AN INFORMATION-LED PROCESS FRAMEWORK FOR HYBRID PROJECTS

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Building adaptation is the broad term used to describe any work to a building beyond maintenance. A hybrid building project is a phrase used for the benefit of research, to define a type of adaptation project where new elements or buildings are combined with existing buildings within the same spatial boundary. The hybrid building process of addition or extension of spatial, structural, façade systems, etc. should result in a singular compound building and not a building of separate parts. The hybrid process has similarities with traditional new build projects but it also offers unique situations that often require a different approach. This is because the approach to design, planning and construction will differ for adapting an existing building, compared to new build. In addition, as-built information will directly influence the design-specific stages of the process. This paper presents a comparative study of design-related variations using the standard RIBA design process. The result was mapped to highlight information, decision and activity flows for a hybrid project framework which has been evaluated by industry experts. A summary of findings from the latter is also presented.

Keywords: as-built information, building adaptation, design decision, hybrid building process, hybrid project.

INTRODUCTION

Building adaptation is the broad term defined by Douglas (2006) to include any work to a building over and above maintenance to change its capacity, function or performance (i.e. any intervention to adjust, reuse or upgrade a building to suit new conditions or requirements). Building adaptation could include:

- Refurbishment - upgrading the aesthetic and functional performance of a building (Douglas 2006).
- Rehabilitation – This is modernisation with some extension work which may comprise major structural alteration to the existing building; mostly housing (Douglas 2006).
- Retrofit or renovation– a retrofit process is undertaken if the building is in a good condition but the services and technology within it are outdated (Langston *et al.* 2007).
- Adaptive reuse - If a particular function is no longer relevant or desired, buildings may be converted to a new purpose altogether (Langston *et al.* 2007).

Adaptation projects constitute a large percentage of work carried out by the construction industry in the UK as in most progressive countries. A number of reasons

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have been ascribed to this trend. It has been stated that old buildings are often cheaper to convert to new uses than to demolish and rebuild (Bullen 2007; Douglas 2006). Today, offices and industrial buildings of the 1950s and 1960s are being recast for domestic and 'leisure' use – for the simple reason that conversion is a cheaper and less complicated process than new build (Powell 1999 p9). To balance the economies of scale and ensure the demand and supply needed to sustain the economy (Petzold and Donath 2004). As an intervention to building obsolescence and deterioration, this practice extends the service life of buildings and reduces the annual replacement rate of a building stock below what would otherwise be required to sustain a set quantity and quality of buildings. Douglas (2006) also said that dilapidation, deficiencies in performance, sustainability of buildings are some of the drivers that have stimulated and maintained the growth in building adaptation and maintenance.

'Hybrid projects' is a phrase, used for the benefit of this research, to define a type of adaptation project where new elements or buildings are combined with existing buildings to completely modify it in order to provide better functionality and meet increased spatial requirements. It is the adaptation of an existing building through a combination of refurbishment, rehabilitation and adaptive reuse.

In contrast to new building; design, planning and construction within existing built contexts necessitates a more complex interaction with the existing building substance, ancillary infrastructure and their respective spatial and performance requirements. The actual presence of the building, including an analysis of its history and changes made during its lifetime will be of some benefit for the hybridisation process. Such that the existing building substance is in all cases the basis for the design and planning tasks that follow (Petzold *et al.* 2007).

In practice however, hybrid projects implies design complexity and construction complications. There are high risks and increase in pressure for timely and efficient project delivery at minimal cost. In addition to this, if not handled properly adaptation operations can cause major safety and security risks for both client and contractor (Douglas 2006). Uncertainty impacts directly on risks; this in turn correlates with the increased demand for design and planning information to manage such risks.

Risks and uncertainty are factors considered in the management of every construction project. However, the difficulty experienced by design and construction professionals in hybrid projects is further enhanced by the lack of 'as-built' information that often characterises such projects. Information (drawings etc.) provided when the building was originally constructed is often inadequate or incorrect due to the fact that building changes are not properly documented (Davidson 2004). Historical information hardly reflects the changes that have occurred over the many decades of the building's existence. Therefore, allowances are often made to enable design errors to be resolved during construction through active design. The heterogeneous and multi-format nature of data presentation creates further difficulty in correlating and consolidating information on existing buildings. The probability for design error at a very early stage of the adaptation is increased as a result of these issues.

