GATEWAY OF PROCESS PROTOCALL IN CONSTRUCTION PROJECT MANAGEMENT

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1 Introduction

Following the critique of Latham (1994) and Egan (1998), on the poor performance of the UK construction industry to deliver projects on cost, time and quality, many professionals in the industry have been forced to ask "what is the best way?" Both Latham and Egan recommend that process improvement was the way out (Wu et al, 2000). According to Kagioglou et al (1998), many contemporary change initiatives focus only on time, cost and quality related issues, when this only makes up 25.6% of problems associated with the construction industry. He observed that 84.4% of commonly associated problems in the construction industry are ***'process'*** related not product related (Goulding and Alshawin, 1999). In line with this, Tzortzopoulos et al, (2005) states that a key to capturing customer requirement and translating it into a successful project relates to the need for improving the performance of the design and construction ***process***. As a strategy for gaining competitive advantage in the business environment, many companies have adopted a ***process-oriented/modelling*** view of their business operations (Wu et al, 2000). It is obvious that a major determinant of success or failure of a product, regardless of the measure of the success or failure, is the ***'process'*** employed in developing that product

Goulding and Alshawin, (1999) state that process modelling is useful in understanding view points, identifying critical information flow and data relationships. In the manufacturing industry, most large organisations have process maps which can assist them in ensuring the delivery of products on time, within budget and to the right quality while capturing the best process practices. In construction, there had been some efforts to devise process maps such as the RIBA plan of work in the UK (Aouad et al, 1999). Manufacturing and construction, might define the word 'process' differently but all fundamental concepts rely on input, conversion and output.

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Figure 1: Model of Production as a Conversion Activity

Construction is a process-based industry. Therefore, it is important to have a clear understanding of the process (Poon et al, 2003). There are different process models in existence since the 1960s (RIBA Plan) and those which have been developed or on the process of development by academia and industry to enhance the effectiveness and efficiency of the design and construction activities in response to the need for improving performance. Some of these are: the Generic Design and Construction Process Protocol (GDCPP), the revised RIBA Plan of work, the BPF Manual, NHS Executive, BAA process and the OGC Gateway Process.

This report will describe Department for Business Innovation and Skills (DBIS) application of the RIBA plan on the Centre for Technology in Government (CTG) project and a proposed alternative using the Generic Design and Construction Process Protocol (GDCPP). Furthermore, it will describe and analyse the value and non-value adding activities within the production activities.

2 The Department Of Business Innovation and Skills (DBIS)

The Department Of Business Innovation and Skills is an independent subsidiary of the ministry of defence which fosters the innovation in the public sector, generate public value. The Company operates a line of ICT scientist trained to simulate nuclear weapons tests using high-tech Super computers. This department designs and tests nuclear weapons through applied research using state of the art technology and collaborative problem solving and online services.

3 Analysis of the working processes of DBIS

Due to the high security requirements of its project, their usual procurement strategies is design and build where not many subcontractors are involved on the project and so the risk of security breach is controlled to the minimum. It would be described as an inexperienced client, but however, a client who knows exactly what they want and how they want it in their tiniest detail and specifications. DBIS has always procured and executed its projects drawing from the philosophies of the RIBA Plan of Work.

4 Centre for Technology in Government (CTG)

The Centre for Technology in Government (CTG) is a 250,000 square foot facility located in Liverpool, UK. This £50,000,000 facility is being built specially to house world class super computers and a nuclear weapons design staff. The mission assigned to the CTG project was for the facility to facilitate and support the design and testing of nuclear weapons through the use of super computers, applications and online services. This involves melding high-tech technology with a range of scientists and ICT specialists. The facility design staff worked as a supported a team approach to carefully consider and balance safety, security, efficiency, life-cycle costs, working conditions, and the need for flexibility to address changing advanced technology for the effective and efficient execution of the project. The project went through the planning stages from late 2008 through 2010.

4.1 The RIBA Plan of Work

The RIBA Plan of Work was originally published in 1964 and has since then undergone a number of reviews to make it flexible for use on other procurement systems such as PFI, BSF, and partnered contracts as it was originally developed to reflect the needs of Traditional contract forms. It provides a sequence of defined work stages for managing the building design and construction process (RIBA, 2008). It also identifies and classifies the construction activities in the whole construction cycle into twelve stages (Poon et al, 2003). These stages can be seen Appendix 1.

