Introducing Hydroinformatics

Michael B. Abbott

ABSTRACT

Hydroinformatics is the name of a new way of applying knowledge as this knowledge is utilised in the worlds of the waters. This new way of applying knowledge, which is developing generally within our present-day societies, is concerned with ways to access and employ electronically encapsulated information, which itself becomes knowledge just to the extent that it is genuinely accessed and authentically employed. The knowledge of how to apply knowledge in the new way is thus itself a certain kind of 'metaknowledge'.

Key words | hydroinformatics, knowledge application, information, metaknowledge

Michael B. Abbott
International Institute for Infrastructural, Hydraulic and Environmental Engineering—IHE, Westvest 7, 2601 DA Delft, The Netherlands
E-mail: *mba@ihe.nl*

INTRODUCTION

This first issue of the *Journal of Hydroinformatics* marks a new and important step in the progress of this subject. It marks the point where hydroinformatics becomes accepted as a viable discipline in its own right, where it comes to presence in a more connected and homogeneous way, and where it attains to a certain permanence of form. It announces the fact that hydroinformatics has arrived, that it is already standing right here, and that it has come to stay.

Hydroinformatics carries into the world of the waters, the *hydro* of its name, all the developments in information, including communication, technologies that our present-day societies provide, thereby giving it the *information* of its name. We here take the word 'information' in the common colloquial sense of 'that which has the capacity to impart knowledge', rather than in the narrower but more strictly scientific sense in which it is used in classical information theory. From the point of view of the societies in which these developments occur, information and communication technologies are only the means to realise what is essentially a social transformation, namely one in which *knowledge becomes a kind of product*, to be produced, configured, brokered, marketed, transmitted, further transformed and ultimately consumed in new ways. It is then usual nowadays to associate this change with a transition from a *modern* to a *postmodern* condition within the societies so affected. In studies of postmodernism, these new ways in which knowledge comes to function are often associated through one common factor, namely a change from an emphasis upon *knowing* to an emphasis upon the *consumption of knowledge*. Thus, for Appignanesi & Garrett (1995, p. 107; see, more originally, Baudrillard 1963; Lyotard 1979//1992):

> The irreversible change from *knower* to *consumer of knowledge* is the cornerstone of postmodernity. This is the real historic change which legitimises postmodernism.

This general tendency within societies that enter into the postmodern condition then leads to the formation of a new way of employing knowledge, which in turn necessitates a new kind of knowledge, which is a knowledge of how to access, absorb and apply an electronically encapsulated knowledge, ubiquitously called information, which itself truly becomes knowledge precisely to the extent that is genuinely accessed, authentically absorbed and properly applied. This new kind of knowledge is therefore a certain kind of 'metaknowledge'. Thus, within the postmodern context, hydroinformatics is the name of this new kind of knowledge as it is applied to the worlds of the waters.

In the case of hydroinformatics, this general postmodern condition first made its appearance during the

development of the fourth generation of modelling tools in the mid-1980s. These were numerical simulation packages that could be set up and run by persons who, although competent in fields to which the solutions were applied, had little knowledge of the way in which these functioned at the level of their numerics, their graphics, their other codings, and indeed all else of this technical-enabling kind. Every aspect of the operation of these tools – their input of site-specific data, their appropriate instantiation with this data for a wide variety of map projections, their calibration, their operation and the forms of their output – were automated. A division then already arose between the producers of the resulting 'packages', who thereby encapsulated their knowledge of the numerics and the control codes that realised the automation process, and the users of these packages, who made use of this encapsulated knowledge without needing to possess such knowledge personally (Abbott 1993). We accordingly nowadays commonly make a distinction between 'tool makers' and 'tool users' within this field. Naturally, a good tool-making organisation is simultaneously one that is a user of its own productions, but the number of the end users of the tools and the variety of their applications usually causes the tools to be applied over a much wider range of applications than are normally available to any one individual tool maker-user. For this reason, institutional arrangements have to be set up to link users of any specific tool to the makers of that tool, usually generalised over classes of tools. This introduces a new kind of social entity which links together local and regional user groups, local-language-service and other (regional) knowledge centres to an on-line service centre at the premises of the tool maker that is linked further to all relevant in-house specialists and their facilities. The on-line service centre may itself be constituted as a multilingual centre using standard commercial Computer Integrated Telephony (CIT) and Customer Relationship Management (CRM) systems. We observe correspondingly that even this first stage introduces new institutional arrangements, so that it already exhibits a *socio*technical dimension.

The first and most immediate consequence of the introduction of such fourth-generation simulation modelling tools and their social-institutional infrastructure has been that the number of organisations and individuals

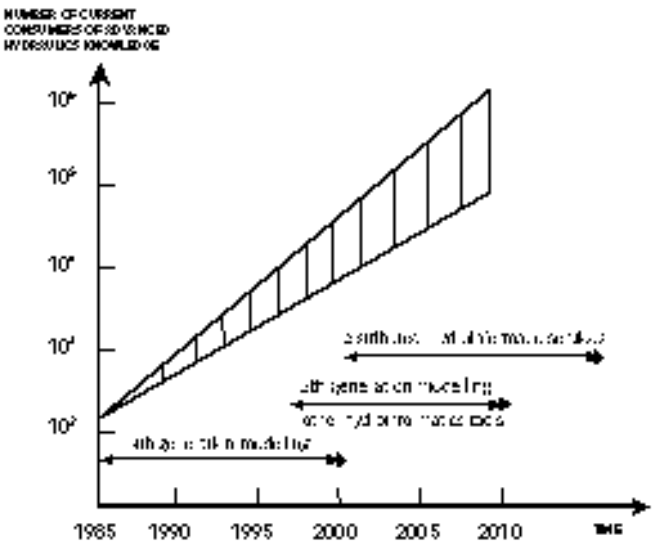

Figure 1 | Historical and predicted growths in the numbers of consumers of high-level knowledge in hydraulics, hydrology and water resources.

making use of the highest level and most comprehensive range of knowledge in hydraulics and water resources has increased by about an order of magnitude every five years. This development is shown as a graph in Figure 1, which also projects this development further forward in time on the basis of expectations that will be introduced presently.

Alongside the elaboration of fourth-generation modelling tools, we may identify the following developments that have evolved directly within this first stage of the hydroinformatics paradigm:

- The assimilation of measured data into numerical models to provide fast and reliable data-assimilation capabilities.
- The analysis, design, installation and operation of combined measuring and numerical-modelling facilities.
- The further integration of such facilities with geographical information systems, and thus with a wider range of social/infrastructural services.
- The introduction of flood- and other early-warning systems.
- The introduction of real-time flood-management systems.

- The construction and operation of real-time control systems, especially for urban drainage networks and wastewater treatment facilities.
- Several enhancements to existing products and services, such as the on-line control of marine operations.

In order to realise these developments, several enabling technologies have been adopted and adapted, such as those of artificial neural networks (ANNs), genetic algorithms (GAs) and a host of enabling tools, environments and internet development technologies such as ActiveX, Java and CGI. Throughout this development we observe an increasing use of knowledge not only by persons who do not possess the knowledge itself, but increasingly by artefacts for which knowledge, as such, can have no meaning.

We further observe that, in almost all of these developments, persons and tools appear in close interaction, thus providing the *material overlaps* of sociotechnical studies (see, for example, Law 1986, 1991). Further to this again, most applications involve combinations of interacting persons and tools, and so interacting combinations of material overlaps.

