Systems analysis: exploring the spectrum of diversity

Bednar, Peter; Katos, Vasilios; Welch, Christine

Published in:
[Host publication title missing]

2007

SYSTEMS ANALYSIS: EXPLORING THE SPECTRUM OF DIVERSITY

Bednar, Peter M, University of Portsmouth, School of Computing, University of Portsmouth, Buckingham Building, Lion Terrace, Portsmouth, PO1 3HE, UK, peter.bednar@port.ac.uk

Katos, Dr Vasilios, School of Computing, University of Portsmouth, Buckingham Building, Lion Terrace, Portsmouth, PO1 3HE, UK, vasilis.katos@port.ac.uk

Welch, Christine, University of Portsmouth, Dept. Strategy & Business Systems, Portland Street, Portsmouth, PO1 3DE, UK, christine.welch@port.ac.uk

Abstract

Complex problem spaces, such as those addressed by knowledge management or systems analysis projects, call for complex methods of inquiry. A phenomenon in contextual analysis means that there is a need to go beyond consensus and recognized 'best practice'. As part of a complex method, for contextual analysis, inter-analysis may be conducted, in which individuals explore one another's perspectives by discussing individually-created narratives. The purpose is not to seek consensus, but to focus on diversity in viewpoints among participants. In this paper, the authors present an approach in which multiple modelling of problem experiences can bring about shifts of perspectives, create new insights and help deepened understandings to emerge. Techniques are presented that support participants to keep an overview of diversity of in-depth inquiries, while not suffocating under information overload due to the large number of narratives. Participants identify clusters of similar/dissimilar narratives in order to limit the number, but not the range of alternative perspectives. The techniques presented are formally described to promote development of decision support systems.

Keywords: Complex Methods, Systems Analysis, Emergence, Multiple Modelling, Narratives, Contextual dependency.

1 INTRODUCTION

When people seek resolutions within complex organizational problem spaces, such as those addressed by knowledge management or systems analysis projects, complex methods of inquiry are needed (see, e.g. Flood and Jackson, 1988; Checkland, 1999). One example of such a method is discussed by Hendaoui and Limayem (2006) who seek an approach to bring together individual perspectives expressed in a context of face-to-face meetings. However, achievement of consensus is not always a desired aim of analysis. In this paper, we will discuss another method, the Strategic Systemic Thinking (SST) framework (Bednar, 2000), which has a purpose to overcome this constraint. In SST individuals are supported to explore their unique, contextually dependent perspectives on the problem space in which they find themselves (intra-analysis). Individual narratives are created by this process, and are then explored collectively in a group discussion (inter-analysis). A feature of inquiry using SST is that the full range of opinion emerging through intra-analysis may be maintained through inter-analysis, so that no ideas are discarded at an early stage. We recognise that the value of analysis using a framework such as SST is in helping people create for themselves an understanding and overview of a problem space. Work by Minati (2006) supports the view that it is both possible and beneficial to have a multitude of diverse ideas related together when inquiring into a complex problem space. For a discussion of the role and usefulness of narratives in creative organizational thinking, see Gabriel, (2000). The purpose in SST is not to make decisions, but to provide support for deepening understanding so that informed decisions may be made. The aim is not to look for consensus. Instead, we focus on diversity of viewpoints among participants, as a sponsor for creativity. It is a vehicle for escaping from the space of 'best practice'.