OVERVIEW OF INFORMATION, DECISION AND ACTIVITY FLOWS FOR HYBRID PROJECTS

The construction industry relies heavily on information for it to function (Davidson 2004). Björk (1999) distinguishes construction into two main subdivisions - material and information activities. This makes the construction industry one of the sectors that have a strong potential to benefit from advances in ICTs and the adoption of new business modes of operation (Rezgui 2001).

It is known that a building will undergo various levels of change throughout its life cycle, even as the understanding and status of the broad terms 'architect', 'drawing' and 'building', alter through context and time (Hill 2005). Therefore, information about a building should evolve as the building itself evolves. The study of information about the product i.e. as-built information is therefore important in the study of the design and construction processes of hybrid buildings.

Characteristics of hybrid projects can also influence the decisions, design and construction activity. These characteristics include the potential complexity of existing building and site, issues surrounding information availability and acquisition, distinguishing between function and functionality and the influence on client/user satisfaction, issues of buildability and interfacing, risks and liability as well as value and resource management. These factors are likely to necessitate effective information, decisions and activity protocols which can be used to organise people and material processes.

Decision making for design

Hughes (1991) classified the building process as a series of decisions (Figure 1), the first decision in hybrid projects for example, is the decision to adapt the building to suit external influences such as the increased need for space. This acts as the trigger to the process of hybrid building procurement. Decisions concerning the project are made after the need is identified, especially in terms of 'corporate' planning and requirements as well as funding limits.

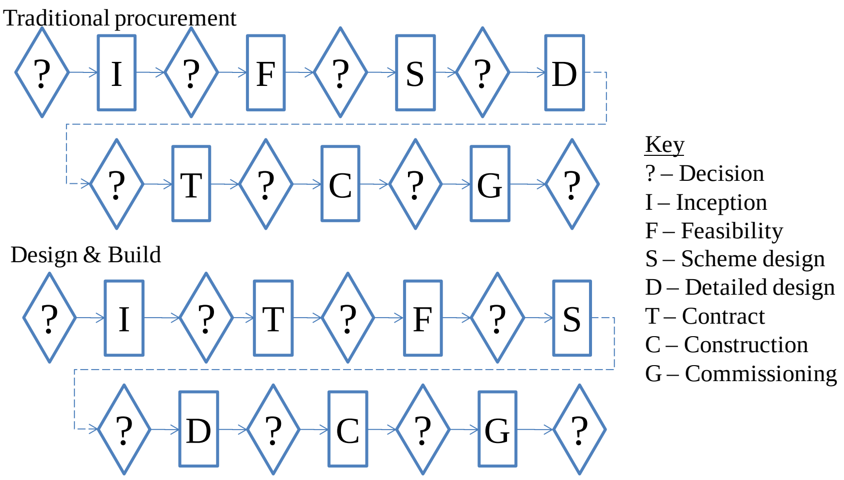

Fig 1: Decisions in traditional procurement processes (Hughes 1991)

Faulty design decisions as a result of inadequate information or communication between different members of the design and construction teams could be resolved by employing the sharing of knowledge and information for making design decisions during the early stages of the process (Quanjel and Zeiler 2007). Based on this model, design decisions made in isolation, using tacit, physical or semantic information alone, should be discouraged. The architect in conjunction with important team members including the client or employer should make design decisions collaboratively. The quality of as-built information plays an important part in this process.

Use of information for design decisions

As Albert Einstein said, ‘Knowledge is experience, everything else is just information’. Experience acquired through the practice of design is seen as readily available, quicker to use, and more ‘palatable’ compared to information in a written form (Mackinder and Marvin 1982). Beyond Einstein's distinction, information is different from knowledge; McDermott stated that leveraging knowledge involves a unique combination of human and information systems. Professionals do not just cut and paste "best practice" from the past to the current situation. They draw from their experience to think about a problem (McDermott 2000). One distinction is according to Galbraith (1974), who said that a basic proposition is that the greater the uncertainty of the task, the greater the amount of information that has to be processed between decision makers during the execution of the task. However, if the task is well understood prior to performing it (because of the amount of information available) much of the activity can be pre-planned. But if it is not understood, then during the actual task execution, more knowledge is acquired which then leads to (decision) changes in resource allocations, schedules and priorities (Galbraith 1974).

