

The gender issue in hydroinformatics, or Orpheus in the Underworld

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ABSTRACT

Hydroinformatics is a sociotechnical endeavour, which is to say that it deals with social processes that cannot proceed without the provision of appropriate technologies and technologies that cannot succeed without the introduction of appropriate social arrangements. In particular, the introduction of decision-support systems for very large numbers of persons in so-called 'third-world' societies, such as farmers, aquaculturalists and medical help providers, must be prepared by studies of the social and the technical aspects inseparably. Such decision-support systems have typically to provide *advice* on water-related issues to a very wide variety of individuals, families and other social groups, so that the advice that is provided must be the most appropriate to the specific individual, family or other social group to which it is given. This kind of 'personalised' or 'customised' service is identified as being essential to what is introduced here as a 'knowledge-intensive agriculture'. The need to customise knowledge in such a context in turn necessitates that each such individual, family or other kind of social group must be accurately characterised by an 'end-user profile' in such a way that the advice that is given may be appropriate. The construction of these end-user profiles is itself a time-consuming task that calls for special skills and it is essential to the integrated sociotechnical design of widely distributed advice-serving systems that this task is identified and characterised correctly. Entirely symmetrically, once advice has been provided, this must be communicated to the end-user, and the way in which this can best be done in turn requires a careful investigation into the skills that it requires and the training which it may necessitate.

Now observations in related problem areas in 'third-world' societies, and specifically in the closely related areas of microbanking and mobile telephony, have shown that many tasks of this kind appear to be particularly well suited to women, rather than to men. The question then comes to be posed of whether and to what extent the provision of advice for knowledge-intensive agricultures should involve women and the ways in which they can best be involved.

It is through such developments as these that a more general problem comes to be posed of whether a whole range of sociotechnical systems in hydroinformatics may be operated on the whole more effectively by women and others again on the whole more effectively by men, and designed and analysed accordingly. In certain cases in practice this may come down to designing and analysing some parts of a total system mainly for use by women and other parts again mainly for use by men. Although these issues arise first and are for the most part discussed here only within one relatively narrow field of applications, to widely distributed (advice-serving) systems, it is suggested that they can be collected together to provide what we can describe in general terms as *the gender issue in hydroinformatics*. It is accordingly anticipated that differences in gender may have much wider implications and applications in hydroinformatics as a whole than are exemplified here.

It is at the same time accepted that 'gender issues' are not concerned with sharp divisions between male and female persons, but are much more diffuse and may be strongly subject to many

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non-genetic, and especially social, influences. Thus, we are speaking here more of a bias towards the employment of female persons and not of any sharp demarcation. In the same vein, although this bias may be strong in some societies, such as many of those in Asia, it may be less pronounced in other societies, such as in Europe or North America. Once again, we have to investigate why this may be the case and how we may be able to recognise its presence in any particular class of applications.

Key words | gender issue, object theory, volume theory

THE ROLE OF WOMEN IN A KNOWLEDGE-INTENSIVE AGRICULTURE

By a knowledge-intensive agriculture we understand combinations of agricultural techniques and technologies that can only be realised and justified by a flow of the most relevant and best available knowledge based on as much data as can be made available on past, present and future meteorological, soil moisture and other relevant conditions. We suppose in fact that in many, if not most, situations, a knowledge-intensive agriculture may become inherently unstable unless supported by this flow of knowledge. Evidently this form of agriculture necessitates the establishment of sociotechnical arrangements for the supply and distribution of the appropriate knowledge, but the effectiveness of this knowledge in turn depends upon its right application and thus upon the accurate definition of the individuals, families and social groups who translate this knowledge into agricultural and related activities. Such knowledge must be adapted or 'personalised' or 'customised' or 'tailored' to each of its specific end users. This condition, however, necessitates that accurate and reliable end-user 'profiles' are established, in principle for each and every end user of the knowledge-supply and distribution system. In such an advice-serving system there are accordingly two different knowledge flows. The one, which is the first in chronological order, is composed of knowledge about the end user that is collected by interview, observation, social interaction and other ways of gathering information about the end user. This knowledge is collected at the 'field' or 'village' level, or at the 'outer periphery' of the system, almost invariably in narrative forms, and is only formulated at all into more scientific representations at an inner periphery, where it is matched with the encapsulated knowledge of economists,

agronomists, aquaculturalists, soil physicists and all other such repositories of relevant knowledge, and combined together further with all available relevant data. On this basis, knowledge can be provided to the end-user, most commonly in the form of advice, and this second knowledge flow proceeds back to the outer periphery, to be distributed there to the end-users individually. Knowledge structures of this kind, incorporating also their 'knowledge centre', have been described extensively elsewhere (e.g. Abbott and Jonoski 1998; Jonoski and Abbott 1998; Thein and Abbott 1998).

Any system of this kind is a sociotechnical system, which is to say that its technical components cannot function at all effectively unless proper social, including institutional, arrangements are also introduced, while its social objectives cannot be realised without the provision of appropriate technical equipment. In the case of advice-serving systems suitable for supporting knowledge-intensive agriculture in so-called 'third-world' societies, a network of persons has to be introduced at the outer periphery who are able to assemble user profiles, transmit these to the inner periphery and take and transmit the advice that the inner periphery provides to the individual end users. We shall suppose here that the principal technical equipment available at the outer periphery for information transmission to and from the inner periphery is the mobile telephone. This mobile telephone is in turn supposed to have the capacity in bandwidth and other parameters promised by current ongoing developments in so-called 'third generation' telecommunication technologies generally and thus, in particular, to provide combined voice, text and graphics capabilities.

It is supposed further that a 'full-scale' advice-serving system of this kind will service something in the order of 1,000,000 end users. Estimates of the time requirements of its various functions then suggest that some 5,000 persons will need to be employed in knowledge gathering and advice distributing activities within the outer periphery in a steady-state mode of operation. The vital question is then posed of the nature of these persons: what qualifications should they possess, what specific talents or abilities should they demonstrate and what kind of training are they likely to require? These and many other questions then however tend to devolve upon one more basic question again, which is whether these persons should be for the most part women, or whether they should rather be for the most part men.

Now consideration of related activities in the provision of micro-banking services and mobile-telephone services in several 'third-world' societies appears to show that there is a definite bias towards the employment of women for this kind of work. By way of an example, women constitute the largest proportion of persons working within the *Grameen Bank* in Bangladesh, which is the world's largest microbanking institution, with some 2,400,000 lenders (92% of them women and a correspondingly large number of women shareholders). Similar proportions of women are engaged by *Grameen Telecom*, and hence *GrameenPhone*, with the longer term aim of providing mobile telephone services in 68,000 villages in Bangladesh, with a potential clientele of more than 100,000,000 persons. Organisations of this kind are not only closely related structurally to those that are at the focus of current developments in distributed decision support, but they are themselves potential partners and providers in such initiatives.

EXAMPLES OF ADVICE-SERVING SYSTEMS BASED UPON END-USER PROFILING

There are very many examples in other areas of activity of elementary applications of user-profiling for providing customised advice. Indeed, many products currently on the market may appear at first sight to provide the kind of

service which is intended here, although few, if any, in fact do this. Among these simple systems the following are typical.