The authors believe that a tendency to look for consensus on 'best practice' may limit participants from exploring the full richness of a problem space. Consider the following anecdote as illustration. Managers in a toothpaste manufacturing company were worried about a drop in sales revenue. A meeting was called to discuss ideas on how to sell more toothpaste in a mature market. Many ideas were put forward and none appeared to be ideal, until the meeting was interrupted by a cleaner, wishing to dust the room. On overhearing the discussion, she made a flippant suggestion – why not make the hole in the tube bigger? This turned out to be the best answer to the experienced problem with market saturation. Senior executives were reluctant to be 'interrupted' by a relatively lowly member of staff. Yet, when they did listen, they found the elusive solution to the perceived problem. Opening up to diversity of viewpoint can be seen to be helpful in this case. Furthermore, it is often the creative and 'off-the-wall' idea, and not existing best practice, which emerges to resolve the problem (Ciborra, 2004). In this paper, therefore, the authors focus on complexification, individual and group sense-making processes (Weick, 1995), and study/analysis of diversity as part of the inter-analysis aspect of the SST framework. The main question addressed here is how the human sense making processes may be supported, and with what techniques and tools. How can participants, i.e. people who are both actors in, and analysts of, the problem space, be supported in their efforts? The authors draw inspiration from Gregory Bateson's concept of 'a difference that makes a difference' here (Bateson, 1972). The SST framework supports efforts to enable individual narratives to surface and to be interpreted. In inter-analysis people need to explore, and understand, emergent properties of narratives that are developed as a means of communication and inquiry. Individuals need suitable tools to help them in their efforts to achieve understandings of one another's narratives.

In a complex problem space, any consensus is always artificial. This is because it masks genuinely multi-faceted views held by individuals, e.g. the paradox when an individual gives an answer 'Yes and No', which is different from the answer 'Maybe'. These views are conditional, and dependent on experience of changing boundary judgements in response to uncertainty in a problem space (Ulrich, 1983; 2001). We recognize a potential for multi-modelling when exploring a problem space, so that role 'flipping' and emergence of diverse individual perspectives can be supported. Multi-modelling leads to a range of insights that cannot be combined into one logical 'whole', but each of which

contributes to richness of understanding (Bednar, 2001; Minati, 2006). A search for consensus, in contrast, would enforce one dominant model and lead to loss of creative potential. However, there are many different kinds of consensus. Whilst we do not wish for a concentration on 'best practice' problem descriptions and problem resolutions, we recognize a need to achieve some kind of agreement on language (Habermas, 1984), even if this is only temporary. SST supports a process of classification of narratives according to particular interesting characteristics identified and defined by participants. The aim is to reduce the number, but not the range, of different viewpoints by picking out interesting features which highlight similarities and differences.

The authors are aware of systems developed to aid convergence on consensus among groups of actors (Hendaoui and Limayem, 2006 op cit). However there are currently few available tools to support analysis which seeks to highlight and maintain diversity in view. The unique contribution of this paper, therefore, is to develop a model which the authors believe could be the basis for such support, drawing on a framework which puts complexification into practice (see Bednar 2000). These systems may help participants to classify narratives according to categories they agree upon among themselves. In this way, clusters of narratives, reflecting diversity of opinion, may be encouraged to emerge in discussion. The paper is structured as follows, section two gives an overview of a proposed methodology and discusses an example to illustrate the approach. Section three contains a formal description of the method and finally in section four the authors draw some conclusions and discuss their implications for research.

2 RECONCILIATION WITH DIVERSIFICATION

One reason why complex problem analysis is a great challenge for development of decision support systems relates, we suggest, to a particular bundle of 'prejudices' (See Weick and Sutcliffe, 2002; Morgan, 1997). These are visible in efforts to create systems that enforce ideas of consensus as best practice (see, for example, Argyris 1990). Further problems may be perceived to relate to efforts that hide complexity with complicated, but still reductionist, approaches, and thus make it difficult for decision makers to create an understanding of apparent, emergent, systemic properties of complex problem situations (Checkland and Holwell, 1998).

The authors suggest a need for complexification in analysis, the reason for this is to allow unique individual views and perspectives to emerge. Every observer perceives purpose and relevance from her own unique point of view (Maturana and Varela, 1980) and cannot therefore delegate the responsibility for analysis to another whether a human expert or a piece of software. Ownership and control must rest with the individuals involved in the problem space (Friis, 1991). However we recognize that individuals require support from tools and techniques and from expert facilitators and this must necessarily include delegation. A paradox arises here as each individual's espoused theory and theories in use are unique to them and cannot be submerged into one consensus view (Argyris and Schon, 1978). The authors recognize a challenge therefore to create tools which can support but not replace individuals who own and control their own analysis.

