PRACTICE NOTE
Mapping project dialogues using IBIS: a case study and some reflections

Kailash Awati

Boehringer-Ingelheim Pty Ltd, North Ryde, Australia

Abstract

Purpose – The purpose of this practice note is to describe the use of the issue-based information system (IBIS) notation to map dialogues that occur in project meetings.

Design/methodology/approach – A case study is used to illustrate how the technique works. A discussion highlighting the key features, benefits and limitations of the method is also presented along with a comparison of IBIS to other similar notations.

Findings – IBIS is seen to help groups focus on the issues at hand, bypassing or avoiding personal agendas, personality clashes and politics.

Practical implications – The technique can help improve the quality of communication in projects meetings. The case study highlights how the notation can assist project teams in developing a consensus on contentious issues in a structured yet flexible way.

Originality/value – IBIS has not been widely used in project management. This note illustrates its value in helping diverse stakeholders get to a shared understanding of the issues being discussed and a shared commitment to achieving them.

Keywords Project management, Communication processes, Information systems, Project teams

Paper type Case study

1. Introduction

A large part of a project manager's day-to-day work is to facilitate communication between stakeholders; to get "everyone on the same page" so to speak. Indeed, this is why project management standards and methodologies devote considerable attention to communication (Project Management Institute, 2008). Despite this, project meetings – particularly those in which issues of importance are debated – can be fractious affairs that generate more heat than light. This is not surprising: project stakeholders typically come from varied professional backgrounds, so differences of opinion are to be expected. To begin with, there are the obvious differences between, say, a business analyst and

a programmer. However, there can also be more subtle differences between project team members who have similar backgrounds. For example, two programmers may have different preferred approaches to solving a particular business problem. In view of this, it is safe to say that projects are socially complex (Conklin, 2005).

On a related note, the early stages of projects are fraught with ambiguity (Williams and Samset, 2010). Yet, it is at this "front end" of projects that the most important decisions have to be made. Front-end decisions are hard because there is:

- uncertainty about scope, i.e. about what needs to be done;
- uncertainty about rationale, i.e. why it needs to be done; and
- uncertainty about approach, i.e. how it should be done.

Arguably, the lack of clarity regarding any of these can sow the seeds of failure in the early stages of a project. This is why project management methodologies emphasize the need to document scope, rationale and approach. However, as experienced project managers will attest to, documenting these matters is one thing, but ensuring that all stakeholders have a shared understanding of what is documented is quite another. Documentation, however elaborate, is worthless if it is not accompanied by collective comprehension of those involved in the project.

In this note, I use a case study to describe how a technique called dialogue mapping (Conklin, 2005) can be used to facilitate a shared understanding of issues encountered in project work. The technique has its roots in the concept of wicked problems – a term coined by Rittel and Webber in a seminal paper published nearly 40 years ago (Rittel and Webber, 1973). To set the context for the present work, I first discuss the concept of problem wickedness and then provide the necessary background on the notation used in dialogue mapping. I follow this with a detailed presentation of how I used it to facilitate consensus on an approach to building a system in the organization that I work for. Following the case study, I present some reflections based on the case study and provide some connections to the literature on sensemaking. I also discuss why other, similar notations do not work as well as the one used in dialogue mapping. Finally, I acknowledge that no method is a panacea – I present some shortcomings of dialogue mapping based on the experiences of other practitioners of the technique and my own experience.

Although the technique of dialogue mapping and others of the same ilk (MacLean *et al.*, 1991; Lee, 1989; Van Gelder, 2003) have been around for a while, they have not received much attention in the project management research literature or in practice. Consequently, my main objective in this note is to draw the attention of the project management research and practitioner community to a useful technique that has not been widely used in managing projects.

2. Wicked problems
Rittel and Webber coined the term wicked problem to describe the dilemmas faced by social planners, such as those engaged in inner-city redevelopment initiatives (Rittel and Webber, 1973). They defined the following as key characteristics of such problems:

- there is no definitive formulation of a wicked problem;
- wicked problems have no stopping rule;
- solutions to wicked problems are not true-or-false, but good-or-bad;

- there is no immediate or ultimate test of a solution to a wicked problem;
- every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly;
- wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan;
- every wicked problem is essentially unique;
- every wicked problem can be considered to be a symptom of another problem;
- the existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution; and
- the planner has no right to be wrong.

