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The Noetic Prism as a theoretical framework for contextualisation

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In this position paper we outline the concept of the noetic prism (Pigott and Hobbs, 2001), and show how it suggests a useful framework for modelling context in managing knowledge. This paper draws substantially on a more detailed treatment of the paradigm of Pigott, Hobbs and Gammack (in prep). The power of noetic prism as framework lies in its generic and principled nature, and gives constructs with which to theorise about the issues familiar in the field, without being grounded only in particular case studies of practice. Reconceptualising the terms data, information and knowledge, it presents a radical departure from the conventional view of the field by removing ontological status from artefacts to active process outcomes. The data, information and knowledge of an organisation are all late-binding, purpose-determined aspects of a single body of material, which we term its *noetica*. Particular bindings are brought out through its being analysed and modelled using various tools and formalisms. This view suggests the homogeneity of the resource, whose status becomes determined by active usage, rather than storage descriptions. This is supported in Clancey's (1997), major review of knowledge representation, which argues that knowledge is irreducibly based in human semantic spaces that can not be considered simply a property derivable from disembodied associations.

In contrast, the standard textbooks (e.g. Hutchinson and Sawyer, 2000) often use the term "raw" in connection with data, implicitly connoting subsequent processing. The usual guiding metaphor is a pyramid, with data being transformed to information and then to knowledge through business processes which add meaning to the lower level formulations. The "pyramid" conceptualisation of these does not handle the issue of context well however, and relies on higher levels to confer meaning arbitrarily on lower ones. Ultimately the human resource is designated the capacity for knowledgable usage of intellectual property, and attempts are often made to capture and store this formally; to make the tacit explicit; to reduce corporate dependence on individuals' knowledge. This is the understanding of many senior executives. As one put it recently for example, "When you have a staff turnover of 20% per annum, that is a lot of knowledge walking out the door."[1] The consequences may be ameliorated by having cross-functional work teams sharing knowledge, but in itself is insufficient at higher levels, where ability to leverage resources is critical. The number of senior people leaving an organisation is a well-known investment indicator affecting its stock market value; and one that is quantifiable. Analogously, it is the human ability to formulate good queries that adds value to data warehouses. Valuable information is implicit in data, and random discovery searching may suggest interesting patterns, but the ability to formulate sharp, *relevant* queries, and to recognise that a pattern is *actually* interesting, is noetica that goes beyond the datastore. Relevance and actuality are contextual issues, relating to knowledge "creation", a vital key to organisational innovation. Losing this ability is a serious management issue.

The interaction among data, information and knowledge is also oversimplified by the pyramid formulation, where their conceptual interdependence is not recognised by a levels structure, in which domain discontinuity, and therefore meaning relatedness is separable and

[1] Steve Hannah, Asia-Pacific Director of Honeywell, Talk given at Murdoch University, November 12th 2001

incommensurate. Whilst the metaphor is a helpful fiction in didactic and other expository situations, it implies a paradigm in which the degrees of freedom at higher levels are not directly constrained by reference to lower ones. This is an essential point about context: that extraneous factors make use of particular noetica, and these lie outside the pyramid model in unrepresented ways. The truism that one person's information is another's data (or noise) implies there is no necessary ontological status to the material but instead it lies in the *person*.

It is a debatable, but usually unquestioned assumption within the field whether real knowledge can emerge from "vacuous" data in a purely empirical way. The inverted pyramid of Tuomi (1999) represents a recognition that data can and does result from categorical decisions made by informed processes. In this view knowledge logically precedes data, which is nothing without reference to the higher levels. Tuomi's view however, retains the limitations of the pyramid metaphor and undermines its value: there is a systemic cyclicity in such definitions such that data, information and knowledge are prerequisites for each other. Extending the implications of this recognition further, we would abandon the pyramid metaphor altogether. In our view an enhancement of the same noetica can occur in any direction, in recognition of the multivalent and multilevelled ontological status of the material traditionally classed as data, information and knowledge.