THE TWO MAIN LINES OF CURRENT DEVELOPMENTS

Against the backdrop of the above developments, we currently discern two main lines of advance within hydroinformatics. The first of these is that of *data mining for knowledge discovery*, which promises to revolutionise the way in which knowledge is produced, represented and applied. Data-mining-for-knowledge-discovery environments are composed of combinations of persons and tools with strong material overlaps that transforms raw data into representations of knowledge that are accessible to the end-users or consumers of this knowledge. The second main line of development is often nowadays fitted under the one rubric of *knowledge management*. As we use the term here, this covers all the ways in which given bodies of knowledge are prepared for consumption so as to be easily distributed and turned to various uses within society. It is also concerned with the effects of changes in knowledge relations within societies upon power relations within these societies, and vice versa. Knowledge management in this more general sense is nowadays particularly directed to the distribution of knowledge as information over electronic networks, such as the Internet, and the corresponding social networks that then come into being.

The first of these two lines of development, that of data mining for knowledge discovery, has one singular advantage for the purposes of this introduction. This is that, as it is currently pursued, it is almost entirely technical, with few if any immediate social implications. The social aspects do not disappear, of course, but their consideration can usually be suspended, to be taken up later in applications, such as at the level of knowledge management. It is essentially this feature that makes this line of developments so much more congenial and correspondingly more readily acceptable to engineers and other professionals.

Reinforcing this tendency to professional acceptance again is the perception that data mining may provide a certain correction to many of the misuses and abuses of fourth-generation modelling tools, and especially to the practice of 'mindless calibration' of models from measurement that has unfortunately characterised so many of the applications of these tools. All too many examples exist where the calibration procedures have been used to cover over and mask gross misrepresentations of the physical realities of a modelled situation, so that the resulting model, although apparently 'well calibrated' is of little or no use for predictive purposes. In view of the now widespread use of simulation modelling tools and the frequency of their misuse, this corrective or at least palliative role of data mining finds a sympathetic reception in many places, thus making it acceptable already within present-day engineering practice. The real significance of data mining passes way beyond such immediately pragmatic aspects, however. Indeed, the question concerning the essential significance of data mining is critical in hydroinformatics.

'Questioning', observed Heidegger, 'is the piety of thought', so that in fact every such fundamental development in technology as this necessarily starts with a

searching question. In the present case this question concerns the way in which knowledge is produced and the means used to represent it relative to a particular kind of consumer. Within the modernist paradigm, now already fast receding behind us, it was the 'knower' who postulated and formulated 'the laws of nature', as a kind of reflection of the world of nature experienced within his or her own mind. The mental reflection at a moment of time was provided with a certain permanence through the practices of certain ways of expression, and in the first place through *writing* (Eco 1976). The modern era was introduced and marked by one very special way of writing, which was a quite new kind of symbolic writing. This is to say that it was, and still is, a writing in which certain marks ordered on a place surface – ink marks ordered on a sheet of paper, chalk marks ordered on a blackboard, etc. – *replaced* certain isolated experiences of our world of nature for the purposes of facilitating our own, otherwise unaided, mental operations (Abbott 1999). Each such mark thereby constituted a *token*, as that which is given up in place of a something else, and in this period the predominant tokens used in science and technology became those that not only replaced, but effectively *effaced* that which they betokened, so that they functioned as *symbols*. In effect, *symbols are tokens that point to themselves*. We accordingly call this period in the history of human activity, with all its corresponding means of representing the matters of science and technology, *the symbolic era*. It reached its apogee in the setting up and playing of language games, its *mathesis,* in an extension and reformulation of an earlier mode of representation using the devices of geometry (Galileo 1638; Abbott 1992; see also again Abbott 1999). Its counterpart was a *taxonomia* which, although it employed symbols extensively, had little or no use for an algebra of the kind that was so essential to this kind of *mathesis*. We situate the period of vigorous growth of the symbolic era in the nineteenth century, although of course its practices have continued and proliferated much further into our own times.

When seen within a wider historical perspective, this development can be seen as providing a certain completion of the programme of 'Enlightenment', increasingly associated with a humanism in which a new kind of subject called 'man' became 'the centre of all things' (Horkheimer & Adorno 1944/1969//1972). As such, it was analysed and questioned critically even before the nineteenth century by such as Locke, Hume and Kant. The great achievements of the nineteenth century itself in science and technology largely drowned out even these voices of questioning, however, with only a few dissenting voices making themselves heard, such as those of Kierkegaard, Schopenhauer and Nietzsche.

It is really only in our own time, but then through an apparently quite other process, through the introduction of computer-based tools in which symbols are not employed explicitly at all, that we arrive at a new emphasis upon signs, understood as tokens that *point away from themselves* towards other objects, situated in the world of nature. Since so many of these tools – finite state automata, artificial neural networks, evolutionary programmes, phase-space reconstruction techniques, etc. – make little or no explicit use of symbols at all, we commonly describe them as *subsymbolic*. Obviously, the symbols still subsist at the level of the descriptions of the ways of working of these devices and precisely for the purposes of facilitating, and even enabling, our own understanding, but they now already come to live a more shadowy, secondary existence, at least one step removed from the immediate experience of the tool-using technologist or scientist. We speak of this new period in technology, and increasingly in science also, as *the postsymbolic era*.

The essential point about the symbolic era is that it locked its proponents into specific kinds of language games in which the systematic manipulation of symbols became the principal instrument for guiding human understanding. However, one cannot employ any language as an instrument without becoming, at least some extent, an instrument of that language. The scientist, and the technologist increasingly also in the symbolic era, framed the laws of nature (in the words of Kant (1787)) after his or her own design, where this design was expressed within the rules of symbol manipulation and in the very first place within the rules of algebra.

The postsymbolic era in technology is then characterised in the first place by a retreat from the position that it is the 'knowing human' who frames the 'laws of nature' after his or her own design. Instead, the person

concerned, who is now more of 'a seeker after truth', sets up the means for nature herself to speak of her own designs, but then in a language which we humans can understand. Instead of setting up as a judge presiding over the affairs of nature, handing down judgements like a Kantian grand inquisitor to be executed by means of the physical interventions of humans and their machines in nature, the technologist becomes one who mediates between the ways of nature and those of humans. In order to do this, he or she must necessarily use devices that allow nature to express so far as possible her own ways, her own interests and her own desires. And then of course these devices that the technologist must necessarily use in this new mediating role are in the first place those for mining data collected with the specific purpose of providing insights into the own ways of nature and for making the products of this mining comprehensible to humans. Thus data mining for knowledge discovery is a first and essential requirements if technologists, and especially hydroinformaticians, are to perform this new mediating role between the world of nature and the world of human societies. Its precept is: *Let Nature speak!*

It should be clear again that those directly involved in data mining for knowledge discovery will not normally adduce these reasons for their activities, but will point to much more immediate and pragmatic objectives. And indeed it is essential that they should do this within the Heideggerian 'mundane and average world' with all its imperatives of financial viability. All ages have remarked on this discrepancy between the reasons that practitioners adduce for their actions and the deeper socio-historical reasons that have been subsequently identified to justify these actions, and indeed the adduced reasons and the historical grounds rarely, if ever, coincide. (Consider, for example, the observations of Tolstoy in literature, of Keynes in economics, of Heidegger in philosophy and of Jung in psychology.)

Every such change of paradigm naturally brings with it a new round of misapplications of the technology and a new crop of abuses within the social applications. Although examples of these are instructive and are unfortunately already plentiful enough, this does not seem to be the appropriate place to regale the reader with 'horror stories' about misapplications of these tools and technologies. The *Journal of Hydroinformatics* may perhaps still publish some 'Cautionary Tales' in due course and with appropriate circumspection.