The department for business innovation and skills (DBIS) strictly applied the RIBA Plan of Work stages for the execution of the Centre for Technology in Government (CTG) project as follows:

4.1.1 Appraisal [A]

Over the years DBIS has nursed the idea of building a new facility to carry out its functions successfully under a relaxed and comfortable environment. In 2008, this idea became a reality when the management decided to form an internal team to prepare an Outline Business Case (OBC) which should demonstrate the options, the benefits to be gained, probable capital cost and profitability, constraints, and the chance of success. After this, a number of consultants were appointed to form the consultant team who conducted a feasibility study and assessments of options (including value and risk assessments) to enable the client decide whether to proceed. Among the consultants were: Skanska Construction and G&C Ltd (an architectural company who specializes also in design and build) to give advice on design and construction; Baqus Group Plc (a building consultancy and Quantity Surveying group) to give cost advice; Mott McDonald to serve as consultant structural engineer; Balfour Beatty Services, to give advice on M&E services and Alamai Northern Construction Ltd to serve as Lead Consultant. To achieve good communication flow and decision making, each was given responsibility as follows:

Table 1: Consultant Team for the CTG project

CONSULTANT	RESPONSIBILITY
Alamai Northern Construction Ltd	**DBIS's Lead consultant**
G&C Ltd	Design and construction consultant/CDMC

Skanska Construction UK	Design and construction consultant
Mott McDonald	Structural engineering consultant
Baqus Group Plc	QS/ Cost consultant
Balfour Beatty Services	Services Engineering consultant

At the end of this stage, the consultant team prepared an initial statement of requirements and suggested Design & Build contract as the possible procurement option. The detailed map can be seen in Appendix 2.

4.1.2 Design Brief [B]

At this stage the Department for Business Innovation and Skills together with Alamai Northern construction and other consultants, were able to develop the initial statement requirement into a design brief confirming key requirements and constraints. Among other requirements, security and safety goal was of high priority. The design is to incorporate high security system to enable testing and operation of advanced online services (electronic or mobile) under extremely secured environment. The office spaces were to be grouped to support a team environment with central break areas to encourage walking the hallways and interfacing with peers. Another design requirement was that the building design (structure and finishing) must address emotion of new recruits, generating excitement and anticipation within them. The project team analysed the project using effective tools and selected again design & build for the project (see Figure 2). In the end they suggested that a sustainability consultant and a security specialist be appointed.

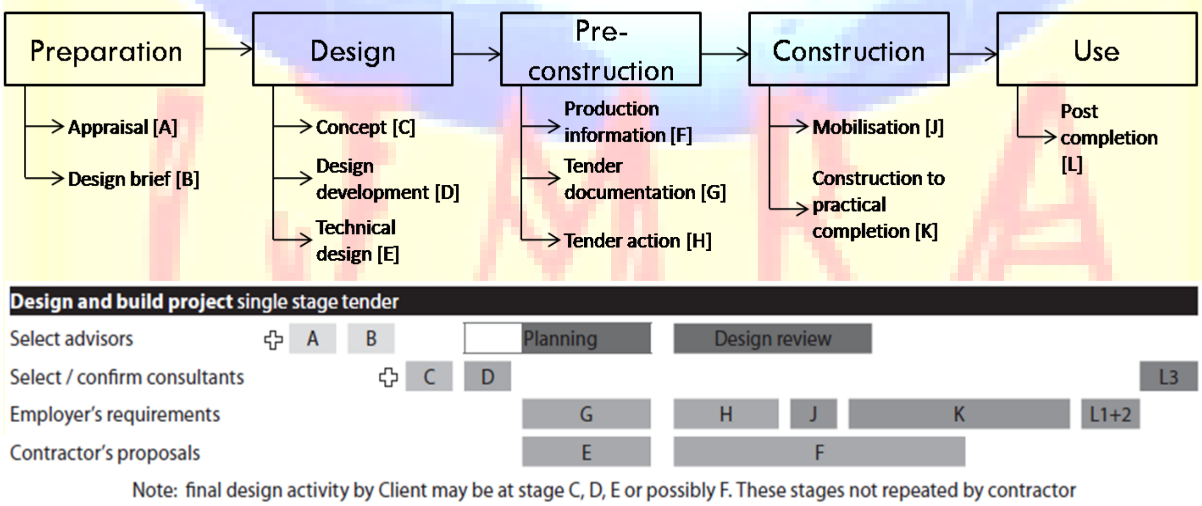

Figure 2: Design and Build process for CTG project (RIBA, 2008)