Many projects exhibit wicked characteristics. For example, a significant number of projects are one shot operations (characteristic 5) that are essentially unique (characteristic 7) – budgetary constraints ensure the former, and the very definition of a project ensures the latter. However, regardless of whether or not projects are complex or wicked, any technique that enables one to make sense of wicked problems ought to have utility in the day-to-day business of running a project.

3. Issue-based information system – a notation to manage wickedness

In a paper published in 1970, Rittel and Kunz described a notation called issue-based information system (IBIS) that was expressly designed to capture the essential points raised in discussions of wicked problems (Kunz and Rittel, 1970). The original notation, which was suitable for paper-based systems, was later adapted by Conklin and Begeman (1988) for use on computers. I will describe a Conklin-Begeman variant of IBIS in this paper, as it is the notation that forms the basis of the technique of dialogue mapping.

The IBIS notation consists of three main elements (Figure 1):

(1) *Issues (or questions)*. These are issues that need to be addressed. Issues are represented by blue-green question nodes "?".

(2) *Positions (or ideas)*. These are responses to issues. The set of ideas that respond to an issue represents the spectrum of perspectives on the issue. Ideas are represented by yellow light bulb nodes.

(3) *Arguments*. These can be pros (arguments supporting) or cons (arguments against) an issue. The complete set of arguments that respond to an idea represents the multiplicity of viewpoints on it. Pros are represented by green " + " icons and cons by red " − " nodes.

Note that although the icons are depicted in grayscale in the figure, they are actually colored in the software tool that supports the notation. I will say more about the tool below.

Figure 1 also shows a couple of important grammatical elements of the IBIS notation: ideas respond to questions and arguments respond to ideas. Also illustrated

is the convention that maps should be read from left to right, and must always begin
with a question – conventionally called the root question.

The connections shown in Figure 1 are not the only ones possible. Figure 2 shows
all permissible links in IBIS.

In essence, the only addition to the rules shown in Figure 1 is the following: any
node can be questioned. This rule mirrors the way in which meetings proceed – issues
are raised, responded to and debated – the debate leading to further questions about
the responses or indeed even the question itself.

A Java-based IBIS mapping tool called compendium is available for free use under
the GNU Lesser General Public License (http://compendium.open.ac.uk/institute/
download/download.htm). It should be noted that compendium augments the core IBIS
notation with a few more node types – I will discuss one of these additional node types
in the case study. For now, I will simply point out that the tool is easy to install and use:
I was able to start creating IBIS maps within a few minutes of downloading the
software.

4. The case study
4.1 Background and context
My employer is a pharmaceutical multinational with over 40,000 employees working in
147 affiliates located in 47 countries. Some years ago, the IT division of the organization
launched an initiative to streamline service development, delivery and support. Among
a raft of other objectives, one of the aims of the initiative is to reconcile and harmonize
several applications and their associated data repositories across the organization. In
March 2010, I participated as an internal consultant in preliminary discussions
regarding the building of a centralized data repository for affiliates located
Asia-Africa-Australasia region. The discussions were aimed at building an
understanding of what purpose the repository would serve, what it would hold and
how it would be built.

Since the project was part of a larger corporate initiative, the basic objective was a
given – we were to build a consolidated data repository for the region. The open
questions were those relating to how this would be done. Further, it was also made clear
that the decisions regarding the open questions were to be made by those participating
in the discussion. Needless to say, there were some differences of opinion regarding what
the best approach would be. These will become evident as the case study unfolds.

Having used IBIS to map dialogues in informal meetings, I was convinced that it
would be of great value in the discussion. So, a few days prior to the meeting, I met the
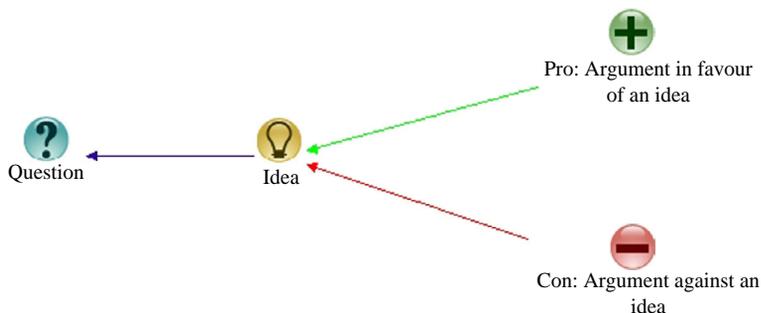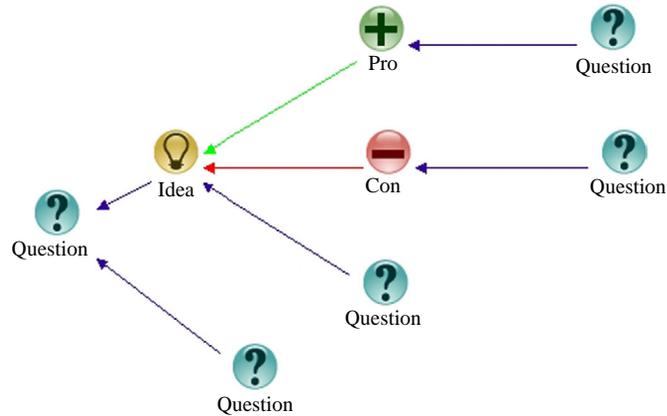

