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Joint Knowledge Base: A Key to Knowledge Sharing and Collaboration

Marco Bettoni[1] and Eddie Obeng[2]

[1]Steinbeis Consulting Center Knowledge Management and Collaboration, Basel, Switzerland

[2]Pentacle Virtual Business School, Buckinghamshire, UK

marco.bettoni@weknow.ch

Eddie_Obeng@pentaclethevbs.com

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Abstract: Knowledge sharing is a key to successful collaboration (online or in presence) and since collaboration is changing due to increasingly emerging so-called “New Collaboration”, so knowledge sharing should change accordingly: we call this New Knowledge Sharing. Organisations wishing to exploit the potential of New Collaboration need to understand how the new knowledge sharing and collaboration are related and in particular, how they actually proceed; the very steps of their interwoven process. During the course of our previous work, the concept of a Joint Knowledge Base (abbreviated to JKB) emerged and became more and more prominent as a key to knowledge sharing. Thus, in this paper, we will first revise and elaborate our concept of a JKB in more detail. We will see how, on the one hand, when working on a shared task each collaborator contributes to its construction and how, on the other, the JKB functions as an *interaction bridge*, and this is why it is a key to knowledge sharing. Secondly, we will describe different opportunities for partners in an interaction (team meeting, workshop, creative session, etc.) to contribute to the creation of a JKB by means of so-called “Distributed Contribution Tools” (DCT) which are standardised artefact-mediated interaction methods developed by E. Obeng. In particular, this second part will present 6 such DCTs and explain how they contribute to the JKB by means of a socially distributed production.

Keywords: knowledge sharing, new collaboration, joint knowledge base, collaboration process, artefacts-mediated interaction

1. Introduction

Collaboration, “the direct and mutually influential active confrontation of two or more people, oriented toward common goals, to solve or master a task or problem” (Stoller-Schai 2021) is changing: in fact, a new way of collaborating is increasingly emerging. We call it “New Collaboration” (Bettoni et al. 2018). One main difference from traditional collaboration is that new collaboration is knowledge-based: it requires the individual knowledge of the collaborators to be integrated into a shared knowledge structure, which we have called a “Joint Knowledge Base” (JKB). Unfortunately, organisations utilise only a small percentage of the potential of New Collaboration. The problem is that the new knowledge sharing, on which the collaboration is based, is not easy to understand. Firstly, you need to be aware that a JKB plays an essential role and take this seriously. Secondly, you must acquire an understanding of how to develop and maintain the JKB and of how the interwoven process between this JKB and new collaboration works. Last but not least, you need to understand learning (and innovation in general) not only as a form of knowledge acquisition (cognitive process) and participation in a social community (social process) but also as collaborative knowledge creation (Paavola et al. 2004), a combination of cognitive and social processes, based on the notion that participation in social activities benefits cognitive processes (Du Chatenier et al. 2009).

2. Previous Work

Recently, in 4 ECKM papers (2017-2020), we developed a few foundations on which to base this understanding. We first looked at certain weaknesses in the conventional understandings of the concepts of “knowledge sharing” and “collaboration” and proposed some improvements (Bettoni et al. 2017). We then further elaborated those improvements and developed an understanding of the essence of collaboration that we called “knowledge-based and community-oriented” (Bettoni et al. 2018). The main difference between traditional collaboration and new collaboration lies in the fact that the task is no longer divided among the people who collaborate and therefore the required knowledge should also be unified; hence the *essential need to share* the knowledge required to carry out the task among all the collaborators.

This notion enabled us during a third step to formulate the so-called Pyramid Principle of Collaboration which claims that collaboration will be engaging, inclusive, empowering and high-performance if it is organised according to a pyramid of seven layers (Bettoni & Obeng 2019). Based on this structural model, we finally looked at some of its layers in more detail (Bettoni & Obeng 2020). We argued that conversation is not sufficient for exploiting the potential of collaboration and proposed the concept of *artefact-mediated interaction* (the 3rd layer of the pyramid) as a solution to this problem.

