will be available to a large number of potential employers who are possibly looking for just such a candidate for a specific task. The search functions allow professionals to research the employment market efficiently for suitable vacant positions in the cultural field. Contact with a potential client/employer can be made electronically – also outside regular working hours. All these factors create the prerequisites to meet the requirements which working in our future knowledge and service society places on every one of us.

The Integration of Mobile Technologies

VERTIKULT is just beginning. However, it is already clear that the transfer potential of the project results will only able to be fully exploited when the conditions which are dominant in the various European countries are already taken into consideration at this early stage. This applies particularly to the East European candidate countries who now have a clear perspective for joining the EU.

In these countries the conditions are quite different from those in Western Europe: Whereas the share of static fixed-line network-based installations is currently about 30–60% in the West, the share in the Eastern European countries lies at about 10%. In contrast, the share of mobile end user devices can be estimated at roughly 60% in Eastern Europe. This means that VERTIKULT must develop parallel strategies in the course of the project and determine in which manner mobile devices must be integrated into the research and realisation targets in order to be successful Europe-wide.

Mobile consumer devices with multiple functions are also playing an increasingly important role in Western Europe. How this role can be integrated into employment mediation and work organisation will also be a subject of research of technology and work in the coming years along with the research into information and communication technologies. In this connection, VERTIKULT is exemplary for fostering interdisciplinary cooperation.

What VERTIKULT Wants to Achieve: The Socio-Economic / Socio-Cultural Approach

Within the scope of an accompanying socio-cultural/socio-economic research program, part of the research will be the estimation of the effects of the project, the provision of consulting services for IT development and the evaluation of project results so that concrete recommendations can be made for the transfer as a business model.

Employment market policy aspects are particularly relevant here because the pressure to justify public budgets is increasing and cultural budgets are certainly no exception here.

The subject of the research will be:

1. effects in the cultural field on the quality of working conditions (coping with the lack of "structural security" and the corresponding insecurity which results, conditions for the acceptance of new forms of work supply and demand, new forms of coordination, generation of new networks, coping with the dissolution of traditional fixed employment relationships, preserving and increasing efficiency in spite of higher organisational outlay, positive handling of the new flexibility potential, consideration of employee interests)
2. effects on the legal framework conditions of the new work relationships as well as definition of limits (employment law, contract law, representation of interest)
3. effects on level of employment, economic development and competitiveness of the individual employee (questions of continuous further qualification and self-motivation)
4. effects on the working conditions of handicapped persons (work organisation which is not dependent on a specific location can be a chance for physically handicapped employees)
5. effects on the working conditions of women during and after the family phase (Flexible work possibilities increase the compatibility of family and occupation and allow highly qualified women to stay in contact with their expert fields or ease the new start after the family phase.)

Who Is Behind VERTIKULT?

The development of the internet portal of VERTIKULT is a research project of the Federal German Ministry for Education and Research (project title: "Development of a vertical portal for cultural tasks"). The realisation of the project takes place in the German state of Rhineland-Palatinate (project title: "Mediation of services and transfer of information for cultural work"). It is financed by means from the European Social Fund and with the support of the Ministry for Science, Further Education, Research and Culture as well as the Ministry for Employment, Social Services, Families and Health of the State of Rhineland-Palatinate. The partner group consists of research institutes and small to medium-sized companies.[6]

To safeguard the European dimension of this project, at the research level, VERTIKULT is also integrated into projects at five European research and cultural institutions. The purpose here is to develop VERTIKULT as a transfer model with its implementation throughout Germany and Europe.[7]

[6] German members are: Fraunhofer-IGD, Darmstadt; Zentrum für Graphische Datenverarbeitung (Computer Graphics Centre), Darmstadt; media k GmbH, Darmstadt; poppke & broos, Frankfurt am Main; Forschungsinstitut Technologie Behindertenhilfe (Research Institute for Technical Support for the Handicapped), Wetter; Institut für Technologie und Arbeit der Universität Kaiserslautern (Institute for Technology and Employment, Kaiserslautern University)

[7] European partners are: MEDICI – Network of the Politecnico di Milano, Italy; Austrian Cultural Service, Vienna; Hungarian Academy of Sciences, Budapest; Patras University, Greece; Hinsenkamp & Co DP, Budapest.

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