KNOWLEDGE MANAGEMENT

The transformation in the role of the technologist generally and the hydroinformatician in particular to that of a mediator is necessarily associated with another transformation, but now one that is proceeding quite generally within present-day societies regardless of whether hydroinformatics participates or not. We have already introduced the initial stage of this transformation as a transformation in the role of technologists, and increasingly of scientists also, from 'knowers' to 'consumers of knowledge'. Now, however, we have to extend the range of persons involved in this process to include those who, although consumers of technology and scientific knowledge, are themselves neither technologists nor scientists, or at least they are not persons who are normally working professionally in the areas of concern here. We could then try to introduce this process as one of a *democratisation of knowledge*, but, as we shall shortly see, this is not entirely satisfactory, and from several points of view.

On the other hand, like so many half-truths, it does make for a nice slogan!

In the period that proceeds that which we are advancing as a 'hydroinformatics era', decisions influencing relations between the worlds of the waters, as the common property of nature and of human societies inseparably, as the 'Goods of the Earth' of Thomas d'Aquinas, are made by only a relatively few persons, who are described correspondingly as 'decision makers'. In one or another instance of last resort in democratic societies, these persons are elected, although in practice their decision-making powers are devolved upon other, appointed, unelected persons who are deemed to be 'experts'. These 'experts' are or are supposed to be 'knowers' in the original, modernist, sense. The aims of tools and tool users are still widely seen as those of helping the 'experts' to draw up proposals for human interventions in the world of nature that the 'decision makers' will subsequently implement or cause to be implemented. Even at the present

stage of development, however, the 'decision makers' are left with very little room to make their own 'decisions', being constrained on the one side by the representations of their 'experts' and on the other side by the expectations of their constituents. Indeed they are often little more than ciphers in the real decision-making process. Moreover, even the part of the 'experts' in this paradigm is being increasingly subverted in practice by the first wave of hydroinformatics tools as introduced earlier, for several studies have already shown how in practice the 'experts' are in their turn often reduced to mere ciphers by the productions of measuring and modelling studies, whereby nothing much remains for these 'experts' to do than to approve the consequences that flow inexorably from the studies (e.g. Teknologiraadet 1995).

Further to this again, just as data mining might be regarded initially as a reaction to the abuses of calibration and other modelling procedures within an existing social context, so the development of network-distributed environmental impact assessment and decision-support systems can be regarded initially as a reaction to abuses of existing sociotechnical decision-making arrangements. It is widely understood, even it not so widely accepted institutionally, that a considerable part of all investments in the water sectors of human economies has been wasted, while the cost to the natural economy has often been immeasurable, and is in many cases irreversible. Indeed in some sectors, and especially in the case of irrigation schemes, it has been argued that the losses often outweigh the benefits; in the case of irrigation, the loss of fertile land owing to salination, the disruption of long-established social arrangements and the increase in water-borne diseases may well have outweighed the benefits of increased food and cash crop production. If we add to this the damage done to the natural economy, then the consequences of such interventions often appear to be very negative indeed.

In many such cases it has been recognised by at least some of the organisations responsible for these projects that the primary reason for this kind of situation is the absence of participation on the part of the local population (World Bank 1992–98). This population is the immediate repository of knowledge about the region itself and of its own social arrangements, whether explicit or implicit. If this population is to be involved, however, a whole new raft of tools is required that will help a great variety of persons to explicate their own positions and elaborate their own judgements about a number of proposed interventions. On this basis, they may then go on to make counterproposals, to organise themselves in support of specific positions and otherwise engage themselves actively in the relevant assessment and decision-making processes. Tools that promote the explication of positions and on this basis facilitate the making of judgements are called *judgement engines*. These tools must necessarily draw upon facts that are presented in ways that this new class of judgement-makers can best understand, such as may be provided already to some degree by fourth-generation modelling systems, measuring networks and data assimilation systems, GIS integration and other such facilities. Such fact-providing tools then becomes *fact engines*. One attempt to provide one component of a network distributed judgement engine is presented in this first number of our *Journal*, but several other such developments are already proceeding to the reporting stage. Such judgement engines will be complimented by other tools designed to facilitate the processes in which concerned persons organise themselves into interest groups and interact with the processes of an increasingly electronic governance of society by applying political pressure and proceeding to litigation and otherwise engaging in social–institutional activity. We may observe here already that, whereas simulation modelling systems and other fact engines are essentially instruments of enlightenment, judgement engines and their associated tools are essentially instruments of empowerment. The purpose of judgement engines and thereby their supporting fact engines in this area is to empower interested persons as genuine stakeholders in water resources.

Thus the notion that 'everything can be left to the experts' is being subverted further again by the second wave of the informational revolution, by the introduction of electronic networks for transporting and distributing knowledge, as initiated through the physical medium of the Internet. As the theory of semiotics tells us, any a such far-reaching technical development, working as it does at the level of signs, must have the most profound social consequences. The immediate result is the need for a new

class of tools that can be characterised in the first place as networked-distributed environmental-impact-assessment and decision-support systems.

The management of the knowledge resources of persons and networks of persons and of the knowledge encapsulated in tools and network of tools, as these persons, tools and their respective networks interact, is, then, the proper business of knowledge management. Knowledge management has to do with the design of social environments and events, new business processes and organisational development initiatives. It is far wider than information management, even as it draws heavily upon the skills and products of information management. Further to this again, within the Anglo-Saxon business community the term 'knowledge management' is usually restricted to the knowledge resources of a particular company or other individual organisation, while we are using it here in a much broader sense. The same may be said also of the term 'information management'. Similarly, the Anglo-Saxon practice has led many organisations to institute a position that they call a 'Chief Knowledge Officer (CKO)' specifically to develop the knowledge core of their business.

Some observations need to be made about the position of papers about sociotechnical developments of this kind within the *Journal of Hydroinformatics*. The first of these is that such developments may appear as rather uninteresting from a traditional engineering, including software engineering, point of view: the technology does not appear to present anything like the same challenges as does that of data mining for example. In point of fact, however, even the technical challenges are still present, but they are of a quite other kind. It is in this case very much as in philosophy as described by Wittgenstein, in that the software industry has managed to produce any number of tools and even complete environments with little or no mutual compatibility, so that anyone who tries to produce integrated products using these tools soon gets tied up in the most agonising knots as they try to link the elements together. The technical difficulty is, in effect, to untie the knots that the software industry has (unwittingly) introduced. It is precisely because the knots have been tied in such complicated ways in the first place that one is obliged to go through such complicated motions, and even downright contortions, to disentangle everything.

The second general point that has to be made at this juncture is that, whereas most people will not claim to know a great deal about such enabling technologies as ActiveX, Java or CGI, almost all will consider themselves fully conversant with such main-line processes as those of gathering experience and making judgements. Accordingly, although most persons will understand the need to study the enabling technologies on the software side, they will not necessarily see much purpose in studying, let alone researching, the human-cognitive and social sides of the subject. Moreover, whereas there is a fair measure of agreement in a still quite restricted literature about the nature of ActiveX, Java or CGI, there is an immense spread of meanings and correspondingly an overwhelming confusion in an (indefinitely) extended literature even about such inference chains as are introduced elsewhere in this issue as:

$$\text{(beliefs, facts (data))} \rightarrow \text{attitudes} \rightarrow \text{positions} \rightarrow \text{judgements} \rightarrow \text{decisions} \rightarrow \text{actions.} \quad (1)$$

The difficulty confronting the hydroinformatician in this area is that of making some sense out of this confusion, and so in this case of disentangling the complicated knots that have been tied by countless opinions over the millennia. Of course, hydroinformatics does not stand alone and unsupported in this situation, for it is as well sustained by the immense efforts, that have been made, and also over the millennia, to create some order out of this confusion.