Figure 1 below reflects four different values within the world of certainty. The four quadrants illustrate that participants may be committed to different types of belief. It is possible for instance to be certain that you have not enough information to make a decision, or certain that there is a paradoxical situation in which apparent alternatives are both true or both untrue. This is not the same as experiencing uncertainty in relation to a question were the values of particular conditions cannot be ascertained (see figure 2. below).

A key purpose for design of decision support systems appears to be to change decision making processes for the better, or to allow decision makers to make better decisions - as defined by some participant in, or observer of a particular decision making system. It is recognized that techniques can support users with rigour in their application of methods and use of logic. However, contextual relevance cannot be separated from the identity of the observer who defines it. This section of the

paper attempts to show how groupings and categorisation can be used to support team members' sense-making processes and understandings.

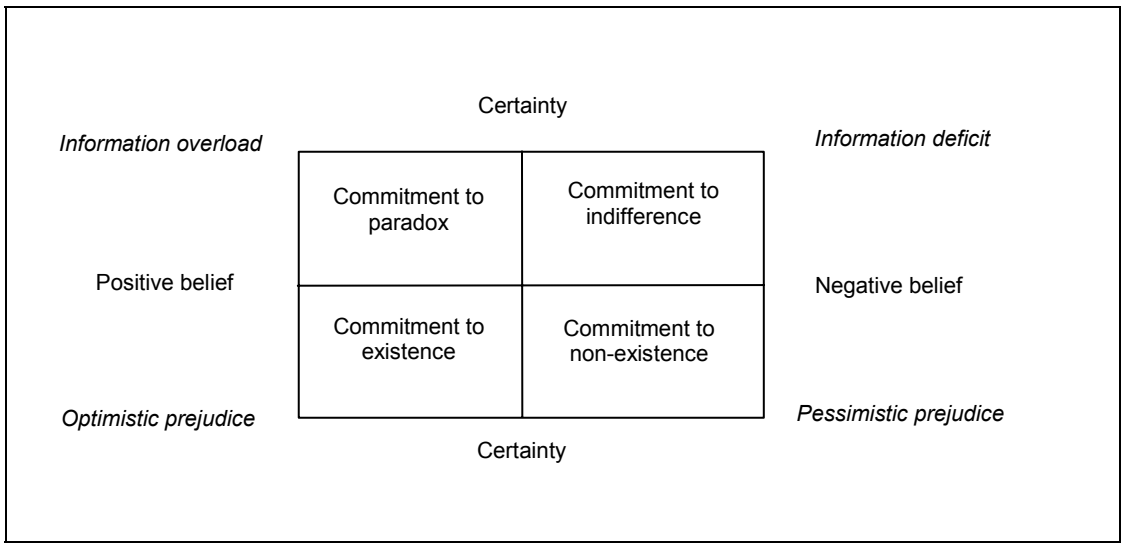

Figure 1. Categories of commitment.

Narratives are developed as part of the process in which they explored. At the same time, they are also being categorised and identified according to each individual's unique worldview. As the participants carry out their exploration, they will generate specific criteria and categorisations for themselves. Consensus and consolidation of index, criteria and category is only required on a linguistic and communicative level – not on content level. The purpose is to support a process where a large number of alternatives may be made available for thorough and in-depth study by decision makers and, at the same time, make it possible for them to keep an overview of the range over which these alternatives are spread. This process may be summarised as follows.

