Quasi Entailment Mesh

Ranulph Glanville, Burak Pak
Sint-Lucas Architectuur
Paleizenstraat 65-67
Brussels 1030
Belgium
ranulph@glanville.co.uk
burak.pak@architectuur.sintlucas.wenk.be

Abstract

One outcome of the fourth in a series of Workshops on Reflection (as an approach to research), the production of a jointly authored subject matter, is discussed in terms of both Pask's Entailment Meshes, and Schön's Reflective Practice. A modification of Pask's specification is proposed for the process of exploring an incomplete subject matter and in progress authoring of an Entailment Mesh, which we call a Quasi Entailment Mesh. The differences are presented and validated. An electronic translation of this Quasi Entailment Mesh is introduced, with indications of further potential uses.

1 Introduction

This paper brings together work from two different areas in learning, both essentially cybernetic in intent, and shows how bringing them together can make new opportunities for learning.

The first of these areas is "Reflective Practice". Reflective Practice was the term chosen by Donald Schön to describe a process by which professionals acquire knowledge appropriate to their professional activity. This knowledge generation activity is typically carried out outside the confines of the academic world, using procedures and processes that are very different to those associated, at least formally, with academic study. However, being different does not make them any the less valuable, especially to those who have developed and use them in improving their professional skills. But, until Schön's work, this sort of knowledge was often and easily considered insignificant, badly formed, muddied, inferior.

The second area is a depiction of the learnable (that is, what may come to be known, hence knowledge) developed by Gordon Pask and his colleagues at Systems Research and called an Entailment Mesh (EM).[1] Pask's EMs are an important constituent of his theory of learning, "Conversation Theory" [Pask, 1976], which eventually became a general theory of communication, of knowing (i.e., an epistemology) and, finally, of actors being in the world (at which point it changed its name to reflect its new scope, and became "Interaction of Actors Theory"). We will introduce the notion of a Quasi Entailment Mesh (QEM), a depiction of steps on the way towards constructing a full Entailment Mesh. A QEM can act both as a device showing learning in a group as it is at any particular moment, offering this to others in order (it is hoped) to facilitate their learning; and as a learning activity—the act of constructing, together, is an act of (socially shared) learning in itself.

The two areas will be discussed in relation to a workshop on reflection that has been run for architects, artists and other designers over the past 4 years at Sint Lucas Architectuur, in Brussels and Ghent, as part of the Research Training Sessions initiative, by one of the authors (Glanville, collaborating with Adam Jakimowicz). The addition of the QEM to the menu of what is taught was an improvisation made in the iteration of April 2009. The realisation of the QEM as an online shared resource was created by the second author, Pak.

2.1 Pask's Entailment Meshes

The Cybernetician and Learning Theorist, Gordon Pask, came to envisage learning as taking place over a vast landscape of knowables. These knowables are arranged in a structured manner (introduced below). Pask considers the act of learning as consisting of a form of conversation in at least two aspects: a conversation with the knowables and a conversation which is concerned with exploring and explaining understandings of what may be learnt. This second activity is often called "teachback" and came out of the need to find a way to test (demonstrate) what a learner has learnt.

One important consideration that lies behind Pask's invention of the EM is the relativity of each learner's learning interest and prior knowledge. It is neither sensible nor possible to insist that all learners come to a learning situation with the same prior knowledge, or that they share interests and all wish to reach the same end point in their acts of learning. This is a key point behind Conversation Theory. Each learner will come to any act of learning with a different prior knowledge to and a different intention from each other learner.

Let us, after Pask, call the items that may be learnt within any field "topics". Topics (knowables through learning) themselves have very rich structures which we will not discuss here. When confronted with a "landscape

[1] In particular, Bernard Scott and Dionysius Kallikourdis

GLANVILLE, R., PAK, B. 2010 Quasi-Entailment Mesh, European Meetings on Cybernetics and Systems Research, 2010, Vienna University / Austria ISBN 3-85206-178-8

of topics", each learner will come with an understanding of a different selection of "start up" topics. (Each learner will also have a distinct understanding of each topic they know, in part because of individual differences, in part because they will find explanations given by particular "subject matter experts" (those agreed to already know a subject area with authority), more or less in tune with how they conceive their own knowledge and ways of learning. We will return to the implications of this condition shortly).