Figure 1.
IBIS node types

project business lead to canvass the possibility of using IBIS to map the discussion. After seeing a brief demo of the compendium tool and IBIS in action, he was quite taken by the idea and was happy to have me use it, providing the other participants had no objections.

4.2 The discussion
The discussion took place in the business lead's office over the course of a day. The participants were the business lead, IT lead and three technical/business experts, who had a good knowledge of the data landscape and needs of the affiliates that were to be included in the first phase of the project.

At the start, the business lead reiterated the purpose of the meeting and then handed the floor over to me. I briefly explained that I would be taking notes using a mapping tool (compendium) and that I would, on occasion, interrupt to seek clarification regarding specific points. Further, I also mentioned that the map of the discussion would be projected on a whiteboard so that everyone could see it and point out if there were any inaccuracies. I deliberately refrained from giving a detailed introduction to IBIS at this time.

I began by asking what the open questions were. The participants mentioned the following points:

- Who is the customer? (who are we doing this for?)
- What is the best approach – several smaller affiliate-oriented databases (data mart) or one big database (data warehouse)?
- What areas should we focus on at first (sales/marketing, finance, etc.)?
- What are the infrastructural requirements (hardware, software, etc.)?
- How do we proceed (next steps)?

I mapped the issues as they were articulated. Figure 3 shows the map at the point where all the open issues had been articulated. There is one thing worth noting: I knew that each of the points would be a discussion unto itself, so I depicted each issue using a compendium map node. Map nodes are not a part of the IBIS notation but they are extremely useful when one wants to factor out more or less self-contained sub-topics in a long discussion.
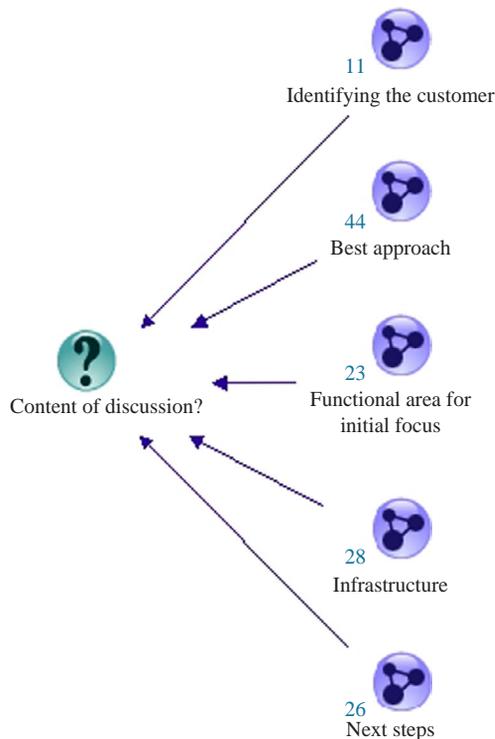
The numbers to the left of each node denote the number of nodes within the (sub) map.

The map simply lists the issues that were raised. Note that when documenting the issues, I did not list any alternatives that were offered by participants. For example, when the issue of functional areas for focus was raised, it was framed as a choice between sales and finance. However, I deliberately phrased the issue as "functional areas for initial focus" so as not to preempt consideration of other areas.

In the interest of brevity, I will focus on the discussion around point 2: the best approach to building the repository. The number of sub-nodes (44) listed against this node suggests that there was a fair bit of debate on this point. Indeed, this was the most contentious part of the discussion. The basic point of difference was whether we should build a single consolidated database as opposed to several smaller ones.

I started the discussion of the approach by drilling down into the sub-map marked "best approach" and creating a question node labeled with the text "what is the best approach to build a regional data repository?"

Almost immediately, a couple of participants offered the following ideas:

• build a single data warehouse; and
• build a number of data marts.

Figure 4 shows the sub-map with the root question and the two ideas.