<http://www.infospace.com>

This is an example of an Internet content provider which offers possibilities for 'personalised content' through its so-called *MyInfoSpace* service and Personal Desktop Portal. After creating an account the user can define his or her user profile for personalised content, which content can vary from stock quotes to news, and from specific readings to links. On subsequent visits to the site a customised web page is set up for that particular user. It is a general information service and more recently several other companies have come to offer similar possibilities. In fact the word 'My' has become a code word for this approach, and many of the largest Internet content providers use it for labelling their personalisation features (*My Yahoo*, *My Netscape*, *My Excite*, *My Lycos*, etc.).

<http://www.amazon.com>

One of the most prominent features of this well known Internet bookstore is its interactive recommendation service. Here the user profile is created by tracking the user's buying history and comparing this with results from online questionnaires. This information is summarised in a database of the user's likes and dislikes, which is then used to provide advice in the form of recommendations for future purchases.

<http://www.datek.com>

This is an example of a site dedicated to online trading on the stock market. It is one of the most prominent sites for managing a personal stock portfolio and for online trading. The whole service is then necessarily organised as a personalised one.

<http://www.personalwealth.com>

This site is similar to the previous one, but with possibilities for obtaining personal advice and recommendations

on asset allocation or specific stock recommendations by building a 'Personal wealth financial plan'. The last two sites are only examples of an increasing number and range of such services. Indeed, in the field of personal financial investment the provision of 'personalised advice' over Internet has grown exponentially in recent months.

<http://www.dietitians.ca/english/profile/nut-index.html>

The entrance page to this site is <http://www.dietitians.ca>. This link provides a simple example of building an end-user's 'nutrition profile' on the basis of which personal advice can be provided for appropriate choices of type and quantity of food. This last example typifies the diversity of services which are moving towards 'personalisation' or 'customisation'.

Returning to the examples so far encountered, we observe that they all appear to be profiled entirely upon the basis of information provided by the end-user personally, without the intervention of a knowledgeable, but independent, observer. In the present case it appears unlikely that the individual end user can build an own profile, but this profile must be constructed in co-operation with a knowledgeable person employed at the outer periphery. Entirely symmetrically, the advice that is provided by the system can better be presented at least partially through an intermediary, which again is a person, and in principle this can be the same person employed within the outer periphery. An issue concerning gender thus arises in systems of the kind that are of concern here which does not normally arise in the simpler systems so far employed so widely in other areas.

Once the relevance of this issue is accepted, even if only within the above narrower context, several questions immediately present themselves. At the most superficial level it seems natural to ask 'why' there should be such differences and, correspondingly, 'where' these differences manifest themselves. There is of course an immense literature that takes this approach in the mass market of 'gender literature', most of it of a popular and superficial nature. Since however hydroinformatics is a postmodern technology, or even 'metatechnology', we clearly cannot fol-

low this approach, but only ask 'how?' within our current societies. The question of 'why?' can then only follow from this by an extrapolation back into certain postmodern, and thereby premodern, precedents (Abbott 1999a,b).

ORPHEUS IN THE UNDERWORLD

Among the most significant postmodern and therewith premodern precedents for such studies are the myths of earlier ages, that is to say from times where myths were more carefully selective and refined than they are today. As Barth (1938–1955) pointed out in his monumental *Kirkchliche Dogmatik*, our own times produce myths in great profusion and variety and at an entirely unprecedented rate, but these are altogether more confused and ephemeral than their predecessors in, for example, the times of ancient Greece. Among the Greek myths, moreover, there is one that stands supreme among those that treat of man's attempt to recover the 'essence of woman' as his muse and how he tried to bring this essence back from Hades itself to what we should nowadays call 'the surface of consciousness'. It is made clear in the myth that this could only be achieved even at that time through the application of music and poetry, so that the perpetuation of the myth and the analysis of the processes whereby it is perpetuated in our own times can only proceed through the analysis of acts of communication at their most exalted and most authentic levels. Entirely consentaneously, the modern representations of this myth have necessarily taken the form of opera, and, of the many major essays in this combination of media, that of Offenbach, *Orphée aux Enfers* or *Orpheus in the Underworld*, being the most ironic and the least conformist, seems to be the most appropriate in this place. For surely nothing could be more redolent of Hades, irony and non-conformity in the minds of most current practitioners of hydraulics, hydrology and water resources than an attempt to bring even some fragmentary parts of the 'essence of woman' back to 'the surface of consciousness'! At the same time, the survival of the Orphic myth through such informationally expensive means as opera demonstrates that this myth has remained and continues to remain intensely relevant to the human condition even in the so-called 'modern' era.

The explicit lesson of the original myth must also however still be taken to heart, for Orpheus did not in fact succeed in his quest, and this because he could not resist a backward glance at that which he aimed to recover. Similarly, within our present context, to ask ‘why?’ is always, to some extent, to look backwards. Similarly again, with reference to Hades, ‘Why? is the question of the devil’ is a common figure of speech in several European languages. Thus in this place also we can only proceed by looking steadfastly forward, not allowing a single backward glance at our objective until we have truly brought it to ‘the surface of consciousness’, that is, until we are fully conscious of its essence. We must think steadfastly about the ‘how?’ and defer all our thinking about the ‘why?’ until we have completed our basic analysis.

(This kind of procedure, of deliberately setting limits upon and otherwise constraining one’s own thinking while investigating a subject, although familiar to those working in phenomenological studies, such as through the Husserlian *epoche*, and in some of the social sciences besides, may be quite unfamiliar to those working in the physical sciences. Some brief explanations may therefore be in order. Our starting point must then be that of all schools of phenomenology, which accept Brentano’s way of distinguishing between life forms on Earth and all other forms: that the former have *intentions*, while the latter do not. Thus, to take two frequently cited examples, ‘every cell has the intention of becoming two cells’ and ‘every larva of a particular kind has the intention of becoming a butterfly’. The resulting *intentional objects* engage in *intentional acts* correspondingly. Within our still current biological cosmology these processes are rationalised in terms of a minimisation of entropy production by the accumulation of negentropy in biological structures – membranes, endocrine systems, etc. – and indeed this rationalisation has long since been taken to the level of ecosystems by authors such as Margelef (1968). Since however in modern information theory negentropy has an exact correspondence to a measure of information, and it is information which can change the behaviour of an object, thus becoming ‘knowledge’, it follows that the acquisition of knowledge may of itself change the behaviour of an organism, whether this be a cell or a human society. It is this feature that sets apart the study of the

physical sciences even from the biological sciences, and much more again from the study of several of the social sciences and, albeit in quite another way again, from theological science. In the case of the physical sciences, in particular, our further knowledge and understanding of an object cannot possibly change the behaviour of that object—the melting point of sulfur, for example, is entirely independent of the extent of our knowledge of this melting point—whereas in the case of our own societies and our own selves this is certainly not the case.)

IMPLECTIVE ASPECTS OF ACTS OF EXPLANATION AND ACTS OF UNDERSTANDING

The starting point here is the elaboration of the profiles of the end users, with a special emphasis on the ‘how?’ of this process. These profiles have to be constructed from all knowledge about the nature and situation of the end user as may influence that user’s or users’ needs for advice and ability to make use of such advice. This knowledge has to be assembled and collated, by hypothesis already primarily and specifically by a woman or women, from a variety of sources, such as by direct observations, interpretations of speech acts and from acts of exemplification. What all of these ‘inputs’ have in common is that they convey *meanings* that are relevant to the situation and intentions, and thus to the needs, of the end user of the knowledge that is to be subsequently provided in the form of advice. Thus these inputs all *express* something to this same effect: they are thus *expressions* of the situation of the user or the users and therewith expressions of the corresponding needs of the user or users for advice.