In most, if not all, structures that are taken to be similar to the EM (for instance, semantic nets, 2006), the traveller (to maintain the metaphor of the landscape of knowable) will move freely and directly from place to place, topic to topic, without the net showing how these places are differentiated and their connections constructed: there are just simple (sometimes multiple) links. Pask places a much greater demand on the making of an EM. He asks not only what is linked to what, but how does that link work. For Pask, you cannot just go from A to B: he asks what distinguishes A from B (connects A to B) and insists this, too, is a topic in the EM. Thus, A only links to B when C is also present: B is the outcome of something akin to a sexual interaction between A and C, giving rise to a topic that requires both in order to exist in the relationship. Some have tried to say that the connection between A and B is a logical relation. In that case, logic and logical operators are also part of the field of study, and either have to be learnt, or are already knowns brought by a learner. So, in an EM, a topic entails (at least) 2 other topics: B entails A and C. Furthermore, logic is only one of many topics in the subject matter, the EM. Consider the following example frequently used by Pask: a circle (B) may be seen to entail, for instance (but not exclusively) rotation (A) of a compass (C).

Let us return for a moment to the condition that a learner, when intending to learn, brings both their own already existing knowledge, and their own intentions and interests, to the EM. We can easily understand that what may be an end point for one learner may be a starting point for another. We can also easily imagine that there are many different routes by which I may move from knowing one to learning another topic. There is no necessary starting or end point: we may go back and forward, we may go round and round and from side to side. The EM must accommodate all these options, and so it must be both richly connected and essentially circular in overall form.

Such large scale circularity is called by Pask "global cyclicity". He insists cyclicity (circularity) must necessarily also be local. Thus, while some learner may wish, knowing A and C, to learn B, another may want to learn A from knowing B and C (and yet another, knowing A and B, may wish to learn C). To extend the example given above, while a circle (B) may entail rotation (A) and compass (C), rotation may entail a compass and a circle; and a compass (C) may entail rotation and a circle.[2]

[2] Archive Footage of Gordon Pask lecture on entailment meshes and cyclicity at Concordia University, 1979. Available at: http://www.cybernetics.com/video/Pask-Entailments.mov (visited 10 January 2010)

An EM is, then, a vastly rich mesh of interconnected, globally cyclic topics, where the relationships between topics are productive and locally cyclic. This is significantly different to other map type networks. But these requirements place a huge burden on the author of any EM, especially when we remember that the descriptions of topics and their entailments are different, according to and reflecting the viewpoint of each subject matter expert, (and each student) will want and need a different realisation of the mesh in what Pask calls an Entailment Structure that supports his particular requirements at any particular moment. (An Entailment Structure is attained by pruning the EM to obtain a net that is heterarchic (multiply hierarchic), in the sense that it has entry points and at least one intended exit point: a technical matter of considerable subtlety and complexity not explore further, here.)

2.2 Entailment Meshes and Other Mappings

Semantic networks are different knowledge representation forms which are deeply rooted in AI research. They refer to a variety of representations ranging from informal to more formal (based on logical propositions). Sowa [2006] describes six different types: definitional ("subtype" or "is a" relations), assertional (propositions), implicational (antecedents-consequences), executable (with attached procedures), learning (neural nets) and hybrid (combination).

These representations are based on an epistemological assumption that interprets knowledge as an absolute and objective image of the world, i.e., "the single truth" [Heylighen, 1997]. In these representation models, the apparent and well documented interaction between the individual's knowledge and social context is ignored.

Wordnet, for instance, is a semantic network that includes English words, synonym(set)s and various semantic relations between them. The definitions are written by a group of lexicographers in the research team. Therefore, they reflect the understanding of that specific group - they are subjective. These descriptions and relations can be multiple, but the authors and the interactions between them are missing in this model. The only communication forecast in the system is the transmission of the intended messages. There is no place for "novelty" or "the unexpected".

Semantic network models contrast with the underlying principles of conversation theory and EMs which value individual prior knowledge as a context-based construction. In this approach, knowledge is constructed in what may be seen as a social context, through social interaction, or conversation (as a metaphor). The justifiability of individual knowledge depends on the coherences with other individual knowledge constructs.

Conversation theory accepts subjectivity as a central element of derivation that allows individuals to construct an understanding together that would not be possible alone. Through the EMs, these cyclical processes of exchange, combination and construction of understandings are assumed to promote new individual understanding (learning).

The basic elements of EMs are topics and relations. Topics are concept representations (such as rotation, a circle or a compass). According to Pangaro [2001] relations are defined as four different types: analogies (similarities or differences), derivations, coherences (when all possible derivations exist between three or more topics) and contradictions.