By way of analogy, if we may compare the task of the data miner with that of cutting tunnels through deep and difficult geological strata in order to reach a vein of valuable minerals, we may compare the task of the hydroinformatician working in the sociotechnical area with that of hacking a path through a dense jungle of opinions, preconceptions and biases. And moreover, just to complicate this situation still more, this is a jungle that, for most of its denizens, does not even exist! Thus, that part of hydroinformatics that often appears from the outside as the 'softest' part, and therefore by implication the easiest part, in fact turns out to be the hardest of all. Most people simply use the words and relations expresses in (1) without reflection, with the self-assurance that they understand their working without further consideration. Heidegger expressed this situation to perfection already in

his first major work, as follows (Heidegger 1927, pp. 168–169//1962, pp. 212, 213, see also Abbott 1991, p. 95):

> 'We do not so much understand the entities that are talked about; we already are listening to what is said-in-the-talk as such – what is said-in-the-talk gets understood; but what the talk is [really] about is understood only approximately and superficially.
>
> '. . . What is said-in-the-talk as such spreads in wider circles and takes in an authoritative character. Things are so because one says so. The average understanding . . . will *never be able* to decide what has been drawn from primordial sources with a struggle and how much is gossip. . . . The average understanding, moreover, will not want any such distinction and does not need it, because, of course, it understands everything.'

The third cause of the difficulties that we have to face here, and one that already prefigures the more contentious issues that we shall introduce next, is that this background to our sociotechnical studies can probably no longer be produced. For the most part, it can nowadays only be studied at a distance in time. So far as we can ascertain, our present-day societies can no longer produce a *Kritik der reinen Vernunft*, a *Sein und Zeit*, an *Erfahrung und Urteil*, or even a *Les mots et les choses*, any more than it can produce a Rembrandt self-portrait or a Beethoven symphony. The societies which made these peaks of creative activity possible have passed irrevocably from the face of the earth, just as surely as have the tectonic forces that created the Alps or the Himalayas. Of course, we can now do many other things that these societies could not. For example, these lines are written while looking across the waters of the Caribbean at a visiting American nuclear aircraft carrier which concentrates the greatest mobile potential for man-made destruction ever known. No previous society could have produced that! The point here is that every era presents its own challenges and provides its own means to meet these challenges. The task of the hydroinformatician is to meet the challenges facing nature and humanity in the world of the waters with the means that are placed at hand in his or her own times. And these *necessarily* include the means that have been bequeathed to us by earlier societies, even (and in fact precisely because!) these societies have themselves passed beyond recall.

Even as the brilliant instant of clarity of impression and thought became diffused and suffused through the rendering of that impression and thought in a more permanent form, it was only through this rendering that it could be carried into its futures, and thus into our own times. This is particularly true of the thought expressed in writing:

The word is the crucifixion of the thought.

THE BUSINESS DIMENSION OF HYDROINFORMATICS

This brings us to the first of the more difficult and more contentious issues that face our *Journal* and its subject generally, which are those of the true purpose of hydroinformatics and thus the uses to which it is properly to be put. This issue is often presented as one of 'ethics', but that can be a misleading designation within a postmodern setting (see, for example, Bauman 1993). A better point of reference is that of the influences of changes in knowledge relations upon power relations, transforming in time into the influence of changes in knowledge structures on power structures. We then speak generally, following Foucault (e.g. 1966//1970) about the problematics of 'knowledge/power'. As introduced earlier, it is just to the extent that hydroinformatics realises its programme through the provision of knowledge to very many persons over electronic networks, and provides also the capabilities for people to express their fears, concerns and aspirations over these same networks, and thence to interact and organise themselves, that it must change power relations within society as a whole. The sign vehicles which the new communication technologies allow us to employ for the transmission, processing and exchange of knowledge lead already to changes in the nature and function of signs within these societies. Thus, just to the extent that these signs succeed in functioning as social forces, so they cause social changes, and then not only in power relations: they proceed further to change power structures.

The hydroinformatician cannot possibly remain indifferent to these changes, but must analyse and research

them alongside his or her other analyses and researches of the means with which they are effected. The new means now being mobilised for hydraulic and related environmental knowledge to be produced, encapsulated, marketed, brokered, leased and purchased, distributed, and everything else of this kind, cannot be properly analysed and researched without a simultaneous and closely co-ordinated analysis and research of the social implications and repercussions of such a mobilisation.

So far, this analysis and research has led to three main conclusions that already influence the way in which hydroinformatics is developing in this direction. The first of these is that hydroinformatics can best be developed and nurtured within a commercial or business environment. The second is that the analysis and design of the new tools of knowledge management and empowerment must proceed on the basis of an investigation of the intentions of their users within appropriate physical and social contexts, so that they must be grounded in the field of science that is called *Phenomenology*. The third, which may appear superficially as conflicting with the first, is that the driving forces of hydroinformatics, the ultimate sources of its creativity, of its *poieses*, must also be investigated, but this brings us into a whole subject area of 'motivations' which must often appear as quite highly irrational. Such forces as drive the quasi-religious zeal of truly creative activity do not proceed on the basis of rational expectations and well-informed calculations, even though these may be employed by way of self-justification, but they proceed from a quite other place. We really have no alternative but to relate this place to the Kierkegaardian 'level of the religious' even though we are not then using the word 'religious' at all in its conventional sense. Since these conclusions are so contentious and the discussion of them is so far removed from the normal scope of a 'technical' journal, some explanation is necessary.

The relation between these theses, passing through the essential reciprocity of the first and third, was explicated already by Heidegger (1963//1977; see also Abbott 1991, pp. 78–79 and Abbott 1999):

> 'The flight from the world of the suprasensory is replaced by historical progress. The otherworldly goal of everlasting bliss is transformed into the earthly happiness of the greatest number. The careful maintenance of the cult of religion is relaxed through enthusiasm for the creating of a culture or the spreading of civilisation. Creativity, previously the unique property of the biblical God, becomes the distinctive mark of human activity. Human creativity finally passes over into business enterprise'.

The essential point concerning its business dimension is that hydroinformatics is a creative activity, but it is creative in a new kind of 'metaknowledge-producing' way, at least one part of which, roughly that of knowledge encapsulation and distribution, is unfamiliar to most persons already working in hydraulics, hydrology and water resources generally. Indeed, this new way of thinking is in several respects quite foreign to that which is followed within most of the established sciences and technologies, which are still dominated by the ethos of an all-exclusive 'knowing'. Hydroinformatics correspondingly encounters a strong resistance in most existing organisation, which are strongly stratified in the sociotechnical sense that it is not so much that persons-as-such are stratified by their education and experiences or that tools-as-such are stratified, but that the material overlaps between persons and tools employed within one stratum of the organisation differ considerably from those employed within other strata (Abbott 1996). Hydroinformatics is often seen accordingly as introducing a new stratum which is intrusive upon established ways of thinking, established procedures and established institutional hierarchies. It may even be perceived as something that is potentially destabilising within an already-established organisation. Like almost every other kind of new technology, it often appears as an unwelcome guest, supported only on sufferance, only as a way of 'staying in business' or of 'keeping up with the current fashion'. Thus, from the standpoint of many organisations, hydroinformatics is something that has to be carefully 'kept in its place', and preferably at a place as far as possible removed within the organisation from the point of application of the technology. The most difficult problems of applying hydroinformatics in practice are rarely if ever of a technical nature, but they are of a socio-institutional nature (see, for example, Abbott & Refsgaard 1998).

At the same time, of course, hydroinformatics has the potential to confer immense benefits upon society, and indeed it is already demonstrating this in many areas and

in many ways, such as will be increasingly apparent as this *Journal* progresses. The basic problem of hydroinformatics at the level of its application is then that of changing or bypassing or otherwise getting around the socio-institutional roadblocks that are erected in its path.

