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# Organisational Learning in the UK Construction Industry: A Knowledge Management Approach

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**Abstract-**This paper describes the work of an EPSRC (Engineering and Physical Sciences Research Council) and DETR (Department for the Environment and the Regions) funded research project – B-Hive (Building a High Value Construction Environment). The research sought to further develop partnering initiatives in the construction industry through learning and reflection. Review processes and appropriate information systems were created to share and store knowledge and assist with the task of more closely integrating the activities of companies which collaborate on construction projects. It is envisaged that these new processes will help in the creation of a more open, co-operative and less confrontational culture that will enable project participants to learn from both collective experience and the knowledge of individuals. Reflection upon this work has enabled us to propose our own knowledge categories of soft knowledge and interpretative knowledge which may be useful for the formulation of knowledge management strategies.

## I. INTRODUCTION: Key Problems in Construction and the Focus of the Research

This paper describes an action research project involving: two major construction clients, a privatised utility company (Thames Water) and a major leisure services provider (Whitbread Hotels); a large construction company (Taylor Woodrow); two leading construction consultancy firms; and London School of Economics and Leeds Metropolitan University. The research method, action research, was particularly appropriate for this project because it promoted learning and understanding through action and reflection culminating in the production of an approach that facilitates organisational learning.

The research addresses the problem of fragmentation in the construction industry. This issue is well documented [19], [11] as being a critical barrier to change since it is seen as a major factor in the poor communications between parties working together on construction projects. The construction industry is organisationally complex and highly fragmented with more than 95% of companies being small to medium sized enterprises [13]. In addition, the construction industry suffers from supply chains and relationships that are both dynamic and transient as a direct result of the temporary nature of construction projects, resulting in a poor communication structure. In 1994 The Latham Report [19]

recorded that there were 163,000 construction companies listed in the DETR's statistical register, most employing less than eight people.

This fragmentation means that the ownership and control of separate functions and their associated processes in a construction project lifecycle resides in the hands of separate organisations with their own distinctive cultures and working practices. There is ubiquitous recognition of the need to restructure the construction industry to overcome this problem by engendering a spirit of compromise and collaboration. Latham (ibid.) generally recommended a rationalisation of inter-organisation agreements and methods of communication and clearer definitions of roles and contract stages. Specifically, paragraph 6.43 of the report recommends that client and contractor enter into a partnering agreement. Under this arrangement, the parties agree to work together on a project

“in a relationship of trust, to achieve specific primary objectives by maximising the effectiveness of each participant's resources and expertise.”

Latham wished to create a team spirit, where co-operation replaced conflict, in order to reduce costs; although how this could work was not made clear.

The meaning of pioneering partnership is still being explored and negotiated within the industry and they represent an opportunity to change the *status quo* and bring about a paradigmatic shift in thinking, but much will depend on the strength of further initiatives if this shift is to be realised.

Concomitant to this fragmentation at the level of organisational ownership is the associated fragmentation at the level of project team membership which manifests itself in two ways. Firstly, the transient nature of team membership during the course of a particular construction project; teams are dynamic in that membership is constantly in a state of flux as individuals move between teams as and when their knowledge and skills are required. Secondly, the fragmentation that exists between projects means that a 'team' is rarely left intact to further build relationships on subsequent projects. Such continuity is essential if learning benefits are to be realised [4].

Egan [11] points to the crucial importance of providing this kind of continuity in team composition:

“The repeated selection of new teams in our view inhibits learning, innovation and the development of skilled and experienced teams” [11].

and

“A team that does not stay together has no learning capability and no chance of making the incremental improvements that improve efficiency over the long term” [11].

It is thus recognised that this fragmentation and instability has led to chronic knowledge loss when compared to other industries.

Similar recommendations to address this problem have come from two different sources. Egan [11] suggests that an objective, impartial “Knowledge Centre” (paragraph 85) be set up to provide access to information regarding good practices, innovations and experiences for any organisation or individual connected with the construction industry.