Arguments for and against the propositions flew thick and fast. I asked the participants to slow down so that I could understand and capture all the arguments made. If the points made were not obvious, I asked for clarifications and captured these as well. As I mapped the dialogue, I shifted nodes around for clarity. For example, although participants offered arguments for and against a particular idea in random fashion, I grouped pro and con nodes separately. The interim map, with pros and cons for the data mart option added in, is shown in Figure 5 (note: the abbreviation OPU (operating unit) in Figures 5 and 6 refers to an affiliate). The map also shows clarifications captured as questions relating to the relevant pro or con node.

By this time, everyone in the group was interacting with the map. Some were making suggestions for rewording text, others seeking or adding in clarifications. In short, the group was working towards a consensus on which approach should be taken.

After the group appeared to have run out of arguments for or against the data mart option, I asked them to do the same for the data warehouse option. The map with the arguments added in is shown in Figure 6.

By this time, the participants had a good understanding of the two options and their implications. I gave the group a few minutes to mull over the map and suggest any changes or additions. There were none forthcoming. I then asked the question, "does the map suggest a preferred approach?" Everyone in the room agreed that it was pretty clear that the data mart option was the way to go; we had a consensus decision.

5. Discussion

5.1 Notes and reflections

At this point, it is worth making a few general observations and reflections about the use of IBIS in mapping project dialogues. These notes are based on the case study and my other experiences in using the technique over the last year or so. I also make connections between my experiences and the literature on computer-assisted deliberation:

- Participants were able to follow the map without any prior introduction to IBIS. This supports the claim that the notation is intuitive (Conklin, 2003).

- The map serves as a succinct summary of the discussion. However, it should be noted that dialogue does not always flow in the logical way as depicted in the diagram. In general, a facilitator will need to steer (or more correctly, nudge) a discussion in the right direction to maintain flow. On the other hand, it is also possible to refactor (or rearrange) the map after the discussion, without changing the meaning and intent of what was said. Refactored maps must be validated by
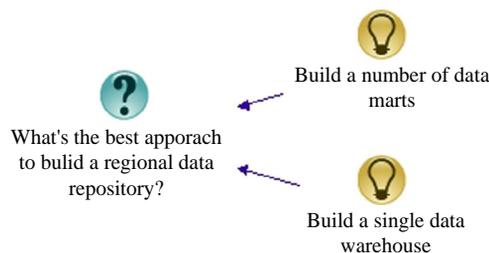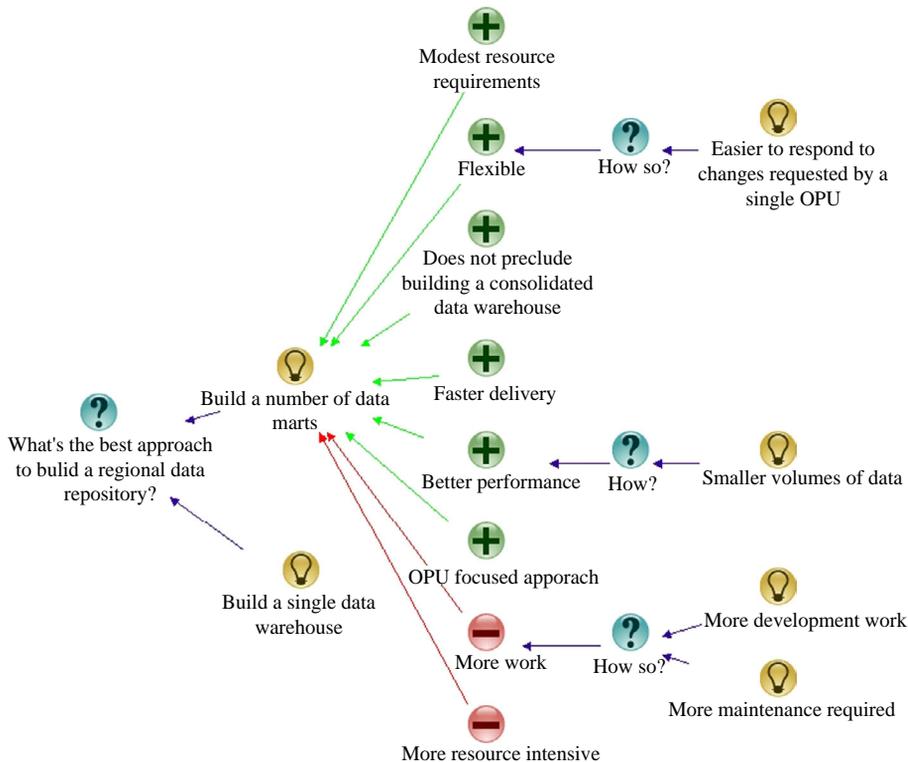

Figure 4.
Case study map 2

Figure 5.
Case study map 3

checking with all participants. In the case discussed above, I used a combination of steering and refactoring on the fly.