The most immediate instrument that falls to hand for this purpose is then that of business enterprise. Hydroinformatics has to avoid the imposition of inappropriate organisational arrangements, it has to overcome uninformed (and often uninformable!) interventions in its activities and it has generally to escape from as many as possible of those constraints that are already only too familiar to practitioners in this field. Hydroinformatics has problems enough in meeting its responsibilities to society as a whole without having to fight strings of time- and energy-consuming battles within its own organisations. This it can best do by meeting the demands of the users of its products as directly as possible, through the setting up of new business arrangements and by practising business enterprise generally.

Unfortunately for this process, the notion still persists among many scientists and engineers that business is only about 'making money'. Now for some persons – financiers, business lawyers and other such opportunists – it may in many cases be no more than that. But for the hydroinformatician-become-entrepreneur it is really about something quite other again, which is *autonomy*. And then not just autonomy in relation to *how* things are done, but, as a consequence of an own kind of research and development, an autonomy in relation to *what* things are done. For the creative spirit, business enterprise is the means to sustain independence of mind and action, such as is the most conducive to the freedom to create in a responsible, truthful and thus pleasurable environment. Business enterprise, and even the money that may go with it, are only the means – even though still the necessary means – to provide the required creative environment.

It follows that hydroinformatics must be very much occupied with the researching, establishing and developing of its business arrangements. This aspect of hydroinformatics must accordingly find a place also in our new *Journal*. (See, by way of an earlier example, Thompson (1998).)

THE PHENOMENOLOGICAL DIMENSION OF HYDROINFORMATICS

In order to approach the most contentious issue of all in this area – and so by way of a halfway house on our way to the formulation of the purpose of hydroinformatics – we can best proceed through the consideration of the nature of phenomena in this subject. Our starting point is that specific direction within philosophy that studies how objects give place to phenomena within our minds, which study is called *Phenomenology*. Thus, in philosophical terms, phenomenology is the systematic study of our ways of thinking about our possible worlds. As a 'thinking about ways of thinking' it necessarily leads to circularities, but these have long since been identified and the precautions required to avoid their potentially vicious consequences have been largely established.

The need for some kind of study of phenomenology arises already in the design of any user interface. For example, even the elementary processes involved in the schematisation of, say, an urban drainage system in a simulation package necessitates a thinking about the ways in which the user of the package may be thinking or come to think about the urban drainage system itself. In the design of the user interface more generally, the designer has to make as systematic a study as possible of the various likely trains of thought of the various users of the package as they apply it in various situations and with a variety of intentions. A large part, if not all, of this process may receive a graphical representation, such as in the form of a directed graph as already exemplified in very general terms in (1) above.

Of course we know of no designer of a simulation package in hydroinformatics who has actually studied Phenomenology as a strict science (and so with an upper-case 'P') within philosophy for such purposes, although we would undoubtedly have much better user interfaces if these studies had been made! It is in fact still possible to manage without such systematic studies at this level. Clearly it becomes more difficult to manage on such an *ad hoc* basis when we arrive at the design of environmental impact assessment and decision support tools, negotiation environments and other such facilities with more varied and complicated human interactions, and for these

purposes some study of Phenomenology is surely desirable, and may well be necessary.

For this purpose we may draw upon the great and irreplaceable studies in this area that were initiated in the nineteenth century by such as Bolzano and Brentano and which were brought to fruition by the twentieth century school of Phenomenology that was established in the first place by Husserl (in 1900/1901//1970). In general, these studies become increasingly important the more that we pass from primarily technical systems to essentially socio-technical systems. This is because it is these studies, more than any others, that enable us to escape from the morass of vapid opinion that otherwise threatens to drag down our thinking and drown us in empty speculations. Phenomenology in this sense enables us to make much more definitive statements about situations, events and phenomena generally and it is for this reason that it is commonly accepted as an 'exact science'. For example, in the design of knowledge management facilities it does not require much reading of Phenomenology to understand that any attempt to provide facilities using technical means alone will be at best suboptimal, and more likely unsuccessful. Indeed, a study of the logical requirements of a purely technical approach, following for example Husserl, should be sufficient to show the impracticability of such an approach. The notion of a 'knowledge centre' then comes to the fore, as a place, physical and virtual, where a variety of humans and their constructs work, together and interactively, while communicating with quite other activities of humans and tools outside the centre, situated at one or more 'peripheries' (Abbott & Jonoski 1998; Jonoski & Abbott 1998; Thein & Abbott 1998).

In the same vein, not only is some background in Phenomenology highly desirable in the design of such processes as (1) as these proceed during the operation of judgement engines, but they are essential when the operations of these engines by other persons must be made 'transparent' (Findley 1961). This occurs when the process that is dual to (1):

$$\text{actions} \rightarrow \text{decisions} \rightarrow \text{judgements} \rightarrow \text{positions} \rightarrow \text{attitudes} \quad (\text{beliefs, facts, (data)}) \tag{2}$$

has to be explicated with, for example, only 'actions' and 'facts [data]' as observables.

The consequence of the neglect of Phenomenology as a strict science are currently experienced most clearly in the failure to meet their objectives of many research and development programmes, whether at the local, national or international level. Even more to the point, the great damages that these programmes have caused and continue to cause in more general business-industrial terms, as exemplified by the virtual elimination of the computer hardware and basic-software industries in Europe, can all be traced to failures at the phenomenological level of understanding in research and development programmes. Our *Journal* can scarcely avoid giving some attention to these matters, albeit within an historical context and exercising the utmost restraint and the greatest decorum in order to avoid unnecessary pain and embarrassment. Done is done; and, after all, in the case of most of the research programmes 'it was only the taxpayers' money', while the distortion of competitiveness relations occasioned by these programmes could have been and in some cases was compensated by other strategies on the part of the disadvantaged enterprises.

In the case of development programmes also, the recognition of the social aspects on the one hand and the neglect of the overall phenomenology of the proposed development on the other hand, leads to situations in which the technical and social aspects do not complement one another at all adequately, and indeed may never come together properly at all. Indeed, on the basis of sociotechnical-historical studies generally we may propose the following principle:

The more experienced and brilliant the persons on the technical side of the project and the more experienced and brilliant the persons on the social side of the project, the more complete will be the failure of the project if these two sides are not properly co-ordinated and connected together.

As a particularly pertinent, because topical, example we may point to the stock market valuations placed upon several Internet companies, and specifically to search-engine providers. It is commonly observed that the enabling technology is really quite mundane and the social-application side often appears confused, ill-informed and poorly organised, but in fact it is precisely

because of this mediocrity on both sides that it is possible to hold the two sides together and thereby make such financial-valuation successes of these enterprises. As probably the most widely available reference describing the highest level of ability on both the technical and social sides held together by a person of exceptional sociotechnical experience and brilliance, we cannot do better than refer to the semi-fictional figure of Jack Aubrey in the 18-volume series of Patrick O'Brian on the role of naval power and intelligence in the Revolutionary and Napoleonic wars of 1800–15. Indeed, the very fascination of these works, leading to their sales of millions in several languages, derives precisely from the pleasure they provide from their depiction of sociotechnical excellence. They illustrate the thesis, advanced fully in the spirit of Heidegger's teachings, that *a fascination with technology is a fascination with truth*.

Whether and to what extent our *Journal* can allow itself to comment at all critically on current programmes, and especially on certain development-aid programmes involving hydroinformatics components with sociotechnical dimensions, is more questionable, and remains for the moment undecided. It is a common experience that critical comments in such areas have little impact and rarely change anything, and it is usually better to make the best of the programmes as they stand and to proceed to other initiatives accordingly.