A closely allied concept to Egan’s “Knowledge Centre” is that of the PROCESS Protocol’s Legacy Archive. The PROCESS Protocol is a model of the construction process developed by an EPSRC funded research project, led by the University of Salford, which breaks down the design and construction process into ten phases. At the end of each phase, it is suggested a review be held, allowing the experiences of a project to be recorded and held in a ‘Legacy Archive’. The archive would be created and maintained, for access by later phases and future projects to aid the process of continual improvement.

The identification of a need for concepts such as the Knowledge Centre and the Legacy Archive appears to be a manifestation of the need for better communication: between individuals, between organisations and between the present and the future. It is recognition of the need to manage the organisations’ knowledge or, as it is now routinely referred to, intellectual capital. As the importance of knowledge management is becoming clearer, its role has begun to move from a supporting position to a strategic one.

The B-Hive project addressed this need by engaging in action research to design and provide a process, with appropriate information systems and technology support, which could be used to create and capture organisational knowledge. The process seeks to promote organisational learning and informed action through a process of analysis and reflection at various stages throughout the construction process.

This process – Cross Organisational Learning Approach (COLA) – is referred to throughout and, after discussion of its academic underpinning, is described in detail. Central to its production was the need to confront some fundamental questions: What is Organisational Learning? How can it be promoted? What is knowledge and how does it differ from information and data? How can it best be managed? These research questions are densely interrelated and the issues raised are primarily soft in nature. Satisfactory answers to these questions are hard to come by but any sensible knowledge management strategy demands that they be addressed. The problem requires holistic consideration of the

issues and does not readily lend itself to reductionist solutions.

## II. KNOWLEDGE AND THE COLA PROCESS

To start with knowledge, it is defined by Smith [29] as the

“understanding acquired through education and/or experience; anything that has been learned, discovered, inferred or understood; the ability to use information.”

That is, it is the ability to use that which has been learnt, experienced and reasoned. In this respect, it seems that learning is the process and knowledge is the product.

The concept of knowledge can also be explained by viewing it as occupying a superior place in a hierarchy in relation to data and information [1], [32]. By definition data is meaningless, but when processed into information it becomes more useful. For example, a database of a building firm may record a stock holding of “100 pieces of pine cladding 6ft x 4in x 1in”. This only becomes useful information when the various elements can be decoded and this would, of course, require an understanding of things such as: what pine is, what its qualities are, and the conventions for recording the dimensions of timber (length x width x thickness) - this taken-for-granted interpretative kind of knowledge (which is discussed later) is embedded in the social system. A richer understanding may be obtained by being able to apply information or ‘soft’ knowledge from different sources. For example pine cladding with a high moisture content is likely to shrink across its width when used in warm and dry conditions. Such information is readily codifiable. Socially constructed knowledge may be used by choosing to use this pine to clad the interior of a room because discussions with the client have revealed that they wish to fit out the house with natural materials. Knowledge is thus about the contextualisation and integration of information so that useful activity may be informed and performed.

While this hierarchy may be valid, Stewart goes on to explain that, since one person’s knowledge can be another person’s information or data, the hierarchy can not be neatly applied in real life. It is this confusion in terminology which makes the subject of knowledge management such a difficult one. On one level ‘knowledge’ is often used as a synonym for ‘information’ whilst there is also a general consensus that knowledge has second higher level of meaning. Thus when people talk about knowledge management they are sometimes using this synonymous meaning to talk about information management under a different guise. They are merely using the term knowledge management to signify that technology is going to be used to store softer information which previously did not lend itself to formal structuring and storage in computer based information systems. The advent

of newer storage and manipulation systems such as document management systems, hypertext and web based technologies has meant that these 'softer' types of information/knowledge can be tackled. There is of course nothing wrong in using the term 'knowledge' in this synonymous sense but it is important to be aware of wrongly assuming common understanding of meanings when tackling knowledge management issues. We could term this use of 'knowledge' as a synonym for 'soft information' as Knowledge Type 1 and shall refer to this as 'soft knowledge'.