Furthermore, Emmitt and Gorse described a collaborative approach to design, stating that the nature of design is such that different people with varying knowledge and expertise will work together. When working in a group, making an informed decision is about utilising the relevant specialist information that is relevant to the problem, some members will possess more knowledge on issues than others. What is important is that the most relevant information is accessed (Emmitt and Gorse 2003).

These citations highlight two important factors for the use of information for design decision making: availability and access to information, collaboration in making decisions. Kalay (2006) emphasised the latter by saying that although participants in a project may be short-termed compared to lifetime of the project itself, the effects of their collaboration, in terms of the decisions they made and the action they have taken when they were part of the project team, may well impact and constrain the freedom of action of other participants long after the original participants have departed.

For design, different types of information are required for decision making depending on the requirements of the project. The type of information and extent of detail would clearly be related to the project and the parties involved but would generally include the management of time, cost, quality, health and safety, environmental impact, and the exchange of information and communications (i.e. administrative, technical, financial or legal information, and the systems and procedures that they use) (Bouchlaghem *et al.* 2004). Broadly, during the project execution, the interests of three distinct client groups are represented — the owners, the users and society. These three groups of interest each value different things at different times in the life of the building (Bertelsen and Emmitt 2005). Specifically, information requirements for the design-specific stages for each project will defer. Although, it has been suggested that majority of the design decisions are made at the concept design stage (Quanjel and Zeiler 2007).

The amount and format of information will depend on the project requirements (Bouchlaghem *et al.* 2004). Building on an existing site implies that there will be environmental, spatial, structural, service, planning and organisational limitations pertaining to the five key building considerations: site, building fabric, structure, services and components. This makes it especially important for design decisions to be based on cogent and precise data.

DESIGN AND CONSTRUCTION PROCESS MAPPING

Each industry has rules and procedures that govern investment, decisions and the creation, management and implementation of activities on which its proliferation depends. The construction industry is no different. Over the past few decades; rules, management and implementation protocols have evolved. The purpose is to ensure that the objectives of each project is met as defined by stakeholders, while ensuring less resource wastage and increased efficiency in the industry as a whole.

RIBA Plan of Work

The RIBA Plan of Work organises the process of managing, and designing building projects as well as administering building contracts into a number of key work stages (RIBA 2007). The building process such as the RIBA Plan of Work can be used to define tasks, actions, decisions and resources needed to implement the project. Having a process implies that information; actions and resources can be tracked throughout the spectrum of the project. In addition, it is also possible to highlight decision 'gates' throughout the process. The work stages therefore forms a good basis to commence the analysis of a hybrid building process.

Information, design decisions and activities mapping

A process map consists of an x and y axis, which show process sequence (or time) and process participants, respectively. The horizontal x axis illustrates time in process and the individual activities or gates. The y-axis shows the departments or functions participating in the process...' (Cooper *et al.* 2005). Bourdieu's field theory (Bourdieu 1969) formed the theoretical approach to mapping the hybrid project process. Field theory defines a theoretical position for study because it applies to a field as the common ground with boundaries where the action occurs by players in the field (Mutch 2006; e.g. Bourdieu 1993). It stems from the Physical Sciences and is mostly applied in Socio-Psychology realms, describing change due to action and effects. It is particularly useful for explaining 'resultant' change as opposed to 'causal' change. This was highly applicable to this context because it focuses on when change is based on a building's adaptation processes rather than what caused the building to be adapted.

This theoretical approach facilitated a more systematic approach to analysing the hybrid project process more systematically. Using the approach described through Field Theory (Bourdieu 1993) and by combining information and materials with people and logistics, a clearer picture of a hybrid project process was derived. Theoretically, the main driver for a hybrid-building project is change implemented over time. People using information to derive a more functional finished project implement change throughout the process. The development of the hybrid project framework therefore commenced with an initial conceptual map, which is shown in Figure 2.

The map shows the building as the context but also as a constant. The building changes but the site setting remains the same. At the core of the model is change, as a factor of people, product (the building) and process. Information and function controls the change process. Information is dynamic within and throughout the process. By comparison, to information, function is less dynamic because its dynamism is bound by variables that are determined at the beginning (from the brief) of the process e.g. cost, and 'almost' fixed by design.