- Although the issue discussed was a simple one with some obvious solutions, it is important to note that the root question did not suggest any particular solution. The question I asked was "what is the best approach to build a regional data repository?" rather than "should we build a data warehouse or several data marts?" Asking open-ended questions ensures that the ensuing discussion does not presuppose solutions or restrict the group's choices prematurely.

- The IBIS grammar does not pit arguments (pros and cons) against each other; the grammar explicitly disallows direct connections between arguments (Figure 2) (Conklin, 2005). Consequently, each argument is examined on its own merits. This feature is useful because it reduces the "my argument is better (stronger) than yours" mentality that often occurs in project discussions, especially those dealing with design decisions. It also helps in keeping the discussion focused on issues rather than individual preferences, thereby leading to decisions based on the greater good rather than personal agendas. Nevertheless, it is interesting that the pros and cons for the data warehouse nearly balance out: for the pro "harmonized" we have the con "harmonization is difficult"; for the pro "fits in with corporate direction" we have the con "top-down approach"; for the pro
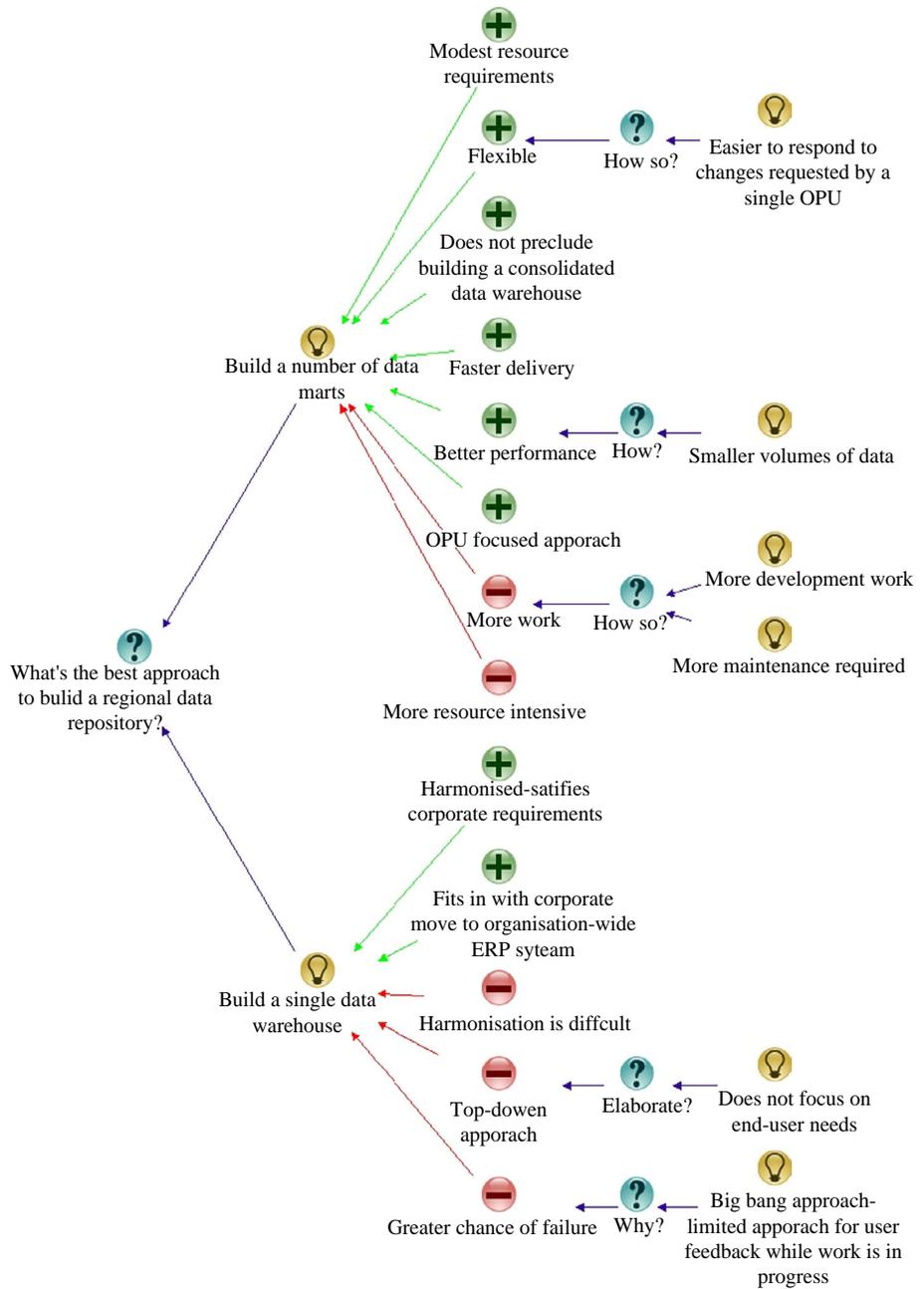
Figure 6.
Case study map 4