The immediate end point in this process is the return flow and assimilation of knowledge in the form of advice by the end user. Once again, and quite symmetrically, we have to do with the conveying of meaning to the end user, so that this advice expresses something to this end user. Thus the advice also is composed of expressions of intentional acts that are desirable on the part of the end user. In the now-classical theory of objects and values, as originally established by Meinong between 1880 and 1920 (but

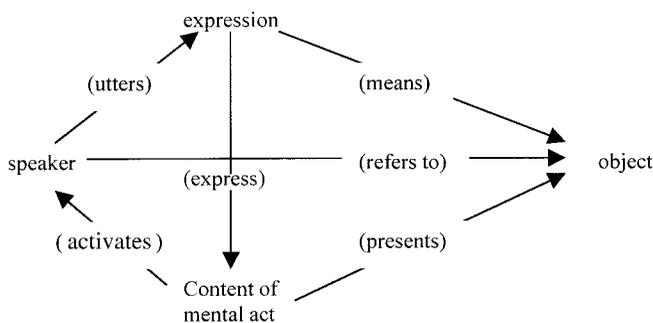


Figure 1 | The system of relationships involved in a speaker's uttering a single expression that acquires a meaning (adapted from Simons 1996).

taken much further since that time) expressions are properly so called because they do express something about the outer world of the expressing (and consequently expressive) agent. Each expresses something that is not itself a belief or a judgement – which are essentially private, subjective and mental – but a state of affairs which is essentially public, objective and tangible. At the same time, of course, the expression has a meaning which is mental and in that way private. In the words of Simons (1996, p. 173): 'In the matter of meaning, it is the relation of presentation that wears the trousers, because it gets us from the private and the mental to the public and objective.'

In the language of the theory of semiotics that is so vital to hydroinformatics, the expression is the sign function that maps (or has the potential to map) a mental content from the transmitting agent into a mental content – 'meaning' – within the mind of the receiving subject. In the event that the expression adopts the sign vehicle of a speech act, the structure of relationships within which the expression functions with a meaning is shown in Figure 1 (adapted from Simons 1996, p. 174).

The term 'object' is used here in the now-standard, Meinongian, sense as any thing at all, whether it exists or not or whether it can enter the mind of a person or not, which can become the subject of true predication. An object then becomes a phenomenon whenever it is regarded from a particular point of view. Figure 1 uses the sign vehicle of a directed graph, being composed exclusively of nodes and arrows, where both nodes and arrows are themselves again objects.

The node objects in the graph are seen to be described by (unbracketed) nouns and the arrow objects by (bracketed) verbs, so that the arrows represent actions on things. Thus, as one instance, the mental content activates the organs of the speaker that provide the sound of the utterance, or, as one step in Figure 1:

$$\text{Content of the mental act} \xrightarrow{\text{(activates)}} \text{speaker.} \quad (1)$$

In the event that we treat any such directed graphical representation as Figure 1 as a definition of a category as this is employed in a standard mathematical sense (Abbott and Dibike 1998a,b), so every process such as that shown in Figure 1 corresponds to a mapping, m (in this case achieved by mental activation) from a source, s (in this case, the content of the mental act) to a target, t (in this case a speaker) or:

$$s \xrightarrow{m} t \quad \text{or} \quad m: s \longrightarrow t. \quad (2)$$

Since the objects in Figure 1 are not in point of fact mathematical objects, Figure 1 cannot define a category in the standard mathematical sense. However, to the extent that all the objects in Figure 1 are imbued by the *intentions* of the speech act, so that they can be regarded as mental acts involving *intentional objects*, whereby they in turn constitute *intentional acts*, so any structure such as that shown in Figure 1 can be described using the physical symbol system (of notation and of operations) of category theory. We may thus still describe Figure 1 as a *phenomenological definition* of an elementary speech act. As is usual in technology, and indeed in much of science as well, we here use a few fragments of the language of mathematics without actually doing any 'real' mathematics at all in the sense of a 'real' mathematician. From the professional mathematical point of view, we are really dealing, at most, with 'pseudo categories', employed only as metaphors.

Now it is an everyday experience in any speech act that a meaning is rarely conveyed by one and only one expression. It is much more usual for the mental content to activate the speaker to provide several utterances that in turn provide several expressions. In relation to the final

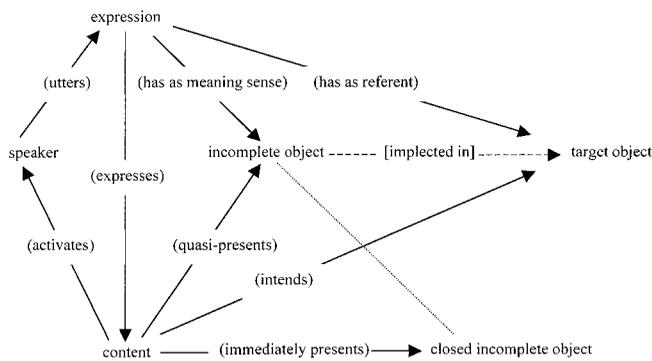


Figure 2 | Objects involved in the more complex category of implected meanings of expressions as implected objects (adapted from Simons 1996).

target object of transmitted meaning, each expression is then in one or more ways *incomplete*: it may be ‘partly true’ relative to the target meaning but it does not encompass the whole target meaning. The corresponding object is thus an *incomplete object*. To the extent that the objects which participate in a sequence of speech acts complement one another in such a way that the incomplete target object at any stage j in this process, O_j , may be supposed to incorporate in principle *all* the properties of the incomplete target objects at stages, $j-1$, $j-2$, etc., so $O_j = O_j(O_{j-1}, O_{j-2}, \dots, O_1)$. In more technical terms, the incomplete object at stage j will have all the *nuclear properties* of the incomplete objects at stages $j-1$, $j-2$, etc. Now, ‘when all the nuclear properties of one object are included among those of another, Meinong says the former is *implexively* contained or *implected* in the latter’ (Simons 1996, p. 177). Thus in the case of a sequence of speech acts, the earlier stages in the sequence of final target objects, as these appear at $j-1$, $j-2$, etc., are implected in the final target object at stage j . The category that corresponds to the correspondingly augmented speech act is shown in Figure 2 (adapted from Simons 1996, p. 179).

Returning now to the immediate practical problem of accumulating meaning from a sequence of speech acts, commonly augmented by other intentionally expressive acts, we see that this can be posed as a problem of sequentially implecting incomplete objects into what is commonly called a ‘closed-incomplete

object’. However, the term ‘closed’, when used in this connection, requires some explanation. For Findley (1963/1995, p. 157) a closed object is one that ‘not only *has* no further properties but is *incapable* of having any’ since the thinker of the object has no further possible interest in any other properties.

(Since this denotation may at first sound altogether too informal and perfunctory to engineers and others who have been brought up with such entities as ‘closed sets’, ‘linear closures’ and ‘closed linear closures’, a simple example may be in order. Consider the system composed of the operators ‘+’ and ‘×’, together with ‘=’, and the variables ‘0’ and ‘1’ with all the usual meanings of arithmetic with the single exception that ‘1 + 1 = 1’. This exceedingly simple system is clearly closed in the mathematical sense, but also in the above sense as well. At the same time, it happens to have a wide range of applications: see Abbott *et al.* (1993).)