Another assumption is that information is factual, whilst knowledge is subjective (Hauschild et al, 2001) which they see as a problem. These familiar conceptions, consistent with the literature and explanatory by reference to practice and cases, betray the fundamentally materialistic and theoretically impoverished basis of much contemporary IS research. Despite continuing interest in data mining and knowledge discovery, the relevance of context in processing data remains critical. "To have an answer without knowing the question, without understanding that you might have been given a different answer if the question had been posed differently, may be more than meaningless; it may be exceedingly dangerous"[2]

By reconceptualising the conventional wisdom on data, information and knowledge, we describe a model that characterises these aspects of noetica in terms of three dimensions of complexity, *viz.* granularity, shape and scope. This move allows a more principled basis for handling context (*inter alia*), without implying a necessary inconsistency with the integrity of implementations based on other metaphors, where the noetica is considered conventionally. Instead the reconceptualisation aims to clarify the confused distinction made (particularly) between information and knowledge in the literature, and to identify category errors in implementation strategies which confound their proper domains. In this our view resembles the shift from Newtonian to Einsteinian physics: localised laws and formal descriptions resulting from a particular analysis or process operate correctly, within understood bounds, but themselves are contextualised and relativised within a larger grounding.

Before leaving the pyramid metaphor it is worth considering an extension sometimes seen in the knowledge management literature, in which wisdom lies at a higher/deeper level knowledge, and due originally to Ackoff, (1989). Whilst this has often been taken as the next logical progression for empirical data, Ackoff, himself a systems theorist, has pointed out the lack of systems thinking in the knowledge management literature (Barabba et al, 2002). Bellinger, Castro and Mills, (n.d.) describe the continuum in progressive but also in systemic terms with *understanding* as mediating support for transition between levels. Understanding

[2] Quote from Postman, N. (1988). Conscientious Objections. New York, NY: Vintage Books. page 26

is not a separate level, but is held to be an interpolative and probabilistic process operating on noetica, allowing new syntheses. Other extrapolative and non-probabilistic processes also apply which (following Ackoff) are held to be largely evaluative, not fully mechanisable processes, and are considered as wisdom by Bellinger. Bellinger (2001) draws upon Czikszentmihaly's (1994) interpretation of complexity, where complexity reflects the degree to which something is simultaneously integrated and differentiated. Combining this with his recognition of the relatedness between context-independence and differentiation he conceptualises wisdom as "simplified complexity". Although definitionally at odds with systems that include judgement at the knowledge level, this formulation introduces an emphasis on complexification through incremental and systemic processes of contextualising.

Regardless of the definitional and terminology variations, there is consensus in the literature that a process exists by which *something* is being transformed into something more useful, either through calculation or through a personal action. A further point of agreement is that this processing is systematic, with outputs becoming inputs to another process: this leads to the definitions of data-information-knowledge being fluid, shifting according to the perspective from which they are viewed. The fundamental problem with this is its circularity. Data, information and knowledge are each defined only in the context of their relationship with the other two, and it is impossible to separate the terms from one other.

In observing a business process it is not actually possible to define at any point whether we are looking at data, information or knowledge. Or indeed, if it is possible to view the same item of ‘information’ simultaneously as expressing a value-added fact, as raw material input to a process, or a basis for reasoned action. Unless we have a frame of reference outside of the three definitions we cannot tell them apart. It is equally evident that the metaphor of transformation is flawed. Processing does not create a new *type* of thing within the system, but rather shows an increase in the value of the material in return for the effort expended within a particular situation. What the definitions share is the idea of a change process during which an input is matched by a relatively valuable output – it is value-added in some way.

Beginning from the fact that we have ‘something’ that is processed or acted upon to increase its value to the organisation we propose a term free of the baggage associated with data, information and knowledge. Since the material under consideration belongs to the realm of the intellect, the term *res noetica* (literally ‘mental stuff’) is appropriate. We use ‘noetica’ to refer to all such materials as form the basis for computation, whether in digital form or in the form of real world documents, procedures and practices. We can now proceed to re-examine exactly what is involved in the process of adding value to this noetica and what form the resultant complexification can take. Although by definition, something is added to noetica when it is ‘value added’, the term indicates our subjective appreciation of the process, not what actually happens, and so we must look more closely at the changes in the noetica itself.