THE TASK OF HYDROINFORMATICS

The two main lines of hydroinformatics, of data mining for knowledge discovery on the one side and of knowledge management on the other side, clearly present great differences in the kinds of difficulties that they present, in the nature of their applications and in the manner in which they can be employed. And yet we have again to insist that hydroinformatics must proceed along both of these lines if it is to realise anything like its full potential. Without a data mining capability, the sociotechnical side will be severely restricted in its field of applications, while without a sociotechnical development data mining will be just as surely constrained in its scope. The first and primary task of the *Journal of Hydroinformatics* at the moment is to keep these two lines of study of our subject together.

It is when we come to ask *why* we should do this at all, however, that we arrive at our most significant, contentious divide. What is the true purpose of hydroinformatics? And, given that we can identify this purpose, what has that to say about our procedure in any particular case?

We have already introduced the level at which the creative drive of hydroinformatics, as of any other creative activity, must properly derive, as the (Kierkegaardian) 'level of the religious' (e.g. Abbott 1991). We have again at once to add that by this we do not refer to any social religions or their combination or their absence, but to a level of experience and activity that is so far removed from normal rational behaviour that, although we do not like to condemn it as 'inhuman', we can no longer strictly predicate it as 'human'. We must then identify it in the strict and proper (and theological) sense of the word as 'superhuman', and indeed it is quite common to speak of a 'superhuman effort' when referring to the corresponding exertions. This is a place where the division between the possible and the impossible is no longer clearly discerned, and where probability has no currency at all. This level of experience appears to be present in all humans whether they know it or not and whether they like it or not. Its manifestation is *faith* even when this is experienced within contexts that are apparently far removed from those associated with social religion. And then, of course, whatever the context, 'faith is a miracle, otherwise it is not faith'. It is indeed the lesson of all ages that all creation springs from this level of internal experience. Hydroinformatics as a technology and so as an act of creation, as a place where, in the words of Heidegger, '*aletheia*, truth, happens', must be founded at this level (Abbott 1991).

The creative act may here rise to the level of a 'passion' in the exact, and again theological, sense. We accordingly have to do here with all manner of behaviour which appears to be highly irrational within the social and specifically institutional context of the Heideggerian 'mundane and average world'. It is driven by forces that are usually hidden even to the individual so possessed and which frequently lead that individual into conflict with established mores and ethics: we then have to do here with the (again Kierkegaardian) 'teleological suspension of the ethical'.

Of course none of this can possibly be admitted in an institutional context, and least of all within a conventional business context. Thus, to take an example that is particularly topical at this time of writing (Wolff 1998, p. 101):

> 'You can't say to investors: I have a problem. A big problem. You can't say, I need your money to feed the mouths I have to feed. I need the money to pour down the maw. You can't say, Hey, what do you think is going on? There's a fire burning like crazy that we have to keep throwing dollar bills on.
>
> And that was, unmistakably, what [the other CEO] was saying. And while that was true of this business and of every other business in the new Internet industry and while everyone knew it was true – that is that cash was being consumed at a rate and with an illogic that no one could explain, much less justify – you must never, never admit it'.

Now two things must be said about this that are of vital significance to our *Journal*. The first of these is that although our *Journal* cannot possibly become involved in any discussion of these matters as such, it cannot avoid considering their influence within specific sociotechnical projects or situations. Moreover, these apparently 'irrational' influences may intrude not only through the individual experience of this 'level of the religious' in the creative process, but also at the social-application level as well. For example, a negotiation platform designed to assist in the settlement of disputes between partners who subscribe to Judaism in the one side and to Islam on the other side cannot fail to take account of the different kinds of values that are placed upon land within the respective social religions (Bany-Mustafa 1998). Similarly, the value of water as a social-unifying force in Buddhism must be taken into account in a decision support system in a Buddhist community (Thein & Abbott 1998). In the same vein, a network-distributed impact assessment system can best use different social nodes for communicating between its inner and its outer peripheral segments, such as schools and microbanking institutions in some Islamic communities and monasteries in certain Buddhist communities (Thein & Abbott 1998). The technical side then has to adapt correspondingly.

The second matter that unavoidably presents itself here is that any such discussions as may arise at all in this area can themselves only be conducted within a specific tradition. Thus not only does the mode of application of hydroinformatics change as we pass from a community with the one tradition to one with another tradition, and with this the technical means that are employed also, but our very way of writing about this must change also. We are often moving from a place where the waters of the world are experienced in one way to a place where they are experienced in a very different way, and our writings as well as our actions must reflect this difference.

Both of these aspects obviously lead to great difficulties in presentation, and these are exacerbated again by differences in languages and the uses of these languages between traditions. Our *Journal* must endeavour to overcome these difficulties within its pages.

THE TECHNOLOGIES OF PERSUASION

It will now be clear that hydroinformatics is not just concerned with the way in which man changes his outer world, the world which he shares directly with nature, but it is also concerned with changing man's inner world by providing the means for men to persuade one another in more equitable ways. The technologies that are used to change the inner worlds of individuals are known collectively as *the technologies of persuasion* (e.g. Norris 1993). These are the traditional technologies of advertising, politics and other activities that may appear at first sight to be far removed from the interests of hydraulicians, hydrologists and environmentalists generally – and which probably in the view of most of these professionals should be kept at as great a distance as possible from their list of concerns! And yet hydroinformatics is unavoidably drawn into this area also and once again regardless of its so-far-established inclinations.

In fact, these professional inclinations often have a sound foundation, in that the devices that pass as the technologies of persuasion are often morally indefensible and even downright obnoxious because of the evident wrong-mindedness of their applications. But we shall have to insist, and again with Heidegger, that a technology is defined as 'a place where *aletheia*, truth, happens' and the technologies of persuasion, if they are truly technologies at all, must 'tell the truth'. 'Being true to the technology' automatically equates to 'telling the truth'. That which is

used for the purposes of misrepresentation cannot then be an authentic technology, but only *an imitation of a technology*. As Karl Barth explained so convincingly (1938–1950//1961) imitation is the hallmark of the inauthentic, of nihilism, of 'nothingness' (*das Nichtige*, *le néant*) as the vehicle of the lie. The one who is true to an authentic technology is thus the one who is automatically 'in the service of the truth', and those who have no use for truth have no use for a genuine technology.

The hydroinformatician whose drives originate 'at the level of the religious' is then obliged to expose deceptions, but even for this purpose he or she must resort to the technologies of persuasion to expose the productions of the psuedo technologies. We thus have to do with applications of the technologies of persuasion which have the purpose of combating and ultimately prevailing over other such (mis)applications. Phenomenology, however, being an exact science, cannot meet this kind of challenge, and indeed was never meant to do so. Although Phenomenology pays the greatest attention to intentions and intentionality within its own field of study, it cannot itself be the subject of specific intentions, and least of all to conflicting intentions. For these purposes something quite other than an exact science is required.

The whole purpose of hydroinformatics is to persuade, even if only to persuade local governments to proceed along one path of action rather than others, or to persuade investors to invest in one way rather than in others, or to persuade contractors to build in one way rather than others, and so on already indefinitely. As hydroinformatics proceeds further into its own version of the communication revolution, extending the range of its influence to millions of interested citizens and empowering them as genuine stakeholders in water resources, so the nature of its persuasive activity changes also. Its task now becomes one of, so to say, *persuading people to persuade people*, rather than leaving them as helpless spectators or, possibly even worse, as the victims of one or the other form of duplicity or coercion. The hydroinformatician has then to provide the means for facilitating processing of persuasion, which processes are always multidirectional. Since persuasion can only proceed through the agency of signs, this necessitates the research and analysis of a range of persuasive activities and their semiotics, and this in turn necessitates a serious study of the technologies of persuasion on the part of hydroinformaticians. Clearly a study of Phenomenology is essential to this purpose, but in this case it cannot be sufficient. It cannot serve as a moral foundation, and it is not well suited as a conceptual foundation either in this area.