In the following, we will revise and elaborate this *interaction approach* in more detail by means of two models: a cyclic model of individual knowledge construction called the *Individual Knowledge Loop* (IKL) and a cyclic model of collaborative knowledge construction called the *Collaborative Knowledge Loop* (CKL). These two models will enable us to deepen our understanding of how each collaborator in the interaction contributes to the construction of a JKB and to suggest, on the other hand, how the JKB functions as a basis for accomplishing the shared task.

3. The Construction of a Joint Knowledge Base

The term *Joint Knowledge Base* (JKB) indicates the shared knowledge structure which is constructed and maintained during collaboration on a shared task (new collaboration). According to Roschelle and Teasley (1995:76), collaborators interact through *language* (*conversation), physical action and combinations of words and action*. During these collective activities, each collaborator contributes to the construction of the JKB relating to the task in hand through their unique knowledge. And at the same time, the JKB functions as a basis for accomplishing the shared task on which the group is working and can also be seen as an essential condition for transforming unique, individual knowledge into shared knowledge (Fig. 1). The JKB collects and organises a set of knowledge elements into a system which emerges during interaction as part of the group working together.

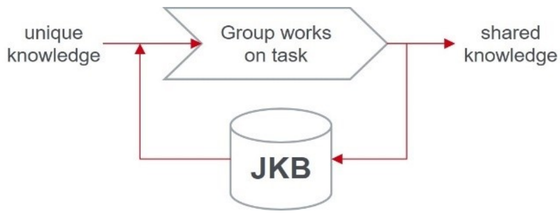

Figure 1: Group working on a task – a transformation from unique to shared knowledge

Laughlin (1980) proposed a *group task continuum* anchored in intellective and judgmental tasks where *intellective tasks* have a demonstrably correct solution whereas *judgmental tasks* are evaluative judgments for which there is no generally accepted demonstrably correct answer. In the VUCA business world, more and more groups are facing *knowledge-intensive* tasks (Bettoni 2000) which are *judgmental* rather than *intellective*. In his study of group problem-solving, Laughlin (2011) further distinguishes 9 additional group task characteristics: additive, compensatory, conjunctive, disjunctive, complementary, divisible, unitary, maximising and optimising. The new collaboration discussed in this paper involves *knowledge-intensive*, *judgemental* tasks which are also *complementary* (combine different abilities, skills, knowledge), *unitary* (cannot meaningfully or efficiently be divided into subtasks and assigned to different group members) and *optimising* (do not have objective suitability criteria).

3.1 A Cyclic Model of Individual Knowledge Construction

Before being shared, any knowledge element must be constructed by an individual group member (collaborators). As a consequence, in order to understand knowledge sharing, we first of all need *a process model* for individual knowledge construction, at least a simple one. The construction of knowledge can be seen as an essentially cyclic process, like a control loop (learning loop). In fact, according to Piaget's theory of cognitive development (stage theory), knowledge begins to be developed during the first stage (birth to 2 years) through so-called *sensorimotor learning*, the essential dynamics of which are cyclic, a kind of control loop called a "circular reaction" (Piaget 1936). For example, between 1 and 4 months, infants are interested in their bodies and try to reproduce an event that they like (e.g.: sucking thumb). These behaviours had been seen as cyclic and called a "circular reaction" by Baldwin (1894) because the action produces the same stimulation which triggers the same action. Piaget saw the importance of this cyclic concept and further developed it by introducing primary, secondary (4 to 12 months) and tertiary (12 to 18 months) circular reactions (Piaget 1936). Later, through his concepts of equilibration and self-regulation (Piaget 1967), he even made circularity the foundation of his theory of knowledge, also called "constructivism".

Thus, our simplified model of individual knowledge construction will also be cyclic (Fig. 2) and to keep it as practical and simple as possible (but not too simple), we will use a circular process as a basic configuration, inspired by a famous, practice-oriented cyclic process: the so-called Deming cycle (Moen & Norman 2009).

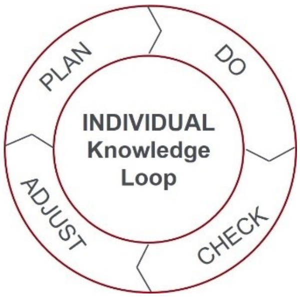

Figure 2: Cyclic model of individual knowledge construction (adapted from the Deming cycle).