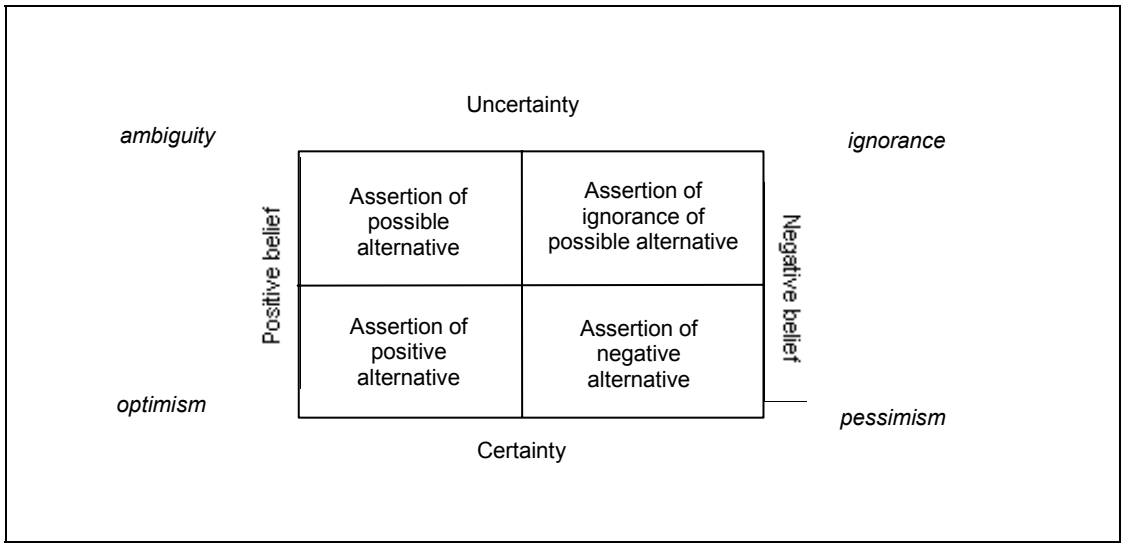

Figure 2. Categories of assertions within narratives.

First, inter-individual reconciliation of narratives takes place. This involves inter-individual sense-making about narratives created, including classification, indexing and signification. Questions are posed such as 'What is unique to this narrative?' 'In what ways is it similar to others?' 'What does this

narrative mean?' 'Under what circumstances is this narrative relevant?' 'At what level of abstraction?' and so on. This is followed by grouping and diversification of narratives. Here, classification may be made according to a model of four-valued logic. How is each narrative characterised? Finally, analysis may be made of grouping and spread according to index and classification etc.

As an example of a complex problem space, we might consider the following. The owner of a sheep farm recognizes that current profits are insufficient to sustain the farm's long-term survival. He initiates an inquiry including his farm manager, the shepherds and other workers employed in the farm, his accountant and a friend who owns two other sheep farms in the same region which are in a healthier financial position. Each participant in the inquiry is initially invited to express an individual view of the position the farm is in, what changes they would like to see in order to bring about improvement and what measures would be needed to carry them out (intra-analysis). When each has produced a 'narrative' answering these questions, a meeting is held at which all narratives are considered on an equal footing, in order to gauge the range of options available (inter-analysis). At the meeting, each narrative is read out and the group is invited to make comparisons between them to identify similarities and differences. Using a white board, a schematic view is created showing which narratives the group perceives to be related to each other and labelling them with a theme. We can describe the process by which they do this as follows:

Participants agree to go through the stories and categorise them using the model illustrated in figure 2. To simplify this, they choose only to look at assertions of positive alternatives. The end result will be a selection of stories, all of which are relevant to positive resolutions of the problem space. Following from this, attention is now put on the content of each and every story. The participants go through each story in turn, trying to make sense of it through discussion and compare it with previous stories.

- Stories that are similar to each other are grouped (assertion of positive belief).
- If a story is different (assertion of negative belief) then it is put separate from the others.
- If some stories are possible alternatives ('maybe' or 'yes and no', ambiguity) to any of the clusters, they are not allocated to them but the relationship is highlighted on the white board.
- Those stories that cannot be related to any clusters are separated from them all on the board. If the reason for lack of similarity appears to be missing information (uncertainty), this is also highlighted.

In this way, clusters emerge which every following story may be compared to, so that new clusters may surface. The result will be a number of clusters on the white board where some may have stories that are related to them but not directly included. If we choose to look only at the (positive) clusters created, the results may be described as shown in figure 3 below.

Cluster 1: Sheep husbandry

Some narratives considered how a flock of a certain size could be looked after more cost efficiently so that animals would be healthy and marketable at a minimum cost;

Cluster 2: Breed of sheep

Some narratives considered whether an alternative breed could be introduced into the flock which would yield more or better quality meat/wool and yield greater revenue for the same cost;

Cluster 3: Marketing

Some narratives considered finding new markets for meat or wool, developing and selling bi-products such as sheepskin artefacts or lanolin, or selling through new channels such as local

farmers markets;

Cluster 4: Diversify

Some narratives considered broadening out the farming activities to include other animals such as goats, or some arable crops;

Cluster 5: Consolidate

One narrative was unlike any others, and considered investigating merger with other local farms or collaborating with other farms in the region in developing markets and reducing costs.