Clearly, the implection process will usually be interspersed by other speech acts on the part of the interlocutor, such as acts of questioning, referring and other such means for facilitating and accelerating the overall process. This in turn extends the category shown in Figure 2, effectively superimposing another layer over it. This does not, however, change the first suggestion to result from this investigation, namely that we might pose the issue of gender in our advice-serving applications as one of identifying a greater or lesser propensity of women to perform certain implexive processes under certain social conditions and cultural contexts. In order to continue along this line of investigation we may then briefly consider the origins of the word ‘implexive’ with its corresponding meanings and associated concepts.

Within the present context the origin may be sought in Meinong’s technical term ‘*implektieren*’. For Meinong, incomplete objects (*unvollständige Gegenstände*) have implexive being (*das implexive Sein*) by virtue of being implected in (more) complete objects. In his influential work on *Meinong’s Theory of Objects and Values* Findlay (1963/1995) translated Meinong’s ‘*implektiert*’ as ‘embedded’. As Jacqueline explained (1996, p. 233): ‘The German word itself derives from the Latin *implecto*, meaning to plait, weave or twist into, entangle in, involve, entwine or enfold ... An earlier source is the

Greek word $\epsilon\mu\pi\lambda\epsilon\chi\omega\acute{\nu}$. Clearly, then, we have to enquire into the ‘how?’ of any observed female predilection for ‘plaiting, weaving, twisting into, entangling, involving, entwining and enfolding’ within a given social situation and cultural context. In order to do this at all adequately, however, we must move further out again, into a Meinongian theory of *values*. We must do this because the ‘how?’ of the objective processes must now be related to the ‘how?’ of their driving forces, and these forces are essentially provided by (gradients in) values and valuations.

IMPLECTED VALUES

It is well known historically that Meinong initially developed his theory of objects (*Gegenstandstheorie*) and his theory of values (*Werttheorie*) separately, only realising their natural contiguity towards the end of his life. Now this late realisation of Meinong can be represented in the language of category theory in the first place in the form of two *functors*, both of which map directed graphs connecting objects into completely isomorphic directed graphs connecting values. The one functor maps categories of objects into categories of *intrinsic values* while the other functor maps (the same) categories of objects into categories of *social values*. Thus the categories of intrinsic values and social values are themselves isomorphic too. By the intrinsic values of an object we mean, in the usual way, the emotional value to the individual of that object, while by the social value we mean the value, and indeed often the money value, that society places upon that object. It is a matter of common experience that many objects with the highest intrinsic value to an individual may have little social value, and indeed little or no money value at all, and vice versa. In many cases, in fact, and as exemplified by intensely personal possessions, intrinsic values may be inversely proportional to social values, while in other cases, such as are exemplified by certain works of art, they may be strongly positively correlated. Both intrinsic and social values can of course vary considerably in time.

Let us first consider the functor that maps the category of implected speech acts of Figure 2 into the correspond-

ing category of intrinsic values. This is schematised in Figure 3.

We observe at once that there may be many modes of implexion that may apply to both the objects and the two broad classes of values to which they are most immediately connected. In Meinongian theory these values are also themselves objects, albeit normally of a higher ‘order’ than the objects to which they apply a valuation. We may have a simple linear recursive process which we may call a *serial implexion*, in which:

$$O_j = O_j (O_{j-1} (O_{j-2} (\dots (O_1)))) \quad (3)$$

or we may have any number of more complex (but less constraining) structures, such as may be exemplified by:

$$O_j = O_j (O_{j-1} (O_{j-2} (\dots (O_k))), O_{k-1} (O_{k-2} (\dots (O_1)))) \quad (4)$$

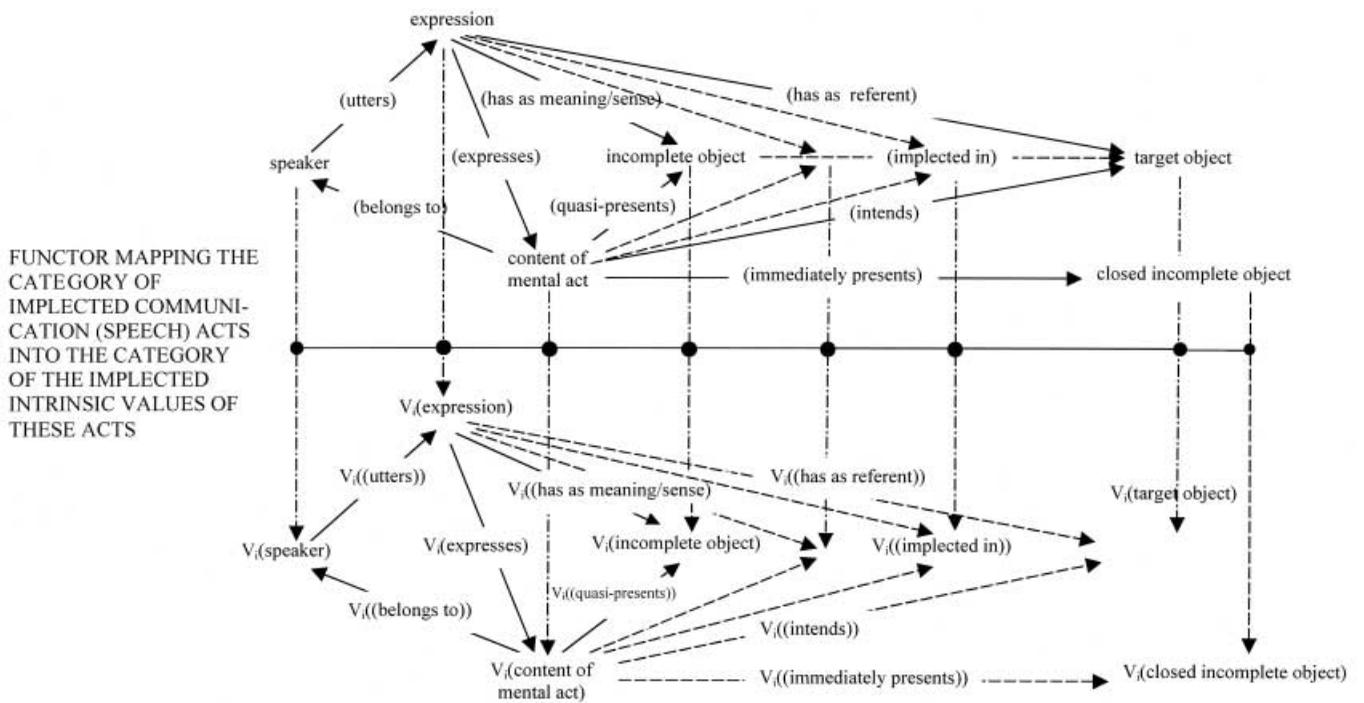
where the O_l , $l=1, \dots, k, \dots, j$, may be objects in the original sense of Figures 1 and 2 or objects in the sense of values.

Now the objects that are values must be connected to the objects in the original sense of Figures 1 and 2 by mappings, as exemplified for intrinsic values in Figure 3, and to these mappings Meinong gave the name of *value-feelings*. But now the mappings are themselves functions of the completeness of the objects in the original sense, both in terms of the existence of the objects themselves or in terms of the existence of certain of their properties. In particular, as one object is implected into another, we should expect that the strength of the value-feeling mapping should, on average, increase. Of course, as Findlay (1963/1995, pp. 268–269) explained:

‘The existence relevant to valuation is an existence for thought and belief, which may or may not be a real existence at all: it is, in terms of Meinongian psychology, an existence mediated by a *judgement*. Value-feelings are therefore as much judgement feelings as they are existence feelings.