According to this model that we call the Individual Knowledge Loop (IKL), the construction of a knowledge element begins by planning (step PLAN) whereby expectations and other constraints are defined. During the second step (DO), the knowledge element is constructed and in the third step, its *viability* is then checked (step CHECK): does it comply with the constraints of step 1 and is it consistent with the current individual knowledge base (IKB)? If the knowledge element is found to be viable, then it will be introduced and assimilated as it is into the current IKB, otherwise further cycles will run (accommodation) during which the element itself will be modified (either by adjusting the planning or the doing) or else the IKB will be adapted and then viability will be checked again. The cycle will repeat itself until the knowledge element is found to be viable.

3.2 A Cyclic Model of Collaborative Knowledge Construction

When a group of collaborators come together and interact, they will obviously bring with them and make use of their individual knowledge loops. In order to be consistent with these individual cycles, the collaborative knowledge construction should also be cyclic. Thus, we suggest a model of collaborative knowledge construction that is also cyclic and structured based on a loop of the same 4 steps: plan, do, check and adjust (Fig. 3). We call it a Joint Knowledge Loop (JKL).

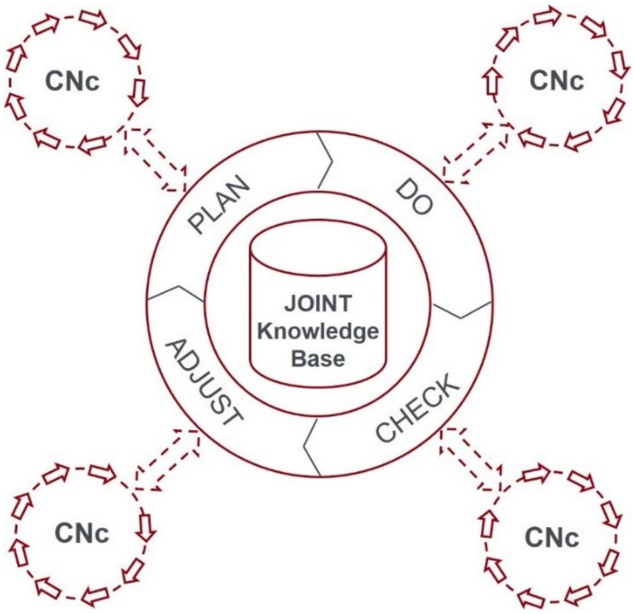

Figure 3: Cyclic model of collaborative knowledge construction

In order to engage all group members, each of the 4 steps of the JKL should be *spread across the turns* of a "Contribution & Negotiation circle" (CNc): one after the other, each participant has the chance to provide their contribution to the step in hand. So, for example, the planning step is carried out via a sequence of turns whereby each participant can *contribute* some constraints and by a *negotiation* in which the group agrees on a shared version of the constraints.

Compared with the IKL, this Collaborative Knowledge Loop (CKL) has three additional activities: 1) detecting divergence across collaborators by *monitoring* ongoing interpretations of knowledge elements and *comparing* them with the intended interpretations for determining whether these fit (CHECK step); 2) *modifying* existing elements when divergence arises during collaboration (ADJUST step); 3) *rectifying* intended interpretations when there are conflicts (meanings do not fit).

During the course of such a collaborative construction (co-construction) of knowledge, each collaborator builds and maintains his/her own knowledge base so that, in a group, we have as many knowledge bases involved as there are collaborators. But the overall shared goal of working with the other collaborators on the same shared task leads to the emergence of *shared knowledge* within these individual knowledge bases: areas of knowledge which mutually converge (and resonate).

3.3 A Distributed Knowledge System

Thus, the Joint Knowledge Base does not exist in a single place; instead, it is *a distributed knowledge structure* made of the converging parts found within the individually constructed knowledge elements. In our view, the IKB and the JKB are knowledge systems in the sense of Immanuel Kant's definition of knowledge: "*A system of compared and connected mental constructs*" (Kant 1781/1787, A97, own translation). Thus, an IKB or a JKB are much more than simply a repository and contribute a greater functionality to cognition than just a memory system.