"more manageable" is countered by the con "greater chance of failure." I emphasize that this emerged from the dialogue – it was not imposed by me.

- Since the group focused on the map whilst the discussion was in progress, differences of opinion and fact were plain for all to see. Further, since nodes were not labeled with the names of contributors, the points made were "objectified", in that they stood as items to be evaluated on their merits. Even though all differences were not resolved (some of the other questions shown in Figure 3 were not resolved), the group ended up with a shared understanding of the issues involved, the possible options to address them and the pros and cons of each option. The point is this: design is often a political process (Rith and Dubberly, 2007) and IBIS helps in disentangling the politics.

- In addition to documenting the essential content of the discussion, the map also captures context and connection – the background and threads of informal logic that accompany the questions that were debated. In short, the map captures rationale – why a particular decision was made. Capturing rationale is especially important when one expects to revisit the discussion later, as is the case in iterative design or analysis. Researchers have pointed out that the capture of context is one of the benefits of using visual sense-making tools (De Liddo and Buckingham Shum, 2010). Of course, the background captured depends on what was discussed by the group. In general, a facilitator should ask questions aimed at filling in context, particularly if it is known that the map will be referred to in future.

- The notation allows for elaboration of specific points in a very natural way – one simply asks an appropriate question about a particular point. For example, the con "greater chance of failure" that was noted for the data warehouse option was expanded on through the question that asks "how so?" It is useful to exploit this feature rather than clutter up nodes with too much information. Of course, at the other end one could end up splitting up points too finely and end up with a proliferation of nodes. Clearly, the facilitator needs to exercise his or her judgement on how points are elaborated.

- The process of mapping slowed the discussion down in two ways. First, I needed to interrupt participants to seek clarifications on specific points. Second, once participants started to engage with the map, they tended to think their arguments through more carefully than they would have otherwise. Since both these factors contribute to better decisions, the slowing down is an advantage rather than a shortcoming (Buckingham Shum et al., 2006).

- The notation shows connections between different points visually. Apart from improving the quality of the debate (Van Gelder, 2003), it also serves as a short-term memory aid for the group – there is less chance that points discussed earlier in the meeting will be forgotten or ignored.

- Finally, the process of dialogue mapping improves inclusiveness of the discussion in that it encourages people to participate. Once people see that their points are being noted down, with equal weight given to everyone's viewpoints, they become more enthusiastic about participating in a collective effort to understand the issue. The case study covers only a small section of the discussions that we had that day. However, it is representative of how we tackled

each of the issues shown in Figure 3. In each case, we were able to achieve a shared understanding of the issue and come to a collective decision about it.

At the end of the day, all participants felt that group had made considerable progress in developing a collective understanding of the data harmonization efforts: we had a good idea of what we needed to do and how we would do it. In the end, though, the best testament to the success of the method is that I received requests for more information on IBIS and dialogue mapping from a few of the participants.

5.2 Analysis
The question of how simple notations such as IBIS can have such a huge positive impact on design discussions has been addressed recently (Selvin *et al.*, 2010). Among other things, Selvin *et al.* suggest that the practice of dialogue mapping (and other modes of participatory design rationale) can be understood by analyzing the dynamics of the mapping process via the following dimensions:

· *Aesthetics.* How practitioners shape the representation.
· *Ethics.* How practitioners' actions affect others.
· *Narrative.* The flow of the discussion; the story it tells and the implied cause-effect relationships.
· *Sensemaking.* The ways in which disruptive or unstable events are dealt with.
· *Improvisation.* The creative moves a practitioner makes (i.e. going beyond the book).

According to Selvin *et al.*, each of these factors affects how the map develops and the issues depicted in it are resolved.