And with its connection with judgements, and with the existence presented by judgement, valuation achieves something of the objectivity of the latter’.

We may suppose at once that, on some average, the quantities $(V_i(O_j) - V_i(O_k))$, $k=j-1, j-2, \dots, 1$ where



FUNCTOR MAPPING THE CATEGORY OF IMPECTED COMMUNICATION (SPEECH) ACTS INTO THE CATEGORY OF THE IMPECTED INTRINSIC VALUES OF THESE ACTS

Figure 3 | The functor mapping the category of original implective speech acts into the category of implected intrinsic values. The influence of the incompleteness of the original objects on the value-feelings can be represented by the dual of this functor, with further arrows to represent the structure of the influence, as exemplified in equations (1) and (2). (Only the functor mappings for the original intentional objects are shown and not those for the connecting intentional acts.)

$V_i(O_1)$ is the intrinsic value of O_1 , are positive. We might even suppose that the gradient set up in intrinsic values through the implective process provides the force that drives the implected elicitation processes that provide the user profile in its appropriate fullness and corresponding completeness (see Abbott and Warren 1974; Abbott *et al.* 1977).

VEDIC INTERLUDE

The knowledge elicitation processes that concern us here have to be repeated at intervals and most commonly when marked changes occur in the profile of the end user. These changes may then be of a fortunate nature, such as through the accedence of new family members to production or the acquisition of new equipment, or it may be of an unfortunate nature, such as the death or illness of

family members or their animals, or through the loss or damage of equipment, such as by flooding. The interrogator must then be, among other things, one who can adapt to the new circumstances in the most apposite manner. Thus the gradient in intrinsic values may well change when making up a new user profile, as compared with the gradient experienced when constructing the previous user profile. The relation between the expression and the content of the incomplete target object, essentially its ‘meaning content’, may change accordingly.

Now the theory of mappings from expressions (such as sentences) into meanings has been studied on the Indian subcontinent from time immemorial. The central element in most of these studies, and one that dates back way beyond the precipitation of the Greek myths, back to the period of the Vedic legends, is called the *Sphota*. The *Sphota* is the principle of the mind which is mobilised and functions when an expression is experienced and becomes meaning.

Now the Vedic seers did not all agree upon the nature of the *sphoṭa* and indeed they commonly divided into three camps concerning its origins and nature. Although fairly presenting the alternative views, Sastri (1980) unequivocally came down upon the side of one of these camps, the side of the grammarians, saying of them that:

‘They adumbrate a theory strikingly original to claim that both word and meaning are indivisible units. The indivisible unit of expression is called *sphoṭa* and the indivisible unit of meaning is called *sphoṭa* or *pratibhā*. The grammarians do not believe that a word is divisible into letters or a sentence is divisible into words. Likewise, they do not believe that the meaning of a sentence is the sum-total of the meaning of the words which are ordinarily described as its parts.’

Thus the succession of (interrogative) speech acts of the kind categorised in Figure 3, as this comes to define a succession of ‘less and less incomplete’ objects, cannot be regarded as the simple sum of its separate acts. The user profile constitutes an indivisible whole, as an object of higher order than its parts. But then, beyond this again, this user profile must be offered up to the judgement engine of the system as an indivisible union, which is again so much more than its parts (see, just as an example, not as it stands applicable here, Huang *et al.* 1999). The ghost of the *sphoṭa* must thus enter the digital machine just as much as it enters the mind of the human agent.

We have to do here with a sociotechnical system, and so one in which the human-social elements are bound up indivisibly with the technical elements. However, the theory of the *sphoṭa* as well adumbrates how the specifically female sides of the human-social elements come into relation with the ‘*sphoṭa*: expression→meaning’ mapping and thus how they enter into the present discussion. In order to trace how this happens, one may recall that the Sanskrit *brahman* refers to the expanded consciousness of the individual self, so that the process of attainment of *brahman* corresponds to the journey of this self through a sequence of ‘less and less incomplete’ objects, with each implected in the next. This process culminates in our case with the target of the closed incomplete object, while in the infinitely more exalted context of Veda it synchronises with the manifestation of *vāk* in the individual being, this being experienced as ‘a flash of spiritual illumination where expression and thought remain completely

identified beyond any [experience of] recognition’ (Sastri 1980, p. xi). However, in Vedic lore, *vāk* is female, as one who ‘does not reveal herself to all and sundry but chooses to bestow her favour on a few who are considered fit for the vision.’

This theory of the *sphoṭa* advances its female elements in other ways as well, of which the following appears to be of the most immediate relevance here (Sastri 1980, p. xi):

‘The sky [*vyoman*], to our knowledge, possesses maximum pervasion. It is why the *Upaniṣads* often describe *brahman* as the sky. In this context let us turn our attention to the oft-quoted line of the *Kena-Upaniṣad* where it is stated that Indra came across a female figure in that sky. She is described as *Umā*. . . . The two words *umā* and *vyoman* bear affinity of meaning and are close to each other. The word *umā*, . . . to protect, is used frequently as an adjective in [the *Rig Veda*]. . . . The word *vyoman*, the sky, is derived from *vi-oman*, meaning “unrestricted favour and protection”. A study of the aforesaid forms may enable us to posit that the two words *umā* and *vyoman* may be linked together, *umā* signifying one who grants favour and protects. And if the locus of the female so described is to be the sky or *brahman* we may be warranted in drawing an identification between [1] *umā*, [2] the power of the sky and [3] *brahman*. It may be noted here that the realisation of the power is possible only when she is pleased to extend the favour.’

Thus the power of pervasiveness of insight, which is then coupled inseparably with protection and thus with sympathy and compassion in this experience, can be released only when ‘she is pleased to extend the favour.’ This pleasure, which is of course universal in its nature, is in our present, much more prosaic, case to be provided by creating ‘positive gradients in intrinsic values’ for this, essentially female, agent.

We should observe that we are no longer dealing here with a relation between women and a process, but with a process that is itself feminine. In the language of modernity this implies that the human abilities that are mobilised in this kind of communication process are an integral and so inseparable part of the specifically feminine genetic material. It seems reasonable to suppose that this genotypical identification manifests itself more explicitly, on average, among phenotypical women than it does, on average, among phenotypical men.

It should then however be further observed with Findlay that (1973/1995, p. 273):

‘Meinong devised an interesting symbolism to express relations of formal sociality. Thus the formula:

$$Je[Ja[Je(x): -VFe]: -VFa]: +VFe$$

expresses the fact that the judgement of the Ego to the effect that the Alter’s (the other person’s) judgement to the effect that the Ego is judging and disliking something, leads the Alter to dislike the Ego’s state of dislike, is something agreeable to the Ego—in other words, I am helped in my grief over some blow by the commiseration of others, and this, though empirically illustrated, represents a formal theorem. Meinong shows that sympathy has a “logic”, more complex, but quite as rich in *a priori* consequences, as the logic representing more objective relations.’

We should then remark in passing that Meinong’s further development of this algebra subsequently developed into a deontic logic (which we may regard here as essentially a logic of obligation) that underlies, among other applications, most current systems used in studies in legal-science (*Rechtswissenschaft*: see Hilpinen (1971) and McNamara and Prakken (1998)).