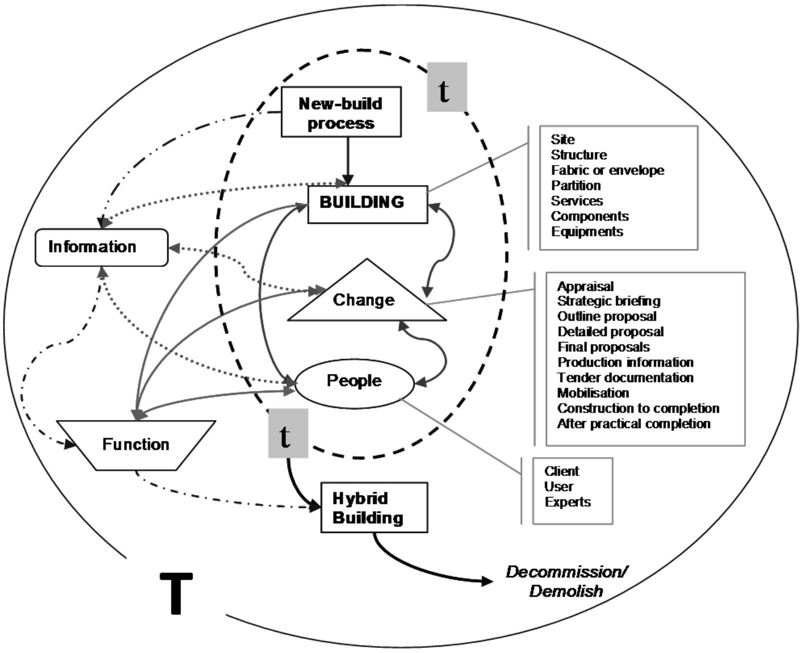

Fig 2: Simplistic research framework (T= building lifecycle and t=development period)

The three main groups of people influencing and participating are the client group, the user group and building professionals. Their tasks and roles will vary according to process per time. Change can be divided into subsets of entities i.e. building layers (Brand 1994) which are not mutually exclusive. This is because the hybrid building can only be described by changes within its entities but not changes of 'all' entities. That is, it ceases to be hybrid if nothing changes or if everything changes. Ideally, a detailed map should include roles, cost, tasks, players, time frames as well as responses and feedback loops.

The initial stages of a hybrid project commences with the building itself, its inherent information with the participation of key parties: the client, users and/or the design team. The challenge at this stage is to unlock the building's potential by utilising available resources. Information and communication technologies could potentially play a key role at this stage.

As work progresses and with the interaction of more people, materials, information to achieve the end product, the hybrid building process and activities becomes more complex.

An effective framework should integrate work stages such as information acquisition by highlighting the importance of usable and relevant information required for the success of any hybrid project. Lack of quality information could lead to wrong decisions being made and things going contrary to plan. The mapping exercise was also cognisant of the need for each different information-led stage to be implemented efficiently; this may impact on the efficient delivery of the project as a whole. However, negative impact could potentially occur when individual stages are not implemented appropriately.

With this approach, a conceptual framework evolved. This framework consists of milestones on the x-axis and sub-levels of information, parties, sub-processes, decisions and actions on the y-axis. The framework particularly emphasised the role of information at each stage, for example, by evaluating which type of information is required for procurement compared to the output from feasibility studies etc on the existing building.

A comparison of the framework milestones and the RIBA Plan of Work stages is shown in Table 2.

Table 2. Comparing the RIBA Plan of Work 2007 and the Hybrid Project Process framework

Stages	**A/B/C**	**C/G**	**A/D/H**	**B/D**	**E/F/G/H**	**J**	**K**	**L**
RIBA Plan of Work 2007	Appraisal, *Strategic* brief, concept design	Outline proposals, tender documents	Appraisal, detailed proposals, tender action	Design brief, design development	Technical design, production information, tender documents /action	Mobilisation	Construction, practical completion	Post practical completion
Milestones	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Hybrid Project process framework	Outline appraisal and development plan	Development core team procurement	Building performance evaluation	Briefing development	Design activity (*Procurement – sub-contractors)*	Planning and logistics	Construction	Evaluation and operations

The milestones are defined as follows; outline appraisal and development plan where a high-level appraisal is conducted by the client team to assess the potential of an existing building and determine the resources (including historical data) available for its transformation. The core team procurement stage is mostly designed for the early selection and contractual arrangement with important professionals. This stage is important for collaborative decisions to take place. Conceptual designs and preparations for planning permission and other legal requirements commence at this stage too.