Now it has in fact been argued, and by authors as otherwise differing as Karl Jaspers and Emanuel Levinas, that although Phenomenology-as-such cannot properly serve the purposes of insinuating the lie, it does have the capacity, *when suitably extended*, to serve the power of truth and thereby to expose the lie. Experience with other such extensions of Phenomenology, and especially the critical analyses of the extensions proposed by Heidegger and Sartre, do little, however, to support this argument (Barth 1938–1950//1961).

In effect, as the 1998 Encyclical Letter *Fides et Ratio* of John Paul II proclaims (p. 36):

> 'We face a great challenge at the end of this millennium to move from phenomenon to foundation, a step as necessary as it is urgent. We cannot stop short at experience alone; even if experience does reveal the human being's interiority and spirituality, speculative thinking must penetrate to the spiritual core and the ground from which it arises.'

Appeals to psychology, and specifically clinical psychology as an empirical science, or to psychiatry as a set of technologies in its own right, appear equally unproductive, with the possible exceptions of certain parts of the works of Carl Jung and his school, which then, however, do not really subscribe to psychology as an empirical science.

More potentially fertile are certain areas of literary criticism and especially those that cover the field of *pastoral* (often rendered as 'pastorale' in English), understood as the rendering of specific mental experiences with a minimum of signifying resources (Empson 1966). By understanding pastoral in this way, we place it within a general theory of semiotic economy. Thus, in the case of a graphical user interface, we may pose the problem of how we can express a certain fact, belief, position or whatever else of that kind, with the minimum number of pixels and the minimum of effort on the part of any specific user or class of users.

More fundamentally, such studies teach us, among other things, that 'understanding' occurs not so much in the signs themselves but in the 'spaces' between the signs, such as between two lines in a sonnet or between two adjacent illustrations in a strip cartoon. Associated with this feature, in the technologies of pastoral we increasingly meet instances of trains of inference that are not logical in any 'standard' sense at all – neither predicate, temporal, deontic or whatever. Instead, we enter into trains or strings of inference which subvert the 'standard' forms, even as these subversive forms do seem to have some kind of 'inner logic' that appears to defy any explanation in 'standard' logical terms. We accordingly say of these inference strings that they are *paralogical*. There are any number of current examples of paralogical devices, of which probably the most widely known are those employed in advertisements and in sequences of advertisements where again, in many cases, 'the message is in the spaces between the images'.

Current studies of paralogical thinking take many of their cues and much of their vocabulary from the work of Derrida. In her English-language edition of certain of Derrida's key essays, Kamuf (Derrida 1991) correspondingly exhorted her readers to 'read between the blinds', observing how the ordered sequences of signs through which knowledge is necessarily transmitted simultaneously obstruct the transmission process itself, so that (Kamuf, in Derrida 1991) 'these . . . could be thought of as slats of a venetian blind, of a jalousie which partially obstructs the view'.

The same notions currently arise also in applications of social value theory to knowledge management processes, where the social value of a working group's knowledge is observed not to combine as a simple sum of the knowledge of a collection of individuals and nor again only as an additive augmentation of these with the 'knowledge content' of their tools, but as well and essentially in the 'social space' between the individuals and their tools that come together to form the group. In the case of commercial organisations, this may be extended further again to encompass the social spaces between the organisation and its clients. These notions are essential ingredients in any attempt to estimate the social value and thence the money value of any organisation in 'the knowledge industry'.

Another set of technologies, used to great effect by the marketing organisations that nowadays run many political campaigns is that of *aporia*, understood as the induction of mutually inconsistent beliefs into individual minds and into collectivities of minds. All of these arcane technologies have of course been rather completely transformed and greatly strengthened by overall developments in 'the media'. The position of our *Journal* here is difficult, but it would seem best to accept some work on pastoral techniques while drawing the line at paralogical and aporiaic devices. In support of this position we may draw upon all traditions, which uniformly regard these devices as potentially dangerous and therefore to be avoided. As Jung so succinctly expressed the danger involved: 'One cannot possess this kind of knowledge without being possessed by it', and that is something that we would not wish on anybody (including ourselves!). Clearly this limit on the sociotechical side of hydroinformatics is far removed from the traditional concerns and interests of professionals in hydraulics, hydrology and water resources; but it is one of the principal duties of our *Journal* to wean these professionals over to new sources of nourishment and inspiration. Equally clearly, our task will not be easy. As a reviewer of a recent work on the playwright Samuel Beckett observed, 'In the 20th century it is axiomatic that the avant-garde is to be misunderstood'. On the other hand, one essential part of our purpose here is to ensure that the next century and millennium will understand the need for such a breadth of view and will come to embrace this range of interests.

CONCLUSIONS

Hydroinformatics is creative, poietic; it is a place where '*aletheia*, truth, happens'. It is therefore a technology in the full Heideggerian sense. We have now seen, however, that it is a technology that itself draws upon, combines and co-ordinates a considerable number and variety of quite other technologies, and even of some sciences. The hydroinformatician is thus every bit as much of a consumer of knowledge as is everyone else in the postmodern

condition. Hydroinformatics is thus a kind of 'technology of other technologies, and sciences', and so a kind of 'metatechnology'. We have now seen how its knowledge content is directed on its input side towards an imbibing and consuming of quite other forms of knowledge than its own, and on the other, output, side to transforming, or 'refining' this knowledge into very different kinds of knowledge again: it consumes knowledge only in order to provide this quite other kind of knowledge. For the moment hydroinformatics does this mostly within its own frontiers, so to speak, in that it is the hydroinformatician who personally performs this work. However, with the more widespread and deeper-going application of electronic information-transmission networks, hydroinformatics aims much more to provide the equipment for other persons than hydroinformaticians to carry out this task. Hydroinformatics itself thus passes from a rhetoric of expertise to a rhetoric of persuasion, or from constative to performative modes of functioning. This is to say that hydroinformatics becomes directed also to providing the means for persons who are by no means hydroinformaticians, and who may have little or no knowledge of most of the knowledge that the hydroinformatician consumes, nonetheless to apply this knowledge in a responsible and valuable way. It is here in point of fact that the added value of hydroinformatics increasingly accrues, both in business terms and in terms of its meeting its human responsibilities.

It is in its role of a consumer of knowledge that this subject becomes 'postmodern', coalescing into a more general postmodern condition of society. It is essentially from this point of view that hydroinformatics may be regarded as a 'postmodern technology'.

Now, of course, many things that pass for 'postmodern' in our present-day societies are uncongenial to many of us: we would much rather that such things were not going this way, and indeed that these changes did not occur. The fact none the less remains that most of our current societies are moving in this direction whether we like it or not, and certainly whether we want it or not. Correspondingly, most of the best writing on postmodernism is by way of reporting on what is actually happening, and not on promoting it. This writing is primarily constative, and not prescriptive.