OBJECTS AS CONSEQUENCES OF INTRINSIC VALUES

In Figure 3 we projected the directed graph of intentional objects and their associated intentional acts into the entirely congruent directed graph of intrinsic values and their relations. In these *schemata*, the intrinsic values and their inter-relations were determined by the objects and their inter-relations. At an earlier time in the process so represented, however, the objects must themselves have been constructed at least partly on the basis of the intrinsic values of the object-creating subject, so that we can infer the existence, prior to the situation shown in Figure 3, of another functor again mapping the category of intrinsic values into the category of objects, so that this functor can be denoted simply by reversing the directions of the functor arrows in Figure 3. In the case of the implection process, however, these two functors may operate alternately, and even synchronously, in time. As Findlay expressed this matter (1963/1965, p. 306): ‘Obviously the rich specificity of my encounter with objects is, in different ways, a richness in the objects *and* a richness in me.’ One

consequence of this is that the sequences of implected objects and their congruent sequences of implected values must usually be considered together in any such processes.

SOCIAL VALUES

The above indicators suggest that one way forward towards a better understanding of the gender issue in this area may proceed through the study of the structure of relations between objects in acts of communication and the corresponding structure of relations between intrinsic values. On the other hand, the very socio-economic viability of a service of the kind that we are considering here necessitates that attention be given as well to the social, including monetary, values that are also associated with the gender issue in the processes of knowledge elicitation and provision. Now already when we considered intrinsic values, which are in their essence personal, we were obliged to ground our discussion in certain ‘depth psychological’, and even specifically Jungian, interpretations of processes of implection and their associated implected values. As we now however precede into the social sphere, which is essentially collective, we are obliged to ground our investigation at a greater depth again, which is situated at the level of myth, legend and saga. At the same time, if we try to do this within the context of the modern era, which as Barth (1938–1955/1960) explained is more prone to mythologisation than any other period in history, so we must open up a veritable Pandora’s box of largely empty imaginings and baseless fantasies. If we are not to be led into complete confusion in this process we must adopt the postmodern position, which is then necessarily also a premodern position, of following the rule of Orpheus, of seeking our ground at the deepest level of experience, which is at the level of the most long-established and consequently most durable of myths, legends and sagas.

We see that we have to do here with the tetradic allegorical structure schematised within the ‘frame’ or ‘brackets’ of the gender issue in Figure 4.

Since we have to do with allegorical mappings between intentional objects, these mappings may be

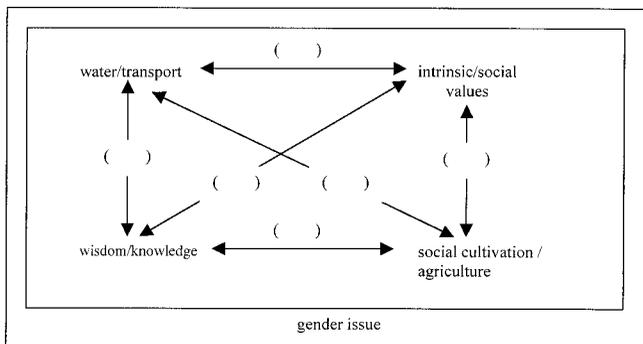


Figure 4 | The tetradic allegorical structure related to social values within the context or 'frame' of the gender issue.

bi-directional, or 'reversible'. There are then six such apparently 'reversible' intentional acts that have to be characterised within the frame of the gender issue. In effect, however, there are really two categories present here, which are dual relative to one another and obtained from one another notationally by reversing the directions of the respective arrows. By analogy with categories composed of mathematical objects, we observe that a category that is a dual of another, original, category commonly resides in an entirely other place in the conceptual and semantic field than does this first, original, category.

Starting with the 'knowledge \leftrightarrow water' allegorical mapping processes, we may recall that for the Greeks, as for the early Christians, alchemists and adherents of many other movements, the fount of wisdom, as the arbiter and prime mover of knowledge, was the female figure of Sophia. The conduit of her wisdom, as that which carried knowledge, was provided by the god Mercury. The allegory was realised through depicting Sophia as a fount or other such source of water, commonly as a mountain spring, and Mercury as the channel, or provider of the channel, along which this water flowed. This is only one, even if probably the most prominent one, of many mappings between wisdom/knowledge and water/transport, and of course it can proceed in both directions independently.

(We should observe in passing that for the alchemists, in particular, Mercury was not only the allegorical channel along which water/knowledge was conveyed, but evolved as a god in a drop of this self-same water/knowledge. Thus

the process of the evolution of Mercury as a mythical element, as a process occurring in some kind of time, was itself also a mythical element, and, yet again, the very time of this process was of a mythical nature too (see, for example, Ogawa 1978). The time of the myth is thus not chronological time, and indeed in theology (as in Barth 1938–1955/1960) it is common in this way to separate legend and sagas, which are partially ordered in chronological time, from histories, which are totally ordered in chronological time, and myths, which are not ordered at all in chronological time (see also Rowell 1978; Turner 1978).

It was through the actions of the androgynous figure of Mercury that the metaphors mapping both water/transport and wisdom/knowledge into soil cultivation/agriculture were also realised. Mercury then took on certain aspect of a more masculine Śiva, from whose unplaited hair the waters of the world were produced in his world-creation dance, and who was thus simultaneously the great destroyer and the great creator through the actions induced by the flow of this water. In the work of soil cultivation/agriculture, the nature of both water/transport and wisdom/knowledge was, in self-similarity, both to destroy and to create. It has always been understood since Hellenistic times, however, that Mercury remained only the instrument of Sophia in this dual approach to soil cultivation/agriculture from both its water and its knowledge sides. The metaphorical relation between the twin notions of the provision of water and all that it contains and the provision of wisdom and all that it sustains in relation to soil cultivation/agriculture has thus long been understood as appertaining to an underlying female principle.

Let us now recall further, from Jung, that in the later-Dionysian ceremonies the figure of Orpheus was raised to a demi-god who brought harmony into a pristine nature. Thus, in the words of Fiere-David (taken from Jung 1964/1966/1993, p. 121):

'Orpheus taught, while he sung and played upon his harp, and his singing was so powerful that it governed the whole world; while he sung along with his harp, the birds flew to him and the fishes left the water and flopped towards him. The wind and the sea were still and the rivers flowed upstream towards him. It rained and hailed no more. Trees and even stones followed Orpheus. The tiger and the lion lay down by the

sheep and the wolves by the hart and the hind. What does this mean? It certainly means that, through a godly insight into nature, . . . the events of nature could be ordered from the inside outwards in an harmonious way . . .'

And yet it was just this same Orpheus who descended to Hades in search of his *anima*, 'his' Eurydice!