In analogy with the Artificial Intelligence concept of a knowledge base (Feigenbaum 1977), we suggest devising an IKB and a JKB as a system constituting two sub-systems: an Objects System (ObS) and a Methods System (MeS). The ObS is what collects and integrates the *pieces* of our individual experience and the MeS is what collects and integrates structures, rules, action schemes and all the other *ways of connecting* the pieces of the OBS. Together, the ObS and the MeS implement the essence of our experiential world: "*The only world we consciously live in*", based on the assumption that "*The thinking subject has no alternative but to construct what he or she knows on the basis of his or her own experience*" (von Glasersfeld 1995:1). This experiential world is a system of experiential coherences "*that the organism builds up in the attempt to order the, as such, amorphous flow of experience by establishing repeatable experiences and relatively reliable relations between them*" (Glasersfeld 1984; Bettoni 2007).

3.4 Shared Knowledge Element

When can we say that a knowledge element of an IKB has become part of the JKB and can be considered as "shared"? In order to be accepted as constitutive parts of the JKB, knowledge elements must be evaluated as *meaningful* by the group. The *meaning* that they must have is not simply a specific relationship between a sign and a reference (lexical meaning) or a grand principle of reason or ethics (philosophical meaning). They must *make sense* to the group in practical ways, especially in relation to the professional experience of each group member. This is why the knowledge elements can enter the JKB only if they successfully pass through a 'sensemaking' process called a *negotiation of meaning:* an interactive process which comprises two highly interwoven activities, participation and reification (Wenger 1998) and which is the first of the two main components of *cognitive presence* (Bettoni et al. 2018). In short: the element of an IKB of any group member must go through a process of group cognition and can enter the JKB only as a socially negotiated result of this process. When the negotiation of meaning succeeds, this leads to the emergence of knowledge areas among the group members which converge and resonate: the elements of these areas can then be considered as "shared" knowledge elements.

The fact that two or more individual knowledge elements are seen as *converging* does not necessarily imply that they exactly overlap or match in all their parts and across all the individual knowledge bases of the group members. It is sufficient if they *fit for the purposes* in hand. In this sense, we should speak more precisely of *taken-as-shared* rather than shared knowledge elements (Cobb 2000:166). It is in this sense that we speak of a "joint" knowledge base: the JKB is the distributed system of those knowledge elements whose meanings *converge and fit across group activities* and enable meaningful conversation, action and interaction in relation to the purposes which emerge step by step during collaboration on a shared task.

4. Boundary Objects

Collaboration will become more successful if the JKB becomes more and more representative of the group's knowledge. When it comes to co-constructing such a *representative* JKB, the 4 steps of the CKL must be distributed across the turns of 4 Contribution & Negotiation circles (see Fig. 3) and this is not easy to achieve! When people engage in conversations and debates for contributing knowledge elements and negotiating their meaning, one of the main difficulties is represented by an *obstacle* called the "semantic boundary", one of three types of knowledge boundaries (Carlyle 2002). Even if a shared language is present which enables the *syntactic boundary* to be overcome, "interpretations are often different" (Carlyle 2002: 444). Interpretations are different because differences in experience among participants have created different *experiential worlds* (von Glasersfeld 1991) and these lead to different conceptualisations and interpretations. Thus, conversation and debate are not enough for making communication and collaboration successful during a CKL.

How could we overcome the semantic boundary? When studying heterogeneous problem-solving by scientists of different disciplines, Star (1989) observed that they were nonetheless able to successfully collaborate and attributed this to what she called "boundary objects": objects that enabled those scientists to establish shared context (Star 1989:47) like, for instance, artifacts, documents, terms, standardised forms and methods, models and other forms of reification (Wenger 1998:105).

5. Distributed Contribution Tools (DCT)

By considering boundary object research as well as its various applications to knowledge interactions (Carlyle 2002; Huang & Huang 2013) and from our own experience with the QUBE system (a 3D collaborative virtual environment) (Pentacle 2019), we have been able to see in a new light the Performance Enhancing Tools (PETs) developed by E. Obeng for the QUBE system (Obeng 1994; Obeng 2003; Obeng & Gillet 2008): we now see a QUBE PET as a boundary object, more specifically as a Distributed Contribution Tool (DCT).