At other times in knowledge management discussion the second, 'higher' level of meaning is used consciously or unconsciously. We may term this Knowledge Type 2. Knowledge type 2 is primarily concerned with practical knowledge. This implies that information has been assimilated, integrated with other categories of information and has or can be applied to solve a problem, accomplish a task or demonstrate a skill, so we can refer to this Type 2 knowledge as 'interpretative knowledge'. What makes interpretative knowledge so difficult to deal with is that it is potentially such a fragile commodity. It may reside in an individual, a group or collectively within an organisation. When interpretative knowledge belongs to a group or organisation, it has been socially negotiated or agreed and these agreements may be tacitly understood, informally approved or formally laid down in procedures. Such knowledge is often held as a complex mixture of all three forms. The social processes that allow this knowledge to be understood, utilised, transmitted and generated are subtle and difficult to analyse. They are, however, the most critical for any knowledge management strategy.

We can shift perception again and use a different categorisation for knowledge. Such a shift is akin to changing the viewing resolution on a microscope: the new lens enables us to view a complex commodity in a slightly different way. This categorisation divides knowledge into that which is explicit and that which is tacitly held. Explicit knowledge may be more readily structured and codified and may be stored in a number of repositories such as databases, spreadsheets, architects drawings, and libraries. It may often be imparted through the use of traditional learning methods [30]. Soft knowledge (Type 1) that is explicit may be more easily captured, stored and disseminated than that which is embedded as tacit knowledge.

Tacit knowledge is that which is stored in peoples' heads and is often communicated informally and is often the most valuable to an organisation. It is personal, being based on an individual's perceptions, values and intuition and is a significant part of the knowledge which defines an individual as an 'expert'. As such it is more difficult to formalise and record and can often be identified as Knowledge type 2. However, both explicit and tacit knowledge can exist as complex mixtures of both type 1 and type 2 knowledge.

These changes in perception about what constitutes knowledge are apposite issues within the context of knowledge management. The challenge within knowledge management is to decide when it is appropriate to change

knowledge types into forms which can be captured, manipulated, stored and communicated by a computer. This may involve converting tacit knowledge, which is not formalised and is therefore difficult to communicate to others into explicit knowledge which can be fully recorded, communicated and shared [34], whilst at the same time, being aware of that which may be lost in translation.

In order for organisations to learn it may be necessary to release the tacit knowledge that is stored in the heads of an organisation's 'experts' to the rest of the organisation, as opposed to being confined to their individual minds. The passing on of knowledge is an essential part of organisational life.

It may be necessary for an organisation to attempt to manage some categories of tacit knowledge, by capturing and converting it into a format (explicit knowledge) that allows it to be communicated to others. It can then be passed on as information (enhanced by experience) to those who may find it useful, fed back as consequences of others' actions and used to identify and exploit new opportunities. One objective is to provide a means by which appropriate tacit knowledge may be externalised and can be codified and thus be exchanged and, indeed, created through the process of reflection and discussion facilitated by the COLA review process. An information system has been developed to support this process and to record and disseminate appropriate forms of the learning which results from the review.

Such information is not normally readily available or easily found. Egan has recognised that it is the knowledge and experience of those that are engaged in the actual activities of an organisation that are vital to the improvement of, in this case, the construction industry. Drucker [8] agrees that feedback is the "primary key" and is the most important principle in learning. However the most important factor here is that individuals should *want* to 'formally' share their experiences, as well as dealing with their important daily tasks.

### III. INDIVIDUAL, COLLECTIVE AND ORGANISATIONAL LEARNING

The relationship between knowledge and learning can now be considered.

The knowledge and experience of an individual shapes the individual's actions through a process known as learning, enabling the individual to change and so deal more efficiently with similar situations and cope with, or invent, different approaches to new situations. Learning occurs when new information is compared to previously received information. The comparison is then reflected upon in order to evaluate a suitable behavioural route to the goals required.

Thus, there are internal and external aspects to learning. The internal aspects address how new information is

processed by the individual. External aspects cover the means by which new information is arrived at.