Figure 3. Example of clusters derived from inter-analysis.

The complexity of alternatives on the white board is significant because they include ambiguous relationships between narratives and also uncertainty. In our example, the group has chosen only to look at positive beliefs. Thus, inter-analysis has enabled the group to see the range of alternative resolutions put forward by individual members without dwelling on the detail of each individual narrative and risking information overload. They have not found it necessary to rush to a premature consensus and rule out potentially creative options. Inter-analysis makes it possible to investigate each cluster in more depth and to produce an information base around the context of the problem. There is then potential for informed decision-making to be supported. The group described in this example is relatively small and it is possible for them to discuss and group the individual narratives with relative ease using only a white board and marker. However, in a larger scale problem space there might be very many participants contributing to the analysis. A means to support the process of developing clusters using decision support software would therefore be very helpful.

3 FORMAL REPRESENTATION OF THE PROCESS

The reconciliation process is formally described as follows. Let $U=\{u_1, u_2, \ldots, u_m\}$ be the set of participants of a group, with $\#U=m$. These members contribute with m stories (narratives). Let $S=\{s_1, s_2, \ldots, s_n\}$, with $\#U=n$ be the set of narratives and number of narratives respectively. Let $C=\{ c_1, c_2, c_3, c_4\}$ be the enumerated set of the four possible classifications. More precisely, the elements of C correspond to the four categories presented earlier, in the following order: “positive belief”, “negative belief”, “ambiguity”, “uncertainty”. The process involves every member belonging to U will assign one of the four classification values to each of stories.

The proposed method is based on the assumption that one person may contribute with more than one narrative, but every narrative will have only one classification on an individual level, as shown in the entity relationship diagram in Fig.4. However, it should be highlighted that multiple classification assignments are not explicitly excluded; in these cases four-valued logic operations should be applied *a priori* (see for example Bednar et al, 2006) in order to result into one classification. In other words, multiple classifications should be reduced into a single classification.

Fig.4 Relations within the individual classification process.

Furthermore, within the individual stage, each member will be also required to classify all stories in S. The selection of all classifications constitute one's *opinion*, which is formally represented as an $n \times 4$ matrix with elements $p_{ij} \in \{0,1\}$ with $1 \leq i \leq n$ and $1 \leq j \leq 4$, where i corresponds to story s_i, and the column j designates the classification. For example, member's u_3 opinion P_3 over 5 stories could look like:

$$P_3 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Following from the above example, the first and third stories are classified as "positive belief", the second story as "ambiguous" (i.e. there is too much and possibly contradicting information), the fourth story as "negative belief" and the fifth story as "uncertain" (i.e. no commitment to express a view due to lack of information).

To illustrate this, we refer to the statements that form the example clusters in Fig. 3. We consider the individual u_3. She compares her narrative (what she thinks is a good solution) to the statements captured in the clusters derived by the group in the example above. Following this sheep example, it can be seen that the individual u_3 believes that her ideas are most similar to - or in agreement with - clusters 1 and 3 as positive resolution to the problem. On the contrary, the individual does not subscribe that cluster 4 is similar to her understanding of what is a good solution, as she is convinced that this is not a good idea. However, for cluster 2, this individual expresses that the breed of sheep alternative *may be* a good solution, indicating some similarities with her understanding of what is a good solution. Finally, for cluster 5 – "consolidate" – the individual does not to commit to any opinion, whether or not cluster 5 represents what she believes is a good solution.

It is obvious from the "one classification per story" assumption mentioned earlier, that the Hamming weight of each of the equivalent binary row vectors is equal to one.