A DCT is a *standardised, artefact-mediated interaction method* composed of a pinboard, a kind of poster (see Fig. 4, 5, 6) and by documentation which describes "what is it?", "why do I need it?", "when do I use it?" and "how do I use it?" It corresponds to what is often called a collaboration pattern in literature (Eppler & Schmeil 2010). What is special about a DCT is that the collaboration involved is always an artefact-mediated interaction (at the pinboard) and that it functions as a boundary object, thus enabling collaborators to establish shared context and to contribute to the steps of a CKL. Interaction by means of a DCT follows the Metaplan technique (Schnelle, 1978) where collaborators meet in front of a panel which holds a structured pinboard (poster); all the participants write their ideas on cards, place the cards on suitable areas of the panel, point to items and ask questions or explain their own ideas. A group member acts as facilitator for the conversation and organises the cards into clusters accordingly.

To construct a representative JKB, it is not sufficient to establish shared context among participants; you also need to lead and facilitate the interactions in such a way that each group member has the opportunity to contribute, feels included and becomes emotionally engaged (socially distributed contribution). This can be supported by traditional facilitation tools (Kaner 2014) but this facilitation alone is not enough. We need to include boundary objects by means of a more systematic approach. Thus, in our approach we suggest using a well-selected sequence of boundary objects of the QUBE system during a group meeting where each functions as a DCT.

During a collaboration event, each DCT provides a generic set of knowledge elements (ObS and MeS) based on the structure of its pinboard (see Fig. 4, 5 and 6) which function as catalysers of the interaction, thus guiding the construction of shared knowledge elements along clearly defined pathways and making the negotiation of meaning more efficient and effective.

A well-designed collaboration event should start with *inclusion*, should provide *orientation*, must be aware of any affected *stakeholders*, needs to consider the involved *change*, requires *actions* to be taken and should finally be *assessed* (evaluated). Based on this generic collaboration framework of six steps, we have selected a standardised method of QUBE for each step as a suitable DCT (boundary object):

- For inclusion and orientation: Hopes&Fears™ and 5Ps™;
- For stakeholders and change: FindingStakeholders™ and GapLeap™;
- For action and assessment: StickySteps™ and Here2There™.

5.1 Inclusion

The DCT called Hopes&Fears™ (Fig. 4) has a pinboard divided in three fields: on the left, a box for the fears, on the right a box for the hopes and below, a box for ways for overcoming the fears. This is a great way to initiate any new activity with stakeholders, especially if there is lots of uncertainty in the goals or methods.

Working with this DCT helps with the first steps of inclusion in teambuilding; it contributes to emotionally engaging team members from the start, helping them to define shared goals, agreeing early on what does and does not fall within the scope, agreeing on what are hard and what are soft success criteria, identifying risks and creating the basis for a common project culture. This DCT should be used at the start of any meeting with new or existing stakeholders (especially where there is uncertainty).

5.2 Orientation

The DCT called 5Ps™ (Fig. 4) provides a way of formulating the essential aspects of a message, task or action. The pinboard is divided in two fields. The box on the left is for the unstructured, spontaneous description of an idea, message or task. The box on the right is structured into 5 fields: Purpose, Principles, People, Process and Performance.

Working with this DCT helps to avoid misunderstandings and communicate clearly about complex issues, like the core elements of a project, problem or solution. It should be used at milestones when the group needs to reflect on the project, task or action and gain a clearer view of its essential aspects as well as every time a team member or stakeholder receives instructions to act independently.