3.1 Schön's Reflective Practice

The philosopher and educationalist Donald Schön (who worked in the department of town planning and urban design at MIT) became interested in how professionals acquire and improve their knowledge of how to carry out their professional work. Schön came to call his vision "Reflective Practice" (RP). Schön recognised that professionals could develop and had access to a type and range of knowledge, quite distinct from the sort of knowledge gained in lectures and formal study. He examined this knowledge, a knowledge he claimed often to be outside the formal realm of words and explanations, in 5 distinct professions[3] in his book "The Reflective Practitioner" [Schön, 1983], subtitled "How Professionals Think in Action".

Schön was not the first to recognise that there might be a knowledge that is not dependant on, or formed in, words. Michael Polanyi [1958] had previously made the concept of "Tacit Knowledge" important in the study of designing, but the concept, on which perhaps the notion of craft is developed, has roots in Greek Epistemology.[4] What Schön did was to show something of how such knowledge could come into being, and be used by professionals. Doing so, he set up an alternative to academic knowledge which took far more account of the making and using of knowledge than the highly sanitised and ritualised account given in general academic discussion.

Schön talks of knowledge in action, reflection in practice, and reflection in action (amongst others). What he is getting at is that we know how to act even if/when we cannot justify our actions with proper formal explanations; and we know how to improve (sometimes redressing balances and correcting our courses), by becoming aware, through a process of reflection, of how we are acting. Reflection (as with many of the words Schön uses) is ambiguous, but Schön is happy to accept a rich variety of meanings, from the dreamy to the rather hard-edged "reflection in the mirror". What he is getting at is that reflection is not a matter of analysis and the construction of tight causality, but a way of acting allowing us to observe our behaviour in general, and to be surprised.[5] Reflection allows us to grasp what we are doing, often while we are doing it, without necessarily making it explicitly verbal. It is about seeing what we do in a different way: that is, it is about differences in viewpoint and ways of viewing.

[3] The professions Schön examined were architecture; psychotherapy; engineering; town planning; and management. He also generalises across professions, confirming that research is an interdisciplinary concern.

[4] Aristotle, who distinguishes several kinds of knowledge, has phronesis, or practical knowledge. (See wikipedia, http://en.wikipedia.org/wiki/Phronesis, visited 10 January 2010)

[5] He makes a particular point of the significance of surprise.

Schön [1985] also discusses the value of the studio as a learning environment. Although not well known in some areas, the studio is the environment of choice and of habit in all fields of visual art and design. It is a discursive environment in which work and ideas are openly discussed and on view: as (author) Glanville likes to say, "the studio is a place where theft is legalised"- a melting pot of speculation and difference.

3.2 Teaching Reflection

In discussing reflection in general, but with particular reference to Schön's reflective practice and in a manner that reflects the position he takes, one is necessarily involved in the recursive action of reflecting on reflective practice. While one might conceivably teach reflection using traditional pedagogical means such as lectures, this approach involves a contradiction in terms. The point of reflection is that it is a practice, not a system of thought. It is an action and it leads to action. You can describe reflection in a verbal and logical way, but this is not the same as doing it. This is an essential characteristic of reflection. Thus it follows that the way to teach (and, of course, learn) reflection is by doing it, and by reflecting on that doing. Such an approach, when allied to the unique experience and ability of each student (the difference), is necessarily conversational. Hence, it needs to be handled responsively and improvisationally. While teachers may have a battery of relevant resources they call upon at any time, it is the ability to call them up in a helpful manner (a manner sustaining others in the conversation) that is a key to a teacher's intervention. In turn, this depends on the ability to catch reflection: to note when it is happening, or when it is pushing to happen, and facilitate students in opening up to it: a concept closely related to Froebel's notion of teaching. The teacher, even more than the student, needs to be acutely and permanently aware of the reflective nature of the learning process, learning event and learning environment, and capture this so students see their own reflective practice and may reflect on it. In this characterisation, if the student is reflecting on reflecting, the teacher is reflecting on reflecting on reflecting!

Central to reflection is the ability to find new viewpoints, new ways of constructing the situation. While the teacher must do this of necessity, it is preferable (and the desired outcome) that students learn to do this for themselves: that is, they learn how to promote reflection not only on their practice (what we may call Schön's task) but also how to reflect on their reflecting and, in a certain sense, to turn their practice into reflection.