The critical stage is when all opinions, from all team members, are consolidated, during the inter-analysis stage. More analytically, during this consolidation state the group aggregate matrix is constructed which is the normalised sum of the individual opinion matrices:

$$G = \frac{1}{m} \sum_{i=1}^{m} P_i$$

The operations above are performed in the set of rational numbers. The consequence of dividing the whole matrix by m essentially maps every row to an equivalent random variable, since the sum of the four discrete values is equal to one. Having a random variable, the degree of consensus per each story can be graphically represented as shown in the example histograms in Figure 5. Now let us assume that the farmer in our example widens his consultation to include four members of his local sheep farmers' association. Each of these individuals forms a view about what would constitute a good solution to the problem. Each individual reviews the clusters established in the group's previous discussions to see which might concur with his own idea of a good solution. The three graphical representations below reflect the following scenarios. Graph (a) shows no consensus at all among the new participants. This would suggest a need to re-think the nature of the problem originally formulated. In scenario (b) there is a divided opinion – some participants agreeing that the cluster matches their view of a good solution and some unable to give an opinion based on the evidence available to them. We might imagine that this would lead to a decision to investigate further. Graph (c) represents total agreement that the cluster does not match the individuals' views of what a good solution would be. This might lead the group to decide to rule this cluster out of future discussions.

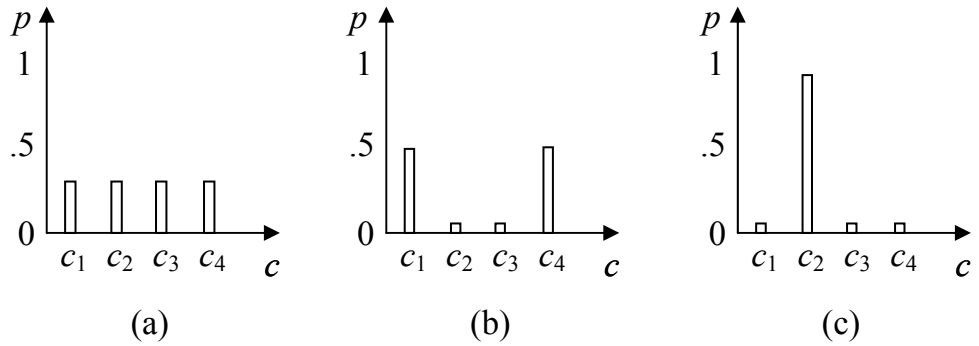

Figure 5. Example degrees of consensus: (a) no consensus, (b) some consensus, (c) strong consensus

The group matrix G is the basis from which the overall degree of consensus is calculated. Typically, this would involve a similarity (or dissimilarity) metric such as the Rand Index, the Jaccard index and the Frank and Mallows measure (Rand, 1971; Hubert and Arabie, 1985; Fawlkes and Mallows, 1983). However, in our case, there is a likelihood that G which is generated from P_i's is a sparse matrix (indicating a high degree of consensus), due to the sparse nature of the latter opinion matrices and therefore a different level of granularity is desirable. Against this, we define the following metric for the degree of consensus, obtained from the elements of G:

$$con_G = \frac{4}{3n}\sum_{i=1}^{n}\left(\sum_{j=1}^{4}(0.25 - g_{ij})^2\right)$$

where $\boldsymbol{g}_{ij}$ is the element on the ith row and jth column in G. It can be easily verified that $0<con_G<1$, with $con_G = 0$ when there is a complete divergence of opinions and $con_G = 1$ when there is a complete consensus. The degree of consensus is a vital metric as it can be a critical factor related to the understanding (or lack of understanding) between the members. More specifically, con_G being close to 0 indicates that the group has problems in creating a common ground of communication. In other words, low levels of consensus at this stage would suggest that the group has a problem in agreeing on the semantics of the communicating language. However, the cause for this lack of communication may not necessarily be known (for example there can be different levels of expertise and different levels of abstraction within the group), but this low value should be used as an "flag" in order not to attempt to collectively analyse the stories or problems further, but revert to the stage of specifying a common understanding by agreeing on the semantics.

However, there is always the event where some stories will not exhibit a high degree of consensus, although that the overall con_G would be adequately high. In the majority of methodologies, these stories would be discarded as being outside the norm, which is highly undesirable in this case. On the contrary, "problematic" stories are highlighted and should be investigated further. This could be sought as a "two-way democracy", where the group not only may elect the ideas that they agree on their classification, but also agree on the ideas that they do not agree on their classification.