Information can be acquired by an individual using methods that are a combination of the two extreme learning methodologies: taught and discovery. Buckler [5] finds advantages and disadvantages in both. The taught method is useful for passing on solutions that may be copied and where conformance to specifications is required. The advantage of teaching is that it is a low risk method of passing on information in a consistent way. The disadvantage of prescriptive teaching - or rote methods of learning - is the increased potential it has for stifling motivation and reinforcing automatic responses to events that might otherwise have presented opportunities for learning.

In contrast, the Discovery method allows theories to be developed and followed through. It provides an opportunity to develop solutions individually thus allowing creativity and innovation. The drawbacks of discovering new information are that it can consume vast amounts of resources, is subject to a higher risk of failure and may allow the learning objectives to stray.

This raises the question of organisational learning. What is it? How can it be promoted? How do these theories relate to organisational learning? In order for an organisation to survive and grow, it must therefore be able to learn, yet as a conceptual entity, as Senge explains, "Organizations [can] learn only through individuals who learn". When an organisation's members consciously learn, and change their behaviour accordingly, the organisation itself can not be said to have learnt. It is only when the effect of an individual member's behaviour has a permanent effect on the behaviour of others within the organisation that it can be said that there has been a "mutual behavioural change" which therefore indicates "mutual learning". It is then that this organisational learning and the capacity to take organisational action, can be seen as an emergent property of that collective individual learning.

Senge identifies five 'disciplines' [28], as ingredients that are essential for a learning organisation. The first four disciplines are based around personal or individual qualities, such as a manner of thinking, a commitment to continuous discovery, a way of perceiving issues, encouragement and motivation and the use of shared views. The fifth discipline, however, deals with the culture of the organisation to provide the conditions that facilitate the creation of interpretative knowledge. It requires that an environment be established where the previous four disciplines are encouraged and can be practised; where there is a desire to operate collectively, there are no personal aspirations for gain nor any need for defensiveness. Senge believes that it is in such an open and learning environment, where new and different concepts can be raised and built on that groups, and therefore organisations, can learn. That learning thus becomes part of the organisational memory: this is sets of shared previous experiences which are important shapers of future action.

Epple, Argote and Murphy [12], in their discussion of knowledge acquisition and transfer, talk of this concept of an

organisational memory and promote Levitt and March's argument (in Epple et al.) that organisations not only learn from their own experience but from the experiences of other organisations (where individuals can pass on that information). As a result of such transfer of knowledge, the learning organisation is said to benefit by increases in efficiency.

In terms of the learning theories discussed previously, a learning organisation must allow both the Taught and Discovery methodologies to operate simultaneously. There must be opportunity for research, innovation and divergence from the 'normal' course and a provision for an amount of resources to be expended in this way. There must be an acceptance that there is no 'right' answer and an attitude that improvement is always possible and achievable. Nevertheless, there must also be a facility whereby information regarding the best current practice (which might be decades old or have been updated earlier the same day) can be accessed and copied or adapted. A mix of the two methodologies is therefore necessary, though the formula of that mix will depend on the organisation and its environment.

Stata in Senge [28] claims that, because of the Tayloristic approach of labour division that has been adopted by most industries in the western world, the workers and the managers have become uncommunicative doers and thinkers. Senge believes that an organisation must bring the two together to enable a learning process to develop. This confirms both Egan's recognition that those engaged in the organisation's activities are vital to that organisation's (or industry sector's) improvement and Drucker's view that feedback is the most important learning principle.

A further requirement for learning seems to be the ability to reflect on past experience to modify future thinking and behaviour. The role of reflection in individual and organisational learning has been considered in detail by Argyris [2] and Argyris and Schon [3]. Argyris in particular has studied the role of reflective practice in organisational learning.

Perhaps one of the most important principles supporting the COLA review process is that of reflective practice. Reflection manifests itself through enquiry [7] and evaluation involving problem solving and reconstructing meaning. It is an iterative process enabling tacit knowledge to become explicit and allowing for the externalisation of interpretative knowledge at each iteration progressively refining and enhancing the individual's knowledge and expertise through reflection which takes place by capturing recurrent issues and problems.