When asked to create and run a workshop on reflection for the Research Training Sessions programme of Sint Lucas Architectuur[6] in Belgium, this workshop was scheduled as the programme's inaugural event. Participants had not yet done anything in the programme to reflect upon: the only possibility seemed to reflect on what the students thought reflection was: to reflect on reflection. At the time this seemed bizarre, yet, in each of

[6] Sint Lucas is based in the cities of Brussels and Ghent. It is the largest School of Architecture in Belgium and has the best known and most successful graduates.

the 3 years since, when our workshop was no longer first in the sequence, we have done the same. Rather than formally study reflection as a topic, we have shifted our viewpoint to reflecting (on reflecting), where reflecting is the act of doing reflection.[7] Teaching reflection is, in our practice, itself recursive. We do not teach the topic reflection, we teach the activity of reflecting through reflecting on it, in a regress of recursion.

In our workshops, we understand reflection as recursive. The practice of reflection involves finding new viewpoints. [Glanville, in press]

4 Working the Workshops: producing a Quasi Entailment Mesh

This is not the place to attempt a full or detailed account of how the workshops functioned. For one thing, as stated there was no overall plan: each workshop was different. Improvisation deriving from conversation was the order of the day.

However, it is appropriate to present one development that has lead to a public outcome. In working as a group, as well as a collection of individuals, an important concern arose—whether (and how) we could create a group outcome. Clearly, individuals co-operated through conversation, and there were consequently shared understandings. What we needed was to develop a form in which to express this.

A means of doing this became apparent in the workshop held in 2009. The approach was itself a form of reflection, and arose in the improvisational atmosphere in which we worked. It is a specific and focussed development of the visual mind mapping Adam Jakimowicz was particularly interested in. It was also inspired by Pask's Entailment Meshes.

Taking Pask's notions would allow us to assemble together the different views of each of the participants in a mind map created in collaboration between all the participants. In fact, it would allow us more. But it would need to be modified to match 2 circumstances:

- Firstly, that we were authoring our EM, not exploring one already made
- Secondly, limitations in time.

The first circumstance comes about from a difference in perspective. Pask's EM is intended (at least in its initial form) to be a more-or-less complete and authoritative landscape of the learnable topics and their legitimate relationships which a learner will enter and traverse in acts of learning. Our aspiration is different: the learning we are concerned with comes about not by following ready made paths, but by creating paths that may be followed, which we were doing not alone, by ourselves, in a ready made learning environment, but in the environment of a group of participants learning together, each providing (part of) the learning environment for the others.

Time limitations mitigated against attempting to make an EM, even if we wished to. The processes of completing universal local (as well as global) cyclicity are enormously time consuming, a considerable intellectual drain. They require persistence and doggedness over an extended time period. In a workshop aimed at busy professionals, these resources are not available.

To deal with these difficulties, we modified three of Pask's requirements, not always damagingly.

First, we did not check for global cyclicity. We simply left this requirement unattended.

Second, we grouped several of the topics we had generated together under a (new) topic (heading), in order to reduce the complexity of the task of connecting. This is explicitly against Pask's requirements of local cyclicity and non-hierarchy, unless you view each sub-topic as an explanation of the (super-) topic.

Third, rather than attempt to create local cyclicity, we found ways of moving towards it. To be certain of creating universal local cyclicity, authors must have access to all necessary topics. We did not: we were not subject matter experts, but explorers in an unmarked landscape. Linking topics, we did demand the generative aspect that requires at least two topics to interact to produce a third, by providing an explanation of how one topic becomes another. This explanation is, of course, a topic, but was not part of the collection of topics that we began from. It is a topic awaiting exploration and integration as a topic itself to be entailed in others, as well as helping in the entailment of another. We also moved to explore derivations working in both directions: if B is derived from A with explanation C, is A derived from B with explanation D or, if we are very lucky, C? This technique provides a way of exploring and expanding, of finding new points of view and of extending the exploration practised by the group.

These modifications disqualify what we constructed from being a true EM. We, therefore, refer to it as a Quasi Entailment Mesh (QEM).

4.1 Extra Benefits of the Quasi Entailment Mesh

The extra benefits to the participants of making our QEM include:

- Borrowing and exploring the ideas and understandings of other participants
- Reflective thinking-while-doing, which is at the heart of reflection-in-action
- Constructing the explanations, which are, themselves, proto-topics (in Pask's sense)

However, perhaps the most valuable new benefit is that this process makes the discoveries of the participants available to others. Such others may not only explore the QEM, but, ideally, may be able to comment, even offering their own insights and understandings, thus growing the QEM.