The third milestone is the building performance evaluation stage. At this stage, historical documents are brought up to date by integrating previous data with current data abstracted from the existing building itself. Historical data and as-built information are superimposed and layered to determine conflicts and resolve them collaboratively prior to commencement of work on site. Importantly, the buildability and adaptability of the building is also determined and the designs are revised to reflect the conflicts and constraints identified from as-built information. In addition, the brief is developed to reflect information from the appraisal and performance evaluation milestones and as it can be assumed that all possible information has been acquired and communicated. The brief can be sealed at the stage. The next milestone – design activity does not represent the stage where design commences, but it is at this stage that design options are investigated, choices and decisions made collaboratively and the final design and specifications produced. Although the design is finalised at this stage, design decisions will continue as expected during the construction stages. However, the expectation is that design changes will be minimal as all design uncertainties have been resolved prior to construction. After construction, all building information should be consolidated for design and construction monitoring, building operation and maintenance.

It is important to note that the framework incorporates reiterative, non-linear processes, decisions and activities in concurrent, measurable loops. No design and construction process is implemented in a strictly linear manner.

EVALUATION

In developing the process framework, the need for early information acquisition, early and precise definition of design intent as well as collaborative design decisions was recognised and integrated. These three factors contribute highly to client satisfaction (value) and effective project delivery. The validation exercise was necessary to identify if these objectives were realised. Importantly, the aim of evaluating the framework was to explore the accuracy and extent by which it describes and facilitates an improvement of the hybrid building process. Eleven design and construction professionals; 2 architects, 2 engineers, 1 building surveyor, 1 development manager/ employer agent, 2 collaboration managers and 1 design consultant evaluated the framework and completed an individually administered questionnaires afterwards. Each evaluator had a working knowledge of hybrid projects with the exception of one engineer who was working on his first hybrid project. The evaluation was however limited by the number of participants involved and the limited client representation. Feedback from clients and other stakeholders would have been highly beneficial for the research.

Summary of findings

Key findings from the evaluation exercise were that:

- The proposed framework is a good extrapolation of table to programmes, critical paths and priority within each category.
- It provides process improvement, collaborative planning and decisions especially for design.
- It covers all milestones for any design and construction project and it highlights key information, decisions and actions that needs to be made en-route.
- The proposed framework is particularly relevant for hybrid projects and it has been evaluated to be progressively relevant and applicable for the efficient delivery of adaptation projects and indeed any other building project.
- The proposed framework will be most effective if engaged by the client to facilitate with brief development prior to design team appointment. The framework will be more effective if client-led, as opposed to based on the architect's recommendation.
- The framework requires early procurement of the core development team. The assurance of a job commission or payment will ensure the participation of the core development team, especially contractors.
- Introducing new taxonomies to the industry might be problematic, therefore, process frameworks should be aligned to well known processes such as the RIBA plan of work.
- The proposed framework highlights the importance of obtaining and integrating information, especially as-built information early in the process. This was considered important for reducing defects at a later stage
- It was suggested that the proposed framework will be effective for gate-keeping of information and the filtering of non-participation and incompleteness.
- The mapping of information, decisions, parties and activities provides a systematic path that guides the thinking and decision-making process. This was considered useful because it reduces the chaotic development path which is caused by variability and uncertainties.

It was also recommended that a more detailed framework should consider the following:

- Cost effectiveness), whole life costing and value management/engineering and the impact on decision needs to be more visible within the framework.
- Mapping of cost/cost implications versus risks across the process
- Integrating the use, role and impact of modern methods of construction and 3D Building Information Modelling on the provision and use of as-built information throughout the process.

SUMMARY

This paper discussed hybrid projects as a type of building adaptation work. It also reviewed literature to discuss the role and importance of information for collaborative decision making among the project team. RIBA work stages remain the industry standard and most projects are still delivered according to this framework. In consideration of this, the conceptual framework was developed by refining, or customising, the RIBA Plan of Work. It identifies stages where problems due to lack of as-built information could compromise the process. The objective of the framework was to improve the process, emphasise and highlight required information, decisions and actions necessary for collaborative planning and delivery of a hybrid-building project. The evaluation exercise demonstrated that this objective was realised.

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