Thus, while it is important that individuals actively learn and modify their behaviour accordingly, it is vital for an organisation that the process of collective learning is fostered by the organisation (and its environment). Reflective practice should not be seen just within the context of the individual since it is a social process [16]. It is:

"...a form of self reflective enquiry undertaken by participants in social situations in order to improve

the rationality and justice of their own practices, their understanding of those practices, and the situations in which those practices are carried out” [27].

A primary function of COLA is to provide a review process forum for the social construction of knowledge. This kind of knowledge may not already exist since it is concerned with the alignment of norms and values within the group; the group needs to establish what can be reasonably expected from each of its members. This knowledge is socially constructed because it is established through discussion and reflection upon past experience and future expectations. Such knowledge, when it is generated, does not belong to an individual but can be seen to exist collectively within the group and it is subject to constant renegotiation.

Reflective practice can have benefits for the organisation as a whole since it contributes to individual learning and, when seen as a social process, it contributes to organisational learning. Individual learning on its own is not sufficient [18] for the organisation to maximise the benefits to be gained from reflection. Individuals move around the organisation from team to team. They do not necessarily share their knowledge and experience with colleagues because the mechanisms do not exist to support sharing, or perhaps they just do not know how, or culture does not facilitate sharing.

Organisations must therefore be aware of the various methods, views and attitudes and how they affect collective and organisational learning.

Various views have been put forward on Knowledge Management strategies and many of them can be seen as complementary rather than mutually exclusive [32].

The National Computing Centre Guidelines suggest two approaches to KM [33]: manage the people or manage the knowledge. The first approach can be seen as suitable for dealing with interpretative knowledge whilst the second is more suitable for dealing with soft knowledge.

Managing the people requires social, cultural and philosophical skills in order to be able to encourage individuals into the mindset of openness and sharing. This approach is primarily concerned with interpretative knowledge. Whilst technologists are primarily concerned with soft knowledge which requires the use of databases, networks and so on.

In reality both of these approaches are often undertaken simultaneously as judgements are made about knowledge which can be beneficially codified and knowledge which is best held within individuals and the social system. The forced introduction of a computer system which stores information previously held informally within the social system is an easy way to alienate those who are intended to use it!

Further views have been put forward by Quintas, Lefrere and Jones [24] who identified various goals that should be developed in order to manage knowledge within an organisation properly and efficiently. These consist of the formulation of a strategic knowledge management policy, the implementation of such strategies, the regular improvement of

processes and the monitoring of knowledge assets and activities.

Lyytinen and Robey [20] suggest four approaches to managing knowledge. Firstly, manage knowledge by improving its accessibility, secondly by encouraging openness and honesty, thirdly to redesign the organisation's structure to improve the flow of information and rethink roles and responsibilities. Fourthly, the values and expectations of experienced individuals must allow changes in perceptions and priorities.

Thus, knowledge management would seem to deal with the entire system that provides knowledge generation and the environment in which it operates

#### IV. COLA AND THE COLA ENVIRONMENT: KNOWLEDGE AND ORGANISATIONAL LEARNING THROUGH REFLECTION

The product of the research is the Cross Organisational Learning Approach (COLA<sup>1</sup>) which has theoretical perspectives in the arena of organisational learning underpinned by the principles of reflective practice and knowledge management and is supported by the development of an information system that facilitates the capture and dissemination of organisational knowledge.

The B-Hive project identified the problems confronting the construction industry as complex, with different participants holding both different understandings of the issues and having often competing goals and where there are no certain and agreed measures of inputs, processes and outputs. The set of approaches and methodologies constituting *problem structuring methods* [25] were adopted both as tools for the academic/industry team to agree on their approach and, later as part of the interventions themselves. An exercise using Strategic Options Development and Analysis (SODA) [9] led to the identification of the issues of post-completion review in the leisure company and the Management of Project Changes in the utility company, as key aspects of the process where unexploited opportunities for learning were being created in a partnering and value sharing environment. B-Hive has run one-day post-completion review workshops with the leisure company. The first two, exploratory, post-completion workshops were run on the basis of value engineering techniques [6] drawing on the experience that the leisure company's representative had in applying this technique. A major constraint on designing a workshop process for project review is the availability of staff and the length of time that they are willing to spend at a workshop. The experience of the exploratory workshops indicated that attention had to be paid to pre-workshop activities and to move some activities that are normally carried out within a workshop to the pre-workshop phase.