Growth is one necessary element in the conversion of a QEM into an EM, for a QEM is understood to be incomplete and ill-formed, both in its scope and range, and in the lack of all-pervasive, persistent and consistent cyclicity. Growth allows a type of curiosity and learning from those who were not in the group and do not believe they understand the notion "reflection" well enough; as well

[7] I invited Dr Adam Jakimowicz to join me in teaching this course: hence the shift to "we". Dr Jakimowicz should be recognised equally for his part in the workshops.

as a move towards a more proper and complete body of knowledge that an EM embodies. It is another necessary element in the conversion of a QEM to an EM.

Finally, the way in which we proceeded provides an alternative model for the gradual building of an EM: a task that Pask understood and dealt with through subject matter experts, and by the software package developed initially by Pask, Scott and Kallikourdis [1975] under the name "ThoughtSticker".

4.2 Making the QEM available in Electronic Translation

A major motivation for creating an electronic (digital) map of the QEM built by the participants in the 2009 Reflections Workshop was the assumption that knowledge in these representations is expressed both in what is shown, and in how it is shown.

A further aim was to explore knowledge representation forms in digital media, to create new interactive possibilities both for the QEM and for future use in related research projects. Thus, creating an "electronic translation" of the QEM (as physically constructed by the group) should be seen as a first step (Figure 1 upper).

Analysis of the QEM revealed it contained parent, child and relational topics joined with single and/or bi-directional links, colour-coded to indicate the authors.
The electronic translation study was targeted to address the following questions:

- How can knowledge representations made by different individuals be made accessible?
- How can these be explored in an interactive manner, moving from topic to topic?
- How can these representations give ideas other than those we already have in minds?

A multi-level radial metaphor was used for translating the QEM, drawing attention to relational topics.

The "child" and "parent" topics were placed at the first and second levels. The relational links are visualised in a semi-transparent manner to give a holistic view of the complexity of the QEM (Figure 1 lower). Detailed information about these relations is revealed through a rollover interaction highlighting the related topics, which allows individuals to follow different routes, moving from one topic to another.

The workshop participants have evaluated this electronic translation. Furthermore, we have also acquired comments from other users who had not participated in the workshop. The comments of both evaluation groups on the success, learning potentials and improvements were collected to be used for future developments.

The author group were generally enthusiastic, and claimed that exploring the QEM in its electronic form had offered them new learning opportunities.

As the electronic translation is based on a dynamic visualisation medium that covers generic "child" and "parent" topics, relations and actors, other QEMs may also be represented using the same approach.

In the future, this implementation can be extended and utilised as a basis for creating a web-based environment model for constructive knowledge production through online conversation. Such an environment will include synchronous and/or asynchronous group communication module and a visualisation module (similar to the electronic translation produced in this study).

The electronic version of our QEM may be visited at: http://d-ref.blogspot.com. We welcome comments.

5 Conclusions

We have reflected on reflection as a process for knowledge generation in professional groups of designers who are learning about research, and have related our findings to a modified version of the knowledge structure known as an Entailment Mesh, in the form we call a Quasi Entailment Mesh. We introduce means of social authoring a Quasi Entailment Mesh by the group. An electronic translation is discussed, and comments by authors of the Quasi Entailment Mesh evaluating this version are presented.

References

[Pask, 1976] Gordon Pask. *Conversation Theory: Applications in Education and Epistemology*, Elsevier, London, 1976.

[Schön, 1983] Donald Alan Schön. *The Reflective Practitioner*, Harper Collins, USA, 1983.

[Schön, 1985] Donald Alan Schön. *The Design Studio; an exploration of its traditions and potentials*, London, RIBA Publications for RIBA Building Trust, 1985.

[Polanyi, 1958] Michael Polanyi. *Personal Knowledge: Towards a Post-Critical Philosophy*, London, Routledge, 1958.

[Pask et al., 1975] Gordon Pask, Dionysius Kallikourdis and Bernard C E Scott. The Representation of Knowables, *International Journal for Man-Machine Studies*, 7, pp 15-134.

[Glanville, in press] Ranulph Glanville *Reflection*, in Reflections 13, Brussels, Sint-Lucas Architectuur.

[Sowa, J. F., 2006] Semantic networks. (Revised and extended version of an article originally written for the Encyclopedia of Artificial Intelligence, Shapiro S (ed.), Wiley).

[Heylighen, F., 1997] Bootstrapping knowledge representations: from entailment meshes via semantic nets to learning webs", International Journal of Human-Computer Studies.