Seen in light of the Selvin model, it is clear that my actions at specific points in the discussion had an effect on the final representation and decision. I will describe a couple of instances to underscore this point.

First, a basic tenet of dialogue mapping is to avoid suggesting answers within questions: for example one would prefer "what is the best approach?" over "what is the preferred approach – A or B?" Being conscious of this, I removed all answers suggested within questions prior to noting them on the map. This had an effect on the form of the representation (aesthetics), but also avoided restricting the group's choices (ethics). Second, the project that forms the basis of the case study is a top-down initiative, primarily driven by a corporate mandate to harmonize and centralize data. Yet, all participants realized that the project would not succeed without the involvement of end-users (the users at individual affiliates). On the face of it, this is a contradictory requirement – but it is one that was resolved by the collective realization that we could indeed satisfy both parties (sensemaking, improvisation and ethics).

These are just a couple of examples to show how dialogue mapping sessions can be analyzed. My intent here is not to offer a deep analysis of the discussion, but to illustrate the ways in which dialogue mapping improves upon other commonly used methods of deliberation in project environments. The work of Selvin *et al.* is one of the few that focus on the dynamics of participatory design sessions: how practitioners actually work, and the moves and choices they make. This area remains relatively unexplored and offers opportunities for future research.

5.3 Shortcomings of the notation
Of course, IBIS is no panacea; it has its own shortcomings. I list some of the more obvious ones that I have noticed in practice. Many of these have been noted before (Conklin and Begeman, 1988):

- Maps can get unwieldy very quickly. The best way to deal with this is to break up discussions into several sub-maps.
- The chronological sequence of the dialogue is not preserved. In my experience, this is a problem only if there is disagreement over the final map.
- Contributions are not attributed. This is generally a benefit, as it reduces conflict over contentious issues. However, it can be a drawback when one wants to know who made a particular point in a past conversation.
- Over splitting of ideas. Sometimes the big picture can be lost in a morass of issues, ideas and arguments.

As with all techniques, many of the shortcomings can be addressed by mindful use of the method. Such an awareness is best developed through practice.

5.4 Why competing notations do not work as well as IBIS
In this paper, I have illustrated the utility of IBIS in facilitating and improving the quality of communication in deliberative discussions on projects. Of course, there are other notations that are similar to IBIS, and I would be remiss if I did not mention them. Some of the better known notations are: questions, options, criteria (QOC) (MacLean *et al.*, 1991); decision representation language (DRL) (Lee, 1989) and argument mapping (Van Gelder, 2002). Although these notations have a similar intent to IBIS, they have not been widely used to map discussions in real time. One reason for this is that the competing notations use non-intuitive representations for nodes. For example, QOC uses rectangles to denote all elements and DRL uses a range of geometric shapes. In both cases, the meaning of a particular node is not immediately obvious – participants have to consciously think about what a particular node represents. In contrast, the meaning of IBIS nodes is immediately obvious through the use of intuitive icons rather than geometric shapes. A second reason is that the competing notations (barring argument mapping) are unstructured – it is difficult to figure out where to begin reading the map. In contrast, IBIS maps are always read from left to right, so it is possible to understand the essence of a discussion at any point during the conversation. This is immensely helpful in meetings. Finally, argument mapping, though structured, is generally geared towards assessing the relative "worth" of arguments for and against a proposition. It is therefore suitable for drilling down into specific ideas and their pros and cons, but not for mapping entire dialogues. I should point out that although there is existing research on the relative merits of the notations discussed above (Stumpf, 1998), the issue is not settled definitively, and remains open for further work. Further, as far as I am aware, none of the techniques mentioned in this section have been evaluated for use in project environments. This too presents opportunities for further study.

Of course, visual notations are not the only game in town: there are other techniques of participatory deliberation and design, some of which may be more familiar to project management professionals and researchers (scenario-based design, Rosson and

Carroll, 2002). It is worth noting that despite the plethora of techniques available, there has been little research on done on the relative efficacy of these. Comparative studies on these methods thus offer avenues for future work.

6. Conclusion

The case study discussed in this paper, though simple, is illustrative of how dialogue mapping works and its potential utility in project management. I would like to emphasize that the technique is easy to learn – I was able to start mapping small informal meetings right after learning the grammar (Figure 2) and playing around with compendium for a day or two. One of my aims in writing this paper was to provide a short introduction to IBIS that would serve as a starting point for project managers interested in using the technique at work (Section 3). Those interested in learning the fine points of the craft should refer to Conklin's (2005) book and the references therein. There are also a number of online articles and tutorials on the technique – a search using keywords "dialogue mapping" and "ibis" will reveal some of these.