These considerations led to the development of a process model. This was an attempt to identify processes to assist in

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<sup>1</sup> Further details may be found at <http://is.lse.ac.uk/b-hive> .

project review in order to: promote the sharing of knowledge across organisational boundaries; and identify the rôle that information systems can play in supporting the process. It also played a major rôle as a communication tool to build consensus amongst the B-Hive project team and to inform other workshop members about the process. The model enabled a dialogue between project members about the status of organisational knowledge and learning and through debates about the concept of a bank of acquired knowledge, the acceptance of the notion of tacit knowledge[23]. This also enabled an approach that placed emphasis on managers' understanding and interpretations of the world in which they work as a basis for moving towards action.[17].

The COLA review process records and monitors key issues, decisions and actions surrounding these key issues ensuring that implicit learning is not lost throughout or on completion of the construction project. The term 'review process' is used which allows of a deal of flexibility in that many different procedures may be performed for a review (e.g. workshop, meeting, teleconference, videoconference, or any combination of these). So far the B-Hive project has mainly used workshops.

There are many situations that may necessitate the review process being triggered, for example:

- Programmed Review
- Post Completion, leading to a review where the scope encompasses the construction project as a whole.
- Stage Completion, scoped for a particular stage of the construction process.
- Time based (e.g. period end, monthly)
- Non-programmed Review
- Issue Resolution, necessitating a review to address a particular problem of high priority, for example running late or over budget or perhaps a technical difficulty.
- Innovation, where a team has been innovative either in process or use of materials this experience should not be lost.

However all reviews facilitate critical reflection on past activities, focussing on individual and organisation learning and allows changing future actions to increase value to all participants.

## V. INFORMATION SYSTEMS AND TECHNOLOGY

Within B-Hive we have developed the information system required to support the COLA workshops. Technology can assist organisations in making effective use of their assets [31]. Such claims, while implying a more efficient utilisation of the artefacts an organisation has purchased, such as machinery, computers and so on, can also apply to the concept of Intellectual Capital [10], [32], that is, the availability of useful knowledge within an organisation.

This is particularly true with organisational learning, since no single application or technology holds the knowledge from individuals within an organisation. Rather, it requires a collection of people and many application types, for example, databases, spreadsheets, word processors, Cad systems, multimedia, workflow, document management and e-mail. The challenge therefore is twofold – to convert relevant categories of soft knowledge into information which can be stored, and to make the stored information available to those who require it irrespective of which part of an organisation they work for or their physical location. An intranet is a mechanism that can be used to provide this access.

An intranet is the utilisation of internet technology to build a private, internal computer network that allows individuals to access an organisation's information systems from any internal location, regardless of application or platform using a web browser. Although intranets are a relatively recent phenomenon, initially made possible by the advent of web browsers such as Mosaic and Netscape in 1993/1994, the term intranet was not used until around 1995 [22], even though internal networks using the internet protocol were already in use.

As Peddler, Burgoyne and Boydell [21] explain, the networking of computers allows individual's experiences to be fed back into the 'collective organisation'. Peddler et al. claim this makes information available that had previously been passed on informally, for example "by the coffee machine". However, it would also be true to say that this is necessary since computers, re-organisation and 'progress' in general have reduced the opportunities for such informal communications.

An extension of this combination of technology and philosophy is the extranet, which provides access to information across organisational boundaries. This is especially applicable for organisations that are co-operating within a group. The use of extranet technology can provide a collaborative virtual environment where individuals can access (where permission is granted) any partner organisation's intranet. In this way individuals, organisations and the partnership can make use of previously gathered information and past experiences and learn from them more easily, regardless of their location, either physically or within the partnership.

The COLA information system supports pre-review event, review event and post-review event activities. Pre-review event information is requested (via questionnaire) to identify major problems and issues throughout the lifecycle of the construction project. Currently the questionnaire is circulated to the construction project team members representing, where possible, all organisations of the partnership.