The exercise in establishing and measuring consensus is also repeated on a finer level. More specifically, assuming that con_G is acceptably high (or has exceeded a set threshold), it is expected that G would be visibly showing clustering of stories with respect to C, or equivalently, a partition of S. The consensus process will then be repeated on each of the partitions, but at this level the focus would be on the content rather than the language. More specifically, this fine-grained classification would relate to whether the members of a given partition are similar in content. The four classification categories in this stage are in line with the coarse categories used at the consolidation stage and are essentially addressing the space "agreement that the stories are similar in content", "disagreement that the stories are similar in content", "the stories seem to be similar and dissimilar in content", "do not know". The same consensus metrics can be applied at this level to determine consensus on the context of the stories.

4 CONCLUSIONS

The contextually dependent nature of any narrative, problem description, its meaning and defined purpose, means that responsibility for understanding and sense-making (problem re-definition) cannot be delegated to any technique or technology. Every observer will perceive purpose and relevance from her/his own unique perspective. Each individual must therefore continue to be her/his own analyst. However, at the same time, the role of techniques and technologies includes supporting and facilitating human beings in their contextual inquiry, which must by definition include delegation. There is a paradox for us here, in that each individual's espoused theories and theories-in-use will be distinctive and cannot be resolved into a simple consensus (Argyris and Schon, 1978). Therefore, in order to bring about supportive technologies for purposeful change, we need a recognition that this resolution cannot be achieved. Human decision makers should not allow technology to automatically substitute (with built-in 'expertise') their contextual experiences of complex problem situations under consideration.

The authors offer support, comprising of a number techniques which reflect different focuses of attention. This effort is needed, we believe, since discussion of problematic issues is dependent upon both the existence of an available language for debate, and the possibility for human actors to avoid information overload. We recognise efforts of other researchers to provide such a language, e.g. in dealing with large bodies of qualitative data, scholars have made use of repertory grids to help them make sense of collections of individual responses. Our purpose here is rather different, however. If a group of analysts are to discuss a problem space in a context, and each is reflecting upon a multitude of in-depth meanings, then communication will fail, as observers reach depth and precision in their understanding of each narrative but lose overview of emergent properties of collections of narratives. It is important therefore to develop supporting tools that allow for recognition of different contextual orders of focus and categories. However, the responsibility (and privilege) of drawing a boundary at any given time to reflect a given interest lies with a particular observer (Ulrich, 2001).

It is argued that a reductionist approach to analysis, which focuses on consensus elements of a problem space in the context of inquiry, will not yield a sufficient knowledge base upon which useful sense-making processes can be built. Just to go through each and every narrative in depth will lead to information overload as numbers of narratives increase. This will not serve decision makers' interests, since it may lead to emergent properties of problem understandings being ignored. We advocate instead a complexification of analysis, which empowers users to explore multiple levels of contextual dependency through the use of supporting techniques. They may then still be able to access emergent properties of a multitude of diverse descriptions of problem experiences sensibly.

The discussion in this paper represents one application of our model, relating specifically to support required in the inter-analysis aspect of the Strategic Systemic Thinking Framework. The authors recognise scope to extend this model to other applications. The model may be applied to provide support in the intra-analysis and value-analysis aspects of SST. However, it also has wider possibilities. We believe it may have an application in compare/contrast-type methodologies. Further, its basis in paraconsistent logic may provide a platform for a new generation of programming. This could, in turn, pave the way for automated decision support systems for complex methods of inquiry (see Bednar, et al 2006). There has been much work in the field of knowledge management emphasising a need for creativity and sharing of ideas. The focus here is on divergent, rather than convergent thinking (Leonard, 1995). In the words of Nonaka and Toyama:

"*Knowledge creation is guided through the synthesis of contradictions ... the world is filled with contradictions: duality is the essence of reality. By accepting such duality and synthesizing it, one can go beyond the simple dichotomy of either/or, and create new knowledge to solve contradictions ... Synthesis is achieved through dialectical thinking and action. However, we believe that 'soft*

dialectic,' which embraces contradictions and incorporates conflicting views, is more suited to synthesis in management than the Hegelian dialectic, which does not allow contradictions to remain in the synthesis."