We are now in a position to move onto the characterisations of the mappings that provide the last apex of Figure 4, which connect all of soil cultivation/agriculture, wisdom/knowledge and water/transport to intrinsic/social values. Since our principal concern at this point is with social values, we must seek our metaphorical tokens at least to some extent at a lesser depth within the collective unconscious, and thus from a later period than those so far employed at this metaphorical level. We are here beginning to move away from the level of the myth and are now of necessity ascending, to move into the level of the legend, and at some point further again into the level of the saga. Seeking the most durable of such metaphorical structures we must again seek instances where musical forms of expressions have been used to carry over the respective tokens into our 'modern' era. Our natural and indeed almost inevitable choice is then *Der Ring des Nibelungen*, the *Ring of the Nibelungs*, both in its original form, as *Das Nibelungenlied*, and in the form of the opera cyclus of the same name written and composed by Richard Wagner (Heusler 1987). In Donington's (1963) Jungian in-depth analysis of Wagner's work, the entire opera begins (pp. 35, 36) with:

'The primordial chaos at the world's beginning [being] regularly depicted as a waste of waters from which the first self-generated gods appeared. . . . Before very long we are going to be shown another regular feature of creation myths: the coming of light into the darkness of the waters.'

However, instead of continuing like any regular creation myth into the formation of life, which also serves in this case as a metaphor for the formation of consciousness, and so of 'intention', the *Ring* takes quite another turn, depicting gold glittering under the waters of the Rhine. This, however, also has many mythical precedents (p. 53):

'We learn from the Prose Edda that gold "gave forth light and illuminated the hall like fire" for the sea-giant Aegir beneath the waters, and incidentally that Aegir had a daughter . . . called Ran, who seems to have been a mermaid; in consequence of which "gold is new called" among other poetic

synonyms "Fire of Waters or Rivers". There is a comparable reference to gold giving off light like fire under the water in [the Anglo-Saxon language foundation myth of] Beowulf's fight with the Mother Monster; indeed this poetic synonym by which "gold" is paraphrased as "fire of waters" or "of rivers" or "of the sea" is widespread throughout the Icelandic Sagas, and is certainly no accident . . .'

In the *Ring of the Nibelungs*, the opening of the first act shows us the gold shining like fire from below the water of the Rhine, as the pleasure and the sport of the Rhine Maidens, for whom it has exclusively an intrinsic value, but then an immensely important one. This gold is stolen however by 'man', who turns it into a social value, and thereby ultimately destroys not only himself but also his gods, as the repositories of his highest values. Only with this destruction at the end of the *Ring* cyclus does the gold revert to the Rhine Maidens again, to retake its original role of imparting intrinsic value. Thus value, as symbolised by gold, is in its origins intrinsic value, and only in a secondary and essentially other social context does it become social value.

(Let us observe at this point that, since we are here rising up to the level of germanic legend and Skaldic Saga, we can already descry certain partial orderings in the sign vehicles – the linguistics tokens – themselves. These orderings also caught the special attention of Manin in his celebrated *Course in Mathematical Logic* (1977, p. 56), as follows:

'It has become very popular in modern linguistics to attempt to find a suitable description of natural language by means of [introducing] generating rules. . . . There has been at least one poetic system in which generating rules occupied an important place. One of the basic elements of skaldic (ancient Icelandic) poetry consisted of special formulas called *kennings*. A kenning is an expression which can replace a single word. For example, . . .

"fire of war" is a kenning for "gold"
 "sky of sand" } are kennings for "sea"
 "field of seals" }

A *simple kenning* is a kenning no part of which is a kenning. The examples above are all simple kennings. They play the role of axioms; obviously only very great poets have the right to create new simple kennings'

Manin observed further in this respect that:

'Even the most casual attempt at writing poetry reveals the psychological reality of prohibitions in versification. But it is

much less obvious that there is a set of generating rules which also has a psychological reality'

It is through such generating rules, as one among many other ordering devices of linguistics, that the legend and the saga come to express their psychological realities and thus cast their own light upon such issues as those of gender that confront us here.)

While apologising for so many quotations at this stage, we can best continue at once to the next mapping, from wisdom/knowledge to intrinsic/social value. We then meet the same kind of metaphorically equivalent mappings as we saw earlier, but now with water/transport equivalent to wisdom/knowledge in relation to intrinsic and social value. Thus, reverting to Donington (1963 p. 53):

'The general reference to such images is to a stirring in the deep unconscious as some light of consciousness is lit; their particular piquancy arises from the familiar incompatibility of fire and water in ordinary outside circumstances, where fire burns but water quenches and candles do not stay alight in the depths of the sea. We have in this paradox a typical symbol of the reconciliation of opposites, by which is meant not suppressing one side of an unwanted conflict into unconsciousness, but somehow learning to live with both sides.'

Within the context of the gender issue this 'reconciliation of opposites' arising from the employment of wisdom/knowledge can be construed as a reconciliation between the intrinsic values associated with objects arranged within a given structure and the social values associated with these same objects arranged in the same structure. We shall return to this in conclusion.

For the third and last of the mappings in this last quadrant of Figure 4, from soil conservation/agriculture to intrinsic/social values, and in the opposite direction again, we can return once more to the Orphic myth, with its reliance on and search for the essential female principle. In this case we have to do more with Bacchus as the god of cultivation (commonly symbolised by the cultivation of the vine). For Bacchus, the sought-after female element was personalised by Ariadne, who had been abandoned by her faithless betrothed on the island of Naxos, but remained always faithful to her vows and maintained her natural purity. These virtues indicate once again the functional components of 'the female principle' that provide

the mapping from soil cultivation/agriculture to social values and it was essentially for her possession of these virtues that Bacchus raised her up to the status of a goddess. Similarly, the perpetuation of the myth in operatic form in the Strauss–Hoffmansthal *Ariadne auf Naxos* clearly indicates its continuing relevance in our own times, while Hoffmansthal himself explained the relations of the virtues so prescribed to the female side of the process of procreation itself. We may in this place also therefore characterise those aspects of 'the female principle' that are necessary to realise the corresponding mapping.

With these functional elements of mappings introduced, even if only so summarily, the reader can fill in the bracketed intentional acts in Figure 4. The full structure of the implected expressions, meanings and understandings between the end user of the advice-serving system and their intermediaries within the outer periphery, together with the corresponding congruent structures of implected intrinsic values and implected social values, can then be portrayed as shown in Figure 5.

CONCLUSIONS

With all of these constructions now in place we can hope to have reached a position where we can safely turn back to confront the question of 'why?' that we posed at the beginning. In the first place our question is simply: why should there be a bias towards women in a sociotechnical system of this kind? After this we can examine the consequences of the answer that we obtain to the design and analysis of systems of this kind.

1. The procedure that has been followed here for investigating the special relevance of women within sociotechnical systems in hydroinformatics, and specifically within widely distributed advice-serving systems, has been that of identifying the special propensities of women towards the objects that enter most naturally into these systems. Since these propensities are grounded for the most part below the level of consciousness, at the (Husserlian) level