As a result of this data collection exercise, problems and issues, arising from the construction project, are collated, categorised and prioritised ensuring that only those perceived to be of major importance by the participants are presented for consideration in the review event. During the review event, actions, decisions and responsibilities are assigned and

recorded against each problem or issue. The review process is designed such that soft knowledge is elicited yet interpretative knowledge is simultaneously created and externalised. The information system will monitor the performance and value of decisions made and actions taken. This information is currently held on a Microsoft Access database.

The database holds the descriptive information on the problems and issues. Each will have supporting historical data dispersed throughout the partner organisations held in many formats such as word-processed documents, spreadsheets, databases and drawings. Where feasible, there will be links between the data held on the COLA project review database and these supporting files and access will be via an extranet.

The COLA information system is not perceived as consisting solely of the Access database system. The primary function of the database system is to capture and process data centred on the review process, for example the following data may be captured and held:

- Pre-review event
- Data on construction projects and partnerships enabling project team members to access construction project information required to set the context of issue(s) under review.
- Data on events that may trigger a reflective review, for example the end of a construction stage or post completion or a significant issue.
- Issue - this may be as a result of a major problem or perhaps where a course of action has resulted in a positive impact and the partnership do not want to lose the associated knowledge. The system facilitates the classification and prioritisation of the issues prior to the review so that a focus is maintained on key business issues during the review event.
- Review event.
- Major decisions, actions and responsibilities from both the historical perspectives in terms of the construction project and those defined in the review event are captured on-line during the review event.
- Post-review event.
- The effectiveness of decisions and actions taken is monitored to assess any value improvements resulting from the review process.

This information is made available to all partner organisations regardless of physical location and may be accessed through an extranet<sup>2</sup> utilising world wide web based technologies.

In addition to the data stored on the database there will be much relevant data stored in many different formats (word-

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<sup>2</sup> Extranet – an extended intranet which is a private business network of several co-operating organizations located outside the corporate firewall.

Intranets – are corporate information networks that use World Wide Web technologies and internet communications protocols.

processed, spreadsheets, other databases etc.) in many different locations across all of the partnership organisations. Such data is important to support context setting, the prioritisation process, contact information, costings etc. Where relevant there will be active links between the COLA system and supporting files and documents.

## V. CONCLUSIONS

To date COLA has been successful within the context of the research project in that many of the key issues surrounding organisational learning, as discussed in this paper, have been addressed. One of those key issues is that during the life of a construction project problems may arise or events occur that result in a non-standard approach being adopted. Normally this would lead to actions being taken that give rise to the benefit of the project (e.g. cost reductions, shorter construction times, new working practices). This leads to the generation of knowledge of how to deal with future occurrences amongst the project team. However this knowledge is socially constructed and may lose context and meaning as the project team is split on completion of the building. Thus, in reality this knowledge is very rarely made available to other projects. B-hive and the COLA process has provided the means by which some of this knowledge may be generated, externalised and stored, readily accessible to all partner organisations.

The COLA approach has most definitely fostered a spirit of trust and co-operation amongst, at the project team level, individuals from the different companies and, at a higher level, between partner organisations; thus addressing one of the major concerns of Latham. This was found to be particularly true when COLA reviews were conducted on Whitbread Hotel construction projects.

However, as with many projects, a number of issues have been raised by the research that could not be addressed at the time. Major issues include:

- Ownership - who owns the captured 'knowledge'? The simple answer is the partnership, but then who has control over it, who owns the technology on which it resides, through which it is communicated?
- What is lost through elicitation and externalisation of knowledge? Whilst COLA is fairly effective it is still a relatively young, and perhaps crude method, and cannot lay claim to being able to fully store and disseminate all appropriate organisational knowledge.
- What happens when one of the organisations leaves the partnership, do they still have rights of access to the repository of knowledge that they have contributed to?

It is intended that the COLA approach will be incorporated into future research initiatives so that the approach can be further refined and that such issues may be addressed.

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