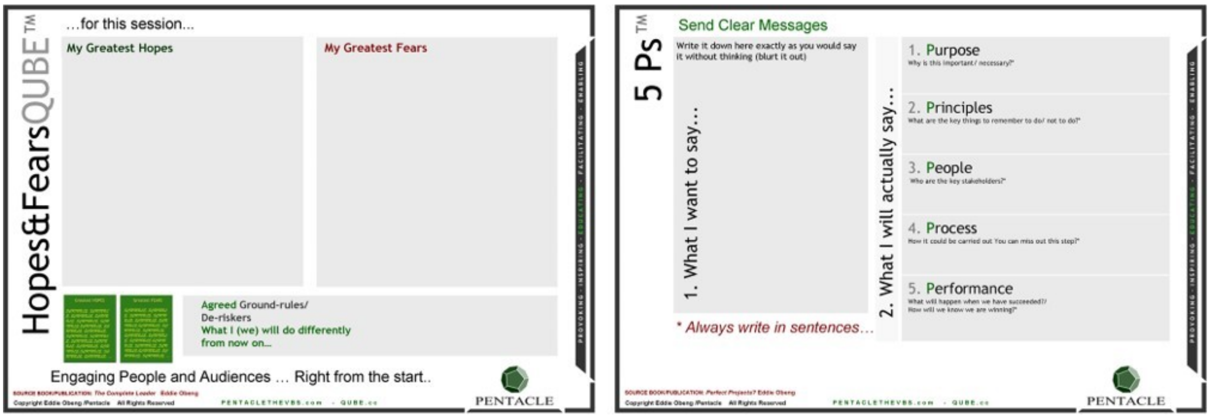

Figure 4: Boundary objects for inclusion and orientation (www.pentacle.co.uk)

5.3 Stakeholders

The pinboard of the DCT FindingStakeholders™ (Fig. 5) shows a typical "window", an area divided in 4 equal sub-areas. The two columns enable two main categories to be distinguished: A) people who will benefit from the project or action, B) people who will be damaged by the project or action. Then the two horizontal rows further divide the two groups by distinguishing whether the project: 1) could happen without them or 2) could not happen without them. This DCT is a quick way to identify the relevant stakeholders and ensures that you will never surprise them. It should be used at the start of the project and at all subsequent review points when you are looking at additional activities needed to deliver the overall project.

5.4 Change

The GapLeap™ pinboard (Fig. 5) is divided in the middle into two main horizontal areas by means of a row called the "gap". This is an area for expressing the difference between the current and the envisaged situation in a short statement. The top left area, called IF NOT FIXED, is for establishing what will happen if the current situation remains unchanged and the top right area for what will happen if the envisaged situation is implemented. The area below the middle row requires a reason as to why the gap has not yet been fixed. After entering their contributions in the four areas, the team will be invited by the facilitator to decide on a time horizon, assign costs and calculate the difference between the costs of IF NOT FIXED and IF FIXED. In a fast-changing, complex world, a team will often identify the need for change. This DCT provides a way of becoming aware of that change and gaining a broad understanding of why change needs to happen and what specifically needs to be done. It should be used every time a team needs to test or justify the need for change and has to present financial numbers or benefits for its business case.

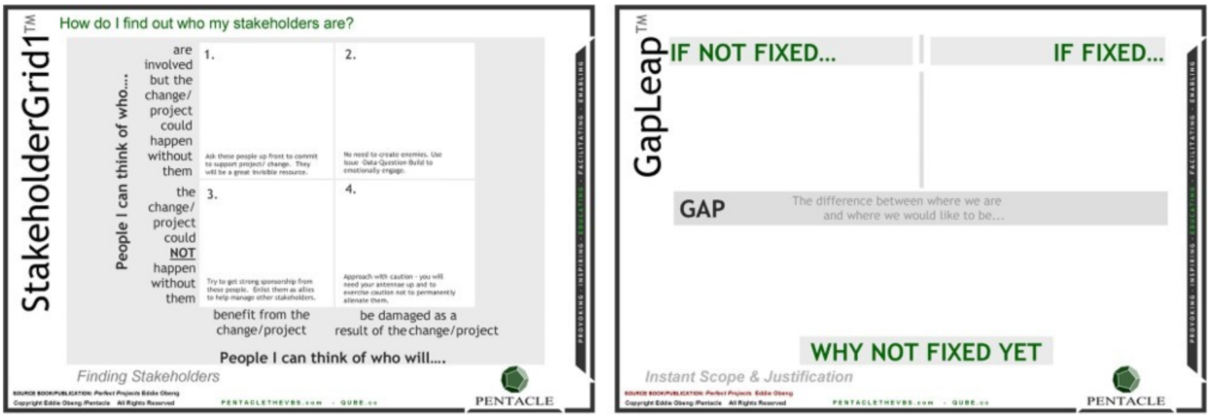

Figure 5: Boundary objects for stakeholders and change (www.pentacle.co.uk)