[Pangaro, P., 2001] A Model of Entailment Meshes CS773A/Stanford/Autumn 2001, Draft V 0.8. <http://pangaro.com/entailments/entailing-v2.htm> visited 10 January 2010.

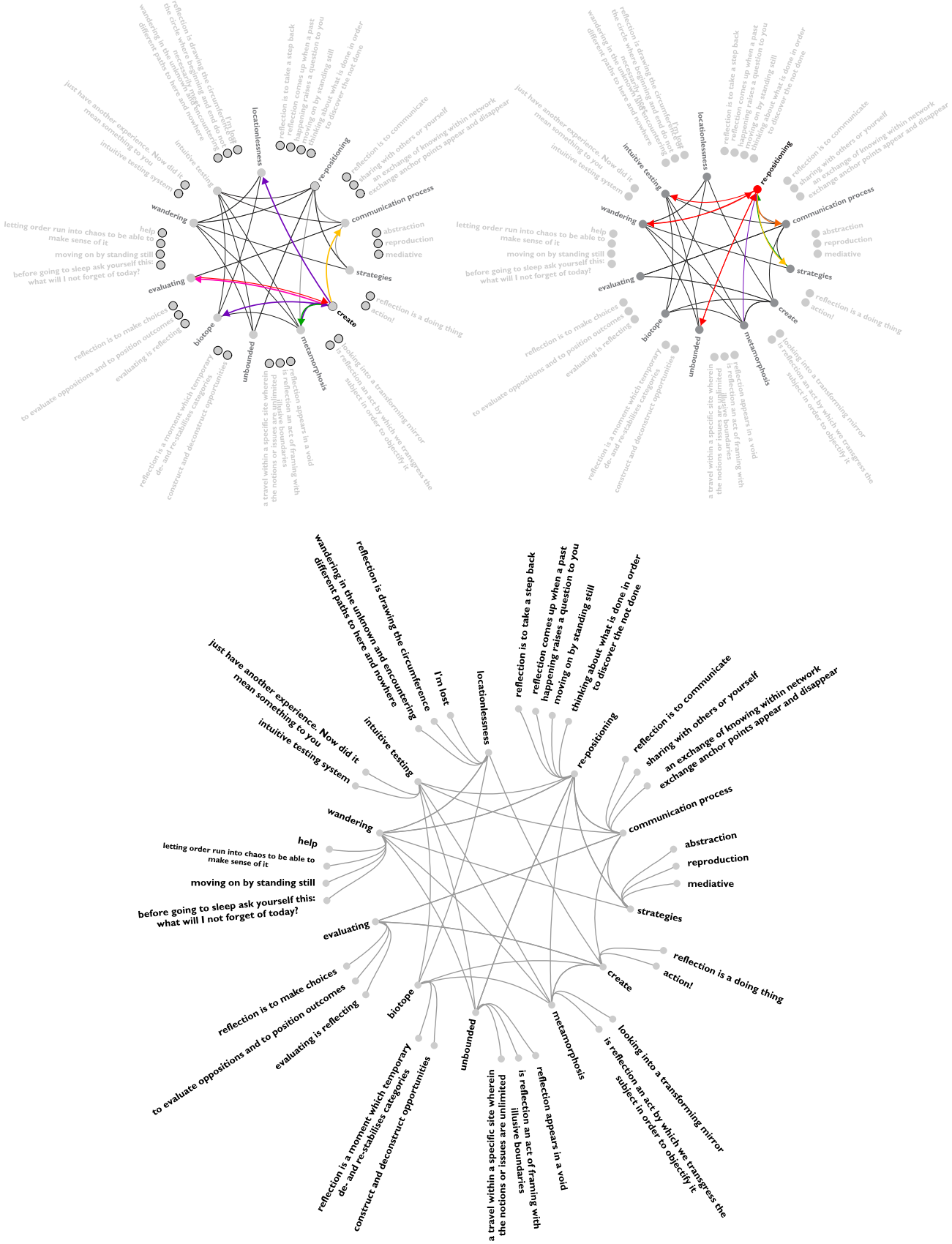

Figure 1. Screenshots of Interactive Quasi Entailment Mesh and sample interactions. Dynamic online version can be reached at: http://d-ref.blogspot.com. (The original version is color coded).

GLANVILLE, R., PAK, B. 2010 Quasi-Entailment Mesh, European Meetings on Cybernetics and Systems Research, 2010, Vienna University / Austria ISBN 3-85206-178-8