Our model, we believe, may have many applications within this context in the future.

References:

Argyris, C. (1990). *Overcoming Organizational Defenses*: Facilitating Organizational Learning. Prentice Hall, Englewood Cliffs.

Argyris, C. and Schon D. A. (1978). *Organisational Learning*. Addison Wesley. Reading.

Bateson, G. (1972). *Steps to an Ecology of Mind*. University of Chicago Press. Chicago.

Bednar, P. M. (2000). 'A contextual integration of individual and organizational learning perspectives as part of IS analysis'. *Informing Science*, Vol. 3, no. 3.

Bednar P. M. (2001). 'Individual Emergence in Contextual Analysis.' Problems of Individual Emergence. Amsterdam, *Proceedings of 12th biannual 'Problems of...' Systems Conference*. April 16-20, 2001.

Bednar P. M., Welch C. and Katos V. (2006). Four Valued Logic: Supporting Complexity in Knowledge Sharing Processes. *Proceedings of the 7th European Conference on Knowledge Management.* Budapest, 4-5 September, 2006. ACL. Reading.

Checkland, P. (1999). *Systems Thinking, Systems Practice: a 30-year Retrospective*. Wiley: Chichester.

Checkland, P. and Holwell, S. (1998). *Information, Systems and Information Systems: making sense of the field.* Wiley: Chichester

Ciborra, C.U. (2004). 'Encountering Information Systems as a phenomenon', in C. Avgerou et al (editors), *The Social Study of Information and Communication Technology: Innovation, Actors and Contexts*, Oxford University Press

Fawlkes, E. and Mallows, C. (1983). A method for comparing two hierarchical clusterings. *Journal of Applied Psychology*. 79 (1) pp. 77-86.

Flood, R.L. and Carson, E.W. (1988). *Dealing with Complexity: An Intrtoduction to the Theory and Application of Systems Science*, Plenum: New York.

Friis, S. (1991). *User Controlled Information Systems Development – problems and possibilities towards Local Design Shops*. Lund University Publications, Sweden.

Gabriel, Y. (2000). *Storytelling in Organizations: Facts, Fictions, Fantasies*. Oxford University Press.

Habermas, J. (1984). *The Theory of Communicative Action*. Beacon Press: Boston.

Hendaoui, A. and Limayem, M. (2006). Idea consolidation process in face-to-face meetings: a new approach to organize and integrate individuals perspectives. *Proceedings of the 14th European Conference on Information Systems.* University of Gothenburg, June 2006.

Hubert, L. and Arabie, P. (1985). Comparing partitions. *Journal of Classification*. Vol 2. pp. 193-218.

Leonard, D. (1995). *Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation*. Harvard Business School Press: Boston, Ma

Maturana, H. and Varela, F. (1980). *Autopoeisis and Cognition*. D.Reidel Publishing: Dordrecht, Holland.

Minati, G. (2006). Multiple Systems, Collective Beings, and the Dynamic Usage of Models. *The Systemist,* 28 (2), Jul 2006. pp. 200-212.

Morgan, G. (1997). *Images of Organization*. Sage: Thousand Oaks.

Nonaka, I. and Toyama, R. (2007). 'Why do firms differ? The theory of the knowledge-creating firm,' in *Knowledge Creation and Management: New Challenges for Managers*, K. Ichijo and I. Nonaka (editors), Oxford University Press: New York

Rand, W. (1971). Objective criteria for the evaluation of clustering methods. *Journal of the American Statistical Association*, 66 (336) pp. 846-850.

Ulrich, W. (1983). *Critical Heuristics of Social Planning*. Wiley: Chichester

Ulrich, W. (2001). 'Critically Systemic Discourse: A Discursive Approach to Reflective Practice in ISD', Parts 1 & 2, *The Journal of Information Technology Theory and Application* (JITTA), 3.3, 2001, pp55-106.
Weick, K. (1995). *Sensemaking in Organizations*. Sage Publications: Thousand Oaks.
Weick, K. and Sutcliffe, K. (2002). *Managing the Unexpected.* Jossey-Bass: San Francisco