Value adding typically involves (1) summarising (through tabulation or graphing), (2) transforming (through selection, formatting or structuring), or (3) contextualising (through timeliness, accuracy and relevance). Each of these activities involves input into the system by the organisation of skill, time and resources, i.e. *effort*. Since the activities are intentional, the result is a product of the initial noetica and the effort input, which may be observed as an increase in *order* (i.e. the opposite of chaos). Thus, we have a direct correlation between the value adding process and a resulting increase in order in the noetica. Adding order affects the noetica: starting with *simples* (noetica as it appears at the start of the process) and ending up with *complexes* (noetica made up of many simples) three types of change are possible:

- A process of *aggregation* forming new *composite* structures. The original simples are still visible, but are now present as part of a new encapsulating shape. (cf. in geology, where the rock type ‘conglomerate’ is made up of fragments of pre-existing rocks cemented in a matrix.) Aggregation complexes include a web site constructed from source documents, or a master book document made from a set of chapter documents.
- A process of *transformation* forming new *compound* structures. Here the simples are no longer visible in the complex: instead new (documents) have been created that derive from the simples. Examples include making a normalised set of tables from a number of spreadsheets, or a summary report from transaction records.
- A process of *interrelation* leading to an increase in *contextualisation*. Here the simples are still present, but now with connections made between them: it is these connections and the networks arising from them that are of value to the organisation. For example, running cluster analysis on a large document set can find commonality of referencing between them and infer chains of influence, but the original documents remain unchanged.

Business computations deliver new enriched noetica suitable for action by a further process. Simples and atoms become complexes by the action of enrichment, but are themselves the subject of further transformation. Processes that focus on aggregation, transformation, or linking (or a combination) will take, as input, the output structures of any other process. In persons, organisations or societies, these processes provide enrichments of meaning, where the understanding brought to a given symbol or pattern grows more deeply informed, more widely experienced, more wholly related. This ultimately implies the continual possibility of further enrichment (given skills, time and resources) as long as we have a living organisation.

We have identified three types of complexity resulting from the order imposed by value adding. We shall refer to the complexification due to aggregation as *granularity*; complexification due to transformation into new compound structures as *shape*, and that due to contextualisation through linking as *scope*, and now examine these more closely.

An increase in *shape* through an intentional act determines the set relatedness of the various items. The order that arises here resides in formal propositional structures, so an increase in the number of tables, indexes, datastores, views and stored queries is seen with an increase in order. And with an increase in order, we see the simple structures (fields, tables) leading to low-order compound structures (databases, connections, stored multi-table queries) and then up to higher compound structures (data warehouses, data marts, ROLAP). The individual elements however, remain recoverable and recombinable.

An increase in *granularity* relates to the user's perception of the noetica, where the order arising is based around discrete structures and lexically identified (elemental) forms. Unlike the increased complexity inherent in the shape dimension, lower levels are occluded by the higher. Here, an increase in order sees bits and bytes in streams and on disks aggregate to form discrete composite noetica, such as documents or code. These in turn become organised into higher level abstract structures such as directories, file systems, playlists, and so forth. At a higher level still, we are forced to use statistics (disk usage, hit rate on a site, age of files, location of systems etc) to understand the aggregation of noetica.

Lastly, an increase in the number of potential connections leads to an increase in the *scope* of the noetica. Isolating the structures that arise in the dimension of scope is harder, partly because scope requires aggregates and shapes to be named or otherwise semantically identified by some organising principle. Moreover, since scope is so much bound up in

transient usages and rules there is a lot more interaction with users and their immediate choices than elsewhere. There is a lot of freedom in choosing names of fields and files, but very little in choosing attributes or protocols. Repeated usages may become sedimented as written procedures, and we see scope embodied in structures such as classification schemes, procedure manuals, Petri nets, topic maps and ontologies.