Of course, small informal dialogues are one thing; large, conflict-ridden meetings involving diverse stakeholders quite another. Mastery at mapping the latter takes considerable practice and experience. However, most of the problems encountered on projects lie in between the two extremes – they are neither trivial nor truly wicked. I submit that the case study is a fairly typical example of a conversation that takes place in the project meeting room. So, in closing, I reprise my main objective, with the hope that I have succeeded in stimulating the interest of researchers and practitioners in the use of IBIS in mapping project dialogues.

References

Buckingham Shum, S., Selvin, A.M., Sierhuis, M., Conklin, J., Haley, C.B. and Nuseibeh, B. (2006), "Hypermedia support for argumentation-based rationale: 15 years on from gIBIS and QOC", in Dutoit, A.H., McCall, R., Mistrík, I. and Paech, B. (Eds), *Rationale Management in Software Engineering*, Springer, Heidelberg, pp. 111-32.

Conklin, J. (2003), "Dialog mapping: reflections on an industrial strength case study", in Kirschner, P., Shum, S.J.B. and Carr, C.S. (Eds), *Visualizing Argumentation: Software Tools for Collaborative and Educational Sense-making*, Springer, London, pp. 117-35.

Conklin, J. (2005), *Dialogue Mapping: Building Shared Understanding of Wicked Problems*, Wiley, Chichester.

Conklin, J. and Begeman, M.L. (1988), "gIBIS: a hypertext tool for exploratory policy discussion", *ACM Transactions on Information Systems*, Vol. 6 No. 4, pp. 303-31.

De Liddo, A. and Buckingham Shum, S. (2010), "Capturing and representing deliberation in participatory planning processes", paper presented at Fourth International Conference on Online Deliberation (OD2010), Leeds, 30 June-2 July, available at: http://oro.open.ac.uk/22279/1/DeLiddo-BuckinghamShum-OD2010.pdf (accessed 15 August 2010).

Kunz, W. and Rittel, H.W.J. (1970), "Issues as elements of information systems", Working Paper No. 131, Studiengruppe für Systemforschung, Heidelberg.

Lee, J. (1989), "Decision representation language (DRL) and its support environment", Working Paper No. 325, MIT AI Lab, Cambridge, MA.

MacLean, A., Young, R.M., Bellotti, V. and Moran, T. (1991), "Questions, options, and criteria: elements of design space analysis", *Human-Computer Interaction*, Vol. 6, pp. 201-50.

Project Management Institute (2008), *A Guide to the Project Management Body of Knowledge*, 4th ed., Project Management Institute, Newtown Square, PA, pp. 243-71.

Rith, C. and Dubberly, H. (2007), "Why Horst W.J. Rittel matters", *Design Issues*, Vol. 23 No. 1, pp. 72-91.

Rittel, H.W.J. and Webber, M. (1973), "Dilemmas in a general theory of planning", *Policy Sciences*, Vol. 4, pp. 155-69.

Rosson, M.B. and Carroll, J.M. (2002), "Scenario-based design", in Jacko, J. and Sears, A. (Eds), *The Human-computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications*, Chapter 53, Lawrence-Erlbaum Associates, London, pp. 1032-50.

Selvin, A., Buckingham Shum, S. and Aakhus, M. (2010), "The practice level in participatory design rationale: studying practitioner moves and choices", *Human Technology: An Interdisciplinary Journal on Humans in ICT Environments*, Vol. 6 No. 1, pp. 71-105, special issue on Creativity and Rationale in Software Design.

Stumpf, S.C. (1998), *Argumentation-based Design Rationale – The Sharpest Tools in the Box*, Research Note RN/98/103, Computer Science Department, University College London, London.

Van Gelder, T. (2002), "Argument mapping with reason!able", *The American Philosophical Association Newsletter on Philosophy and Computers*, Vol. 2 No. 1, pp. 85-90.

Van Gelder, T. (2003), "Enhancing deliberation through computer supported argument mapping", in Kirschner, P.A., Shum, S.J.B. and Carr, C.S. (Eds), *Visualizing Argumentation: Software Tools for Collaborative and Educational Sense-making*, Springer, London, pp. 97-115.

Williams, T. and Samset, K. (2010), "Issues in front-end decision making on projects", *Project Management Journal*, Vol. 41 No. 2, pp. 38-49.

Corresponding author
Kailash Awati can be contacted at: kailash.awati@boehringer-ingelheim.com