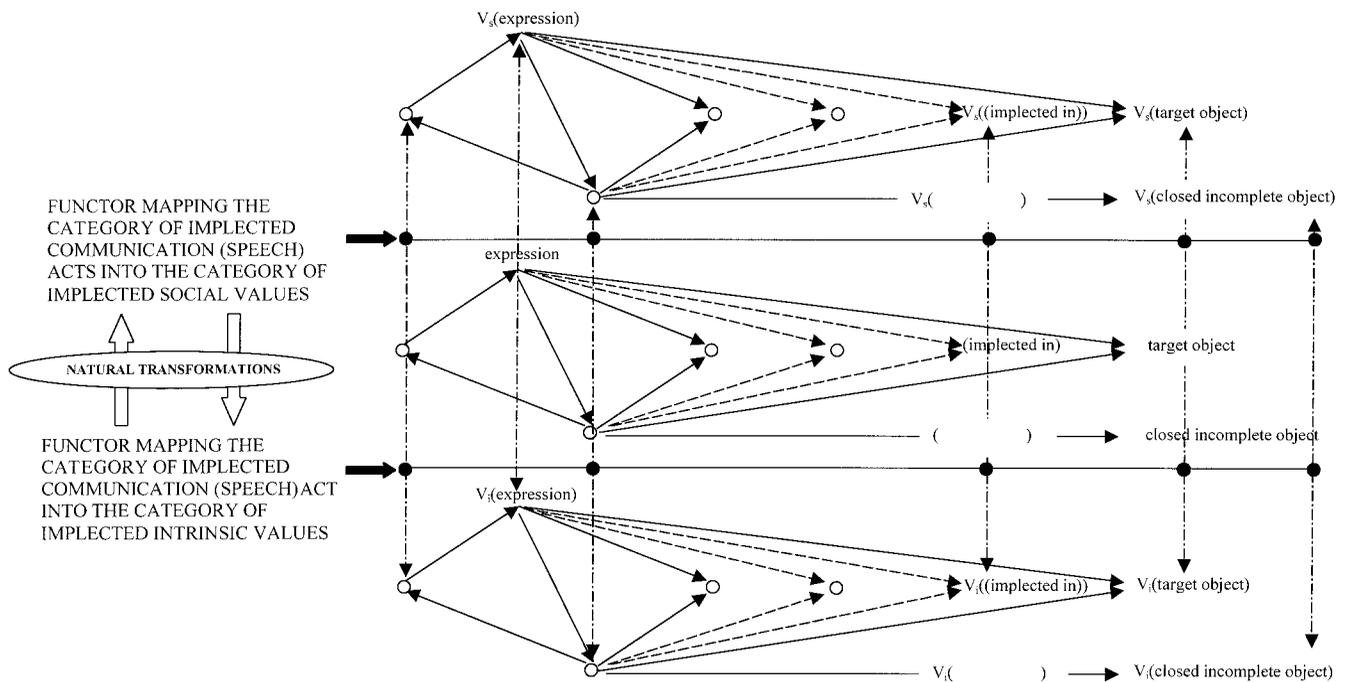


Figure 5 | The category of objects, intrinsic values and social values for knowledge elicitation and provision, their functors and the 'natural transformations' that map these functors, the one into the other.

of the pre-predictive and the pre-linguistic, their phenomenology is not generally accessible to a direct modern-scientific (predicative and conventional-linguistic) analysis. Instead it has been necessary to analyse certain arcane repositories of knowledge in this area, such as are encountered in their most concentrated form in the most durable of the ancient myths, legends and sagas. Everything in this case functions in terms of the most potent symbols and their symbolisation processes. As Donington expressed this matter (1963 p. 21):

'A symbol invariably arises from the heart upward. This is because a symbol is not an intellectual counter at all. Thoughts are intellectual counters; symbols are emotional counters, compounded at once of feeling and intuition. Not only do symbols represent inner realities; they are inner realities.'

This is to say that the primary role of women in the hydroinformatics systems considered here is not in the first place an intellectual one (even though their intellect is important too!) but it is primarily one of

feeling and intuition. The basic reason for preferring women over men on average within certain key parts of the hydroinformatics systems exemplified here is the natural consonance which they demonstrate, quite intrinsically, with the main tasks which they have to perform. Expressing this in more popular terms, what is most necessary here is a well-grounded and properly directed sympathy and understanding, and this must have precedence over intellectual ability even though it cannot replace it. It would not be difficult to find intellectually brilliant persons—we all know at least one!—who would be complete disasters in this kind of work.

2. The question of what in fact constitutes 'a well-grounded and properly directed' sympathy and understanding within a given social context may be answered by seeking *indicators* of such inclinations and propensities within that context. As exemplified in the text, a natural propensity of women towards an implexive construction of end-user profiles might

be expected in a society where women are inclined 'to plait, weave or twist in to, entangle in, involve, entwine or enfold'. More generally, each of the mappings examined here indicates the specific female traits that lend certain functions more to the attention of the female element.

3. This predominance of the 'emotional' and 'intuitive' aspects in this kind of work corresponds to the location of the forces that drive the work process to the level of intrinsic values in the first place, and to the level of social values only in the second place. However, one of the essential attributes of women within these activities is an ability to balance between the often apparently conflicting requirements of intrinsic and social values, as exemplified in the kennings for the repository of values, or gold itself, as '“the fire of waters” or “of rivers”, or “of the sea” ', and the related female element subsequently identified. Beyond this again, as explained at several places in the text, women in many societies have an innate wisdom that makes it possible for them to reconcile apparently conflicting interests, often in unusual but productive ways. Although much is commonly made of conflicts between intrinsic and social values, the main point that is made here is that there is nothing essential about these conflicts. The *Ring* itself exemplifies how 'the love of gold' in man and gods drives out love and consequently destroys man and gods alike, but it opens and closes with a natural love that is identified with the intrinsic value of gold and which remains implicitly present, because musically recalled, throughout Wagner's work. In the words of Donington (1963 p. 52):

'Inwardly, "gold" may certainly operate as a "poison of love" . . . but on a symbolic level, gold has other association of a very positive, not to say archetypal importance, as innumerable myths reveal; and these deeper associations are subliminally but effectively at work on us in [the *Ring*]'.

4. This ability to balance the intrinsic values and the social values of structures of objects can be given a representation in the model of category theory which we have used to notate this paper. On the one hand we have a functor that maps a category of the

objects that are of central concern into a category of intrinsic values, and on the other hand we have a functor that maps this same category of objects into a category of social values. The intrinsic congruence of these functors when a well-grounded and properly directed sympathy and understanding is associated with them leads to the notion that any one of these functor could map into the other through a *natural transformation*. Indeed, although the use of this term in mathematics has now become so specialised as to be apparently very far removed from the present application, the origins of the term and the use of the word 'natural' itself, as something irreducible to further analysis, does not seem to be so far removed from our present situation. It is this natural-transformation feature that is especially exemplified in Figure 5.

5. The archetypal traits and propensities identified and reified in this paper indicate the necessity to involve women directly, closely and extensively in many, and probably most, knowledge-intensive agricultures and indeed in many other sociotechnical systems now being prepared in the field of hydroinformatics. The gradients in intrinsic value provide the one motivating force while the gradients in social values form another, and these two forces have the capacity to reinforce one another, and thus to provide a synergy between the two object-value systems. The consequence of this for the generation of a more commodious life and for the alleviation of poverty in rural areas are potentially momentous. In the words of Muhammad Yunus, the founder of the *Grameen Bank* and now the godfather of the *Grameen* family of companies (Yunus 1997):

'It is the responsibility of any civilised society to ensure human dignity to each and every member of the society, and to make sure that each and every member gets the best opportunity to reveal his or her creativity.

Poverty is not created by the poor. It is created by the institutions we have built and the policies that we pursue. We cannot solve the problem of poverty with the same concepts and tools which created it in the first place.

To create a poverty-free world we need a new conceptualisation, a new analytical framework, which takes ensuring human dignity to every human being as its central task.

We can achieve what we want to achieve. The essential condition, however, is that we must have a burning desire to achieve it. If we believe in a poverty-free world, we can create it.

To begin with, instead of basking in the glory of our wisdom, let us severely question it. It is about time that we did that.'

ACKNOWLEDGEMENTS

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