Although described separately in the examples above, complexification is unlikely to occur as a single type only. In each example, complexification along other axes is also evident: for example constructing a web page increases both contextualisation and aggregation. A typical business process is likely to involve complexification along all dimensions simultaneously, with one or other is likely to predominate according to the current focus of interest.

We can now summarise our revised perspective:

- We have used the term *noetica* to describe collectively all of the materials of computation, and argue that there is only one set of noetica, processed in different ways, and which acquires order through the imposition of three different principles.
- Three separate but interrelated principles of *scope*, *granularity* and *shape* each inform the noetica at any one time. The nature of any point in the noetica will be characterised by the extent to which scope, granularity or shape informs the decision-making or processing.
- The result of value adding to the noetica is an increase in aggregate, compound and contextualised structures, measured as *complexity* of the noetica.

Using these principles, we can map the noetica in a 3-dimensional space framed by a triangular prism, which we call the *noetic prism* (Figure 1).

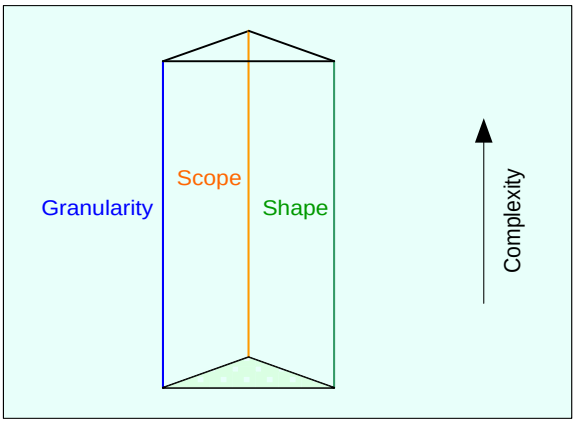

Figure 1. The Noetic Prism showing vertices of granularity, shape and scope.

The prism permits a *four*-dimensional co-ordinate vector space: the three vertices represent three dimensions of noetica (granularity, shape and scope) and the vertical axis represents complexity, i.e. a measure of the intentionality stored in the noetica (as a function of time, effort and skill). The space enclosed by the prism is fractal in nature and can be used to represent the noetic resource for a country, an organisation or an individual. It may also be used to represent a single item such as a database, spreadsheet, or mailing list. In each case the noetic resource has its own measure of complexity, scope, shape, granularity, and the effect of adding a new body of noetica to an existing body can be measured as a vector addition. To have representational power for its user the resource is contingent on the lawful principles of organisation held by the greatest observing entity. Where there is an overarching

shared value or belief system, such as exists in an entrenched culture, the noetica is communicable. The prism itself however is not otherwise an objective formalism.

The noetic prism permits noetica to be modelled in interesting ways. Firstly, any noetic state can be delineated in terms of its relative proportions of noetica along the granularity, shape and scope vertices. The impossibility of having extent in one vertex without the other two is evident, since any point in the space must have three values. Secondly, the model eliminates the need for a 'hierarchy' of noetic types, as the difference between types of noetica appearing at a given instance is one of focus rather than separation or processing status. This focus enables us to avoid the trap of working with structures particular to one vertex with tools appropriate to another. Thirdly, greater complexity does not preclude further processing: old complex structures can become new simple structures with an increase in complexity along the prism vertices. The "simplified complexity" resulting from increased integration of highly differentiated noetica can be shown. Finally, management implications result from using a vector space to plot coordinates in the prism. In principle this enables the use of vector mathematics to analyse and map the effect of a specific and context bound effort (resource, skills and time) applied to a body of noetica.

We believe that our model of the noetic prism offers a useful new perspective on the old problem of definition (and consequent measurement and management) of the data-information-knowledge complex. By abandoning the hierarchical model of process and transformation, we are free to view the intellectual resources of an organisation and their use in terms of a focus on three different dimensions of complexity, seen as vertices of a triangular prism. This revised perspective allows a fresh analysis of many of the common problems in the management of intellectual resources, and we believe the noetic prism can become a valuable practical tool. Our current research is examining this potential.

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