It is a dominant theme in every tradition that not only does each age present its own challenges to mankind, but each and every age provides its own means for mankind to meet these challenges. Hydroinformatics is placed firmly within such a tradition. The challenges facing mankind in its relation to the waters of the world appear to us as unprecedented, but at the same time the means that are made available to us, both from the past and in our own time, are just as unprecedented also. Hydroinformatics is all about meeting these new challenges by employing these new means. The works on postmodernism are concerned in the first place to present the challenges as these arise in our present-day societies, but it is the task of practitioners in all fields, and not least in hydroinformatics, to meet these challenges. To the extent that we succeed, so we change also the nature of these societies by changing the very way that they think and behave towards the worlds of the waters. From this point of view, not only is hydroinformatics a postmodern technology, but it belongs to a process of redefining the postmodern condition as a whole.

Some concluding words should be said also about the manner in which this *Journal of Hydroinformatics* should contribute to the development not only of hydroinformatics as a discipline, but to the body of hydroinformaticians as a community. A primary aim of this *Journal* is to promote this community; to provide a 'home' to those who have a community of purpose in this area, whatever the specific nature of their immediate interests, means and objectives. This aim of 'building community' remains as a beacon towards which we must constantly steer.

REFERENCES

Abbott, M. B. 1991 *Hydroinformatics: Information Technology and the Aquatic Environment*. Ashgate, Aldershot, UK, and Brookfield, USA.

Abbott, M. B. 1992 The theory of the hydrologic model, or: The struggle for the soul of hydrology. In *Advances in Theoretical Hydrology, a Tribute to James Douge* (ed. O'Kane, J. P.), pp. 237–254. Elsevier, Amsterdam.

Abbott, M. B. 1993 The electronic encapsulation of knowledge in hydraulics, hydrology and water resources. *Adv. Wat. Resour.* **16,** 21–39.

Abbott, M. B. 1996 The sociotechnical dimension of knowledge. In *Hydroinformatics '96* (ed. Mueller, A.), pp. 3–18. Balkema, Rotterdam.

Abbott, M. B. 1999 Forchheimer and Schoklitsch: a postmodern retrospection à la recherche du temps perdu. In *Memorial Symposium P. Forchheimer and A. Schoklitsch, Proc. 28th IAHR Congress, Graz* (ed. Graf, W. H.).

Abbott, M. B. & Jonoski, A. 1998 Promoting collaborative decision-making through electronic networking. In *Hydroinformatics '98* (ed. Babovic, V. M. & Larsen, L. C.), pp. 911–918. Balkema, Rotterdam.

Abbott, M. B. & Refsgaard, J. C. 1998 (eds) *Distributed Hydrologic Modelling*. Kluwer, Dordrecht.

Appignanesi, R. & Garatt, C. 1995 *Postmodernism for Beginners*. Icon, Cambridge.

Bany-Mustafa 1998 *The Role of Hydroinformatics in the Oslo Peace Process*. IHE internal seminar, summer semester, unpublished material.

Barth, K. 1938–1950 *Die Kirkliche Dogmatik*. Evangalische, Zollikon-Zürich//1961 *Church Dogmatics* (trans. Bromiley, G. W. & Ehrlich, R. J.). Clark, Edinburgh.

Baudrillard, J. 1963 *Le Système des Objets: la Consommation des Signes*. Gallimard, Paris.

Bauman, Z. 1993 *Postmodern Ethics*. Blackwell, Oxford.

Bolzano, B. 1837/1989 *Wissenschaftslehre, Bernhard Bolzano-Gesamtausgabe* (ed. Berg, J.). Fromann, Stuttgart.

Brentano, F. 1862/1960 *Von der Mannigfachen Bedeutung des Siendes nach Aristoteles*. Herder, Freiburg in Breisgau/Olms, Hildesheim.

Derrida, J. 1991 *Between the Blinds* (ed. Kamuf, P.). Harvester, New York/Wheatsheaf, London.

Eco, U. 1976 *A Theory of Semiotics*. Indiana Univ., Bloomington, USA.

Empson, W. 1966 *Some Versions of Pastoral*. Penguin, Harmondsworth.

Findley, J. N. 1961 *Values and Intentions: A Study in Value Theory and Philosophy of Mind*. Macmillan, New York.

Foucault, M. 1966 *Les Mots at les Choses*. Gallimard, Paris//1970 *The Order of Things*. Routledge, London.

Galileo Galilei 1638 *Discorsi e Dimostrazioni Matematiche Intorno a Due Nuove Scienze Attenenti alla Meccanica*. Elzevier, Leiden.//1914 *Dialogues Concerning Two New Sciences* (trans. Crew, H. & de Salvio, A.). Macmillan, London/1954 Dover, New York.

Heidegger, M. 1927 *Sein und Zeit*. Neimeyer, Tuebingen//1962 *Being and Time* (trans. Macquarrie, J. & Robinson, E.). Blackwell, Oxford.

Heidegger, M. 1963 *Die Technik, und Die Kehre*. Neske, Pfullingen//1977 *The Question Concerning Technology and Other Essays* (trans. Lovett, W.). Harper, New York.

Horkheimer, M. & Adorno, T. W. 1944 *Dialektik der Aufklaerung*. Soc Studies, New York/1969 Fischer, Franfurt am Main//1972 *Dialectic of enlightenment* (trans. Cummins, S.). Harder, New York.

Husserl, E. 1900,1901/1913 *Logische Untersuchungen*, Niemeyer, Tuebingen and Halle//1970 *Logical Investigations* (trans. Findlay, J. N.). Routledge, London.

John Paul II 1998 *Fides et Ratio*. Libraria Editrice Vaticana//Veritas, Dublin.

Jonoski, A. & Abbott, M. B. 1998 Network distributed decision-support systems as multi-agent constructs. In *Hydroinformatics '98* (ed. Babovic, V. M. & Larsen, L. C.), pp. 1219–1226. Balkema, Rotterdam.

Jung, C. G. 1944/1952 *Psychologie und Alchemie*. Rasch, Zuerich//1953 *Psychology and Alchemy* (trans. Hall, R. F. C.). Routledge, London.

Kant, I. 1787 *Kritik der Reinen Vernunft*, second edition/1979, facsimile edition, Reclam, Leipzig//1929 *Immanual Kant's Critique of Pure Reason* (trans. Kemp Smith, N.). Blackwell, Oxford.

Law, J. (ed.) 1986 *Power, Action and Belief: A New Sociology of Knowledge*. Routledge, London.

Law, J. (ed.) 1991 *Sociology of Monsters; Essays on Power, Technology and Domination*. Routledge, London.

Lyotard, J.-F. 1979 *La Condition Postmodern; Rapport sur le Savoir*. Minuit, Paris//1992 *The Postmodern Condition; A Report on Knowledge* (trans. Bennington, G. & Massumi, B.). Manchester University Press, UK.

Norris, C. 1993 *The Truth about Postmodernism*. Blackwell, Oxford.

O'Brian, P. 1970–1997 *Master and Commander*, through 16 other titles to *The Yellow Admiral*. Harper Collins, London.

Teknologiraadet, 1995 *Magt og Modeller: Om den Stigende Anvendelse af edb Modeller I det Politiske Beslutninger* (Danish Technology Council, *Power and Models; On the Increasing Application of Computer Models in Political Decision Making*, in Danish). Teknologiraadet, Copenhagen.

Thein, K. N. N. & Abbott, M. B. 1998 Internet-based management of water resources for a new Burma. In *Hydroinformatics '98* (ed. Babovic, V. M. & Larsen, L. C.), pp. 957–963. Balkema, Rotterdam.

Thompson, G. 1998 Hydroinformatics: a cornerstone to information technology in business. In *Hydroinformatics '98* (ed. Babovic, V. M. & Larsen, L. C.), pp. 9–14. Balkema, Rotterdam.

Wolff, M. 1998 *Burn Rate, or How I Survived the Formative Years of the Internet*. Weidenfeld, London.

World Bank 1992–98 *http://www.worldbank.org/wdr/*