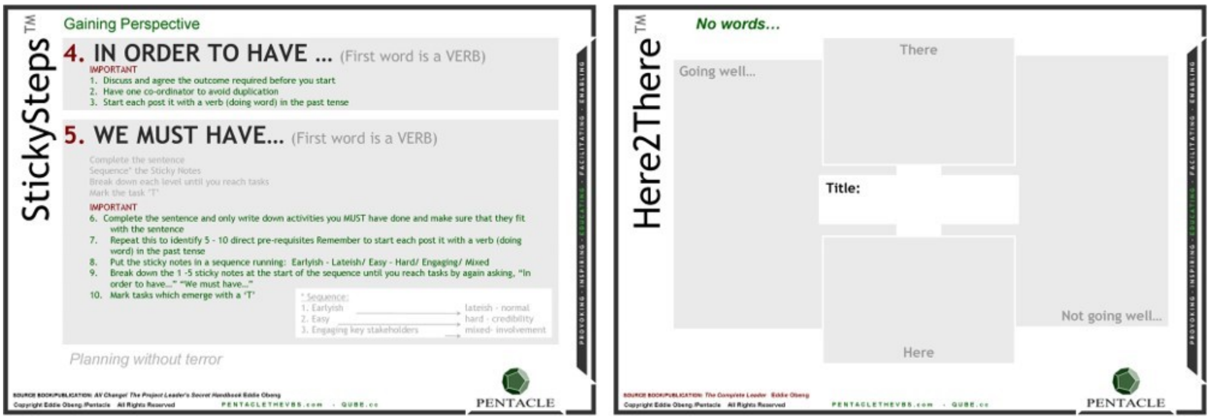

Figure 6: Boundary objects for action and assessment (www.pentacle.co.uk)

5.5 Action

The DCT called StickySteps™ (Fig. 6) displays a simple pinboard with just two areas; a row on the top for expressing the overall goal and a large area below this row for breaking down the overall goal of the action into the means required to achieve it. If one or more actions in this lower area are still too large, the team repeats this step by adding a lower breakdown level; the breakdown continues until you reach tiny, little steps (tasks). This DCT provides a quick and effective way to plan a project or action whenever they are almost too large to contemplate. This kind of breakdown (goal to action) allows interdependencies between parts of the project, action or task to be dealt with appropriately.

5.6 Assessment

The Here2There™ pinboard (Fig. 6) offers four equal areas on three levels for performing a very quick progress review to be used at frequent, short review events, for instance in regular, weekly meetings when the team wants to update every member on the principal outcomes achieved. No words are allowed! The participants are advised to use images and metaphors to describe: 1) their current state (field “Here”); 2) where their journey should end (field “There”); 3) what’s not going well; 4) what’s going well.

6. Conclusion

During collaboration on a shared, unitary task (new collaboration), a distributed knowledge structure is constructed, maintained and shared: we call it a *Joint Knowledge Base* (JKB). It collects and organises into a system a set of shared knowledge elements which emerge during interaction within a group working together on a knowledge-intensive group task. Thank to this, the JKB facilitates communication and collaboration: it functions as an interaction bridge.

But making such a bridge *representative* of the group's knowledge is not easy! As a solution to this problem, we have suggested: a) a cyclic model of collaborative knowledge construction; b) the Contribution & Negotiation circle as the interactive process a knowledge element must go through in order to be allowed to enter a JKB; c) an inner structure of the JKB, distinguishing pieces of knowledge (Objects System, ObS) and ways of connecting these pieces (Methods System, MeS); d) Distributed Contribution Tools (DCT) as *boundary objects* that enable group members to establish shared context by means of artefact-mediated interaction.

A set of six DCTs (for *inclusion, orientation, stakeholders, change, actions and assessment*) has been presented which makes it possible to see how, in principle, to structure a well-designed collaboration event as a sequence of artefact-mediated interactions. The DCTs, based on the structure of their pinboard, provide an initial set of explicit knowledge elements (ObS and MeS) that all group members can use as demarcations guiding the flow of the interaction. This channels the construction of shared knowledge along explicitly defined pathways, thus making the Contribution and Negotiation cycles more efficient and effective. Eventually this leads to a distributed Joint Knowledge Base which is representative of the group's knowledge.

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