It was decided that after stage C (Concept), proposals will be requested from Skanska Construction and G&C Ltd. The winner will proceed with other consultants already appointed by the client. The detailed map can be seen in Appendix 2.

4.1.3 Concept [C]

During this stage, the consultant team/project team developed the conceptual design of the facility drawing upon the design brief. They team visited the site and reported on possible constraint. They held weekly meetings between them to allow for all aspects of the design to be discussed in front of the client and stakeholders. At the completion of these meetings, the team assembled the key points that they learned through the conceptual design process into functional and operational requirements (F&OR) and cost plan by room type. The F&OR was then used as the core portion for request for proposal (procurement). The detailed map can be seen in Appendix 3.

4.1.4 Production Information [F]

The production information stage started early because DBIS chose to develop only the concept design and allow the contractor to develop the rest of the design for the sake efficiency. At this stage, all the members of the cross functional team provided information relevant to their field; architectural, structural and services engineering information including contract documentation and tender information, were given to the Lead consultant who prepared and submitted the stage report to the client for approval. However, the successful contractor will require more information when developing the design at stage D. The detailed map can be seen in Appendix 3.

4.1.5 Tender Documentation [G]

At this stage, Baqus Group were the most involved ad they had to receive the F&OR and documentation from other project team members to prepare documents necessary for Skanska and G&C Ltd to provide their proposals. In the end the Department for Business Innovation and Skills approved the document and was sent off to the bidding contractors. The detailed map can be seen in Appendix 4.

4.1.6 Tender Action [H]

The contractor's proposals were received and appraised in good time. It was found that the proposal from G&C Ltd was suitable to the client. Therefore G&C Ltd was invited for negotiations on some aspect of the works e.g. Installations of Super computers and Security. After negotiations were complete, DBIS passed on the concept design, outline proposals for structural and building services systems, updated online specifications and preliminary cost plan. The detailed map can be seen in Appendix 4.

5 Limitations of RIBA

- It does not state explicitly the document to produce at each stage
- It does not look at the whole life view of the project as it does not incorporate facilities management inputs as design progresses throughout the project
- Problems were not corrected at each stage before moving to the next (no Phase reviews)

- It does not identify the particular individuals performing a function at a particular stage on the process. RIBA plan shows that all project team members give inputs at all stages. The advantages of using Cross-functional teams in decision making can not be overemphasised; however, the use of it must not be abused. There are certain stages in the process that obviously does not need the inputs of some members of the project team. In other work not consequential. The parties responsible for a particular process level must be identified otherwise, this will always be a waste of time, money and resources on the part of those whose inputs does not apply or have negligible effect on the project process.

6 Generic Design and Construction Process Protocol (GDCPP)

The Generic Design and Construction Process Protocol (GDCPP) is a product of the Built Environment at the University of Salford. It is a high level process map aimed at providing construction companies with a framework that will enable them improve their design and construction processes (Wu et al, 2001). The GDCPP was defined by Aouad et al (1999) as;

> *"a way in which the processes involved in the designing and construction of a structure are re-arranged so as to produce a more efficient, effective and economical way of undertaking the design and construction of projects"*

Examples of benefits that can be realised from the process protocol are; wastage reduction, shortening of duration of projects and improving communication methods and channels (Aouad et al, 1999). The process protocol functions on the basis of eight key principles which have been borrowed from the manufacturing industry. These principles address, directly recognised problem areas in construction where significant improvements have been called for. The eight principles are;

- Whole project view
- A consistent process
- Progressive design fixity
- Co-ordination
- Stakeholder involvement and teamwork
- Feedback
- Process flexibility, and
- Customisable process

The Process Protocol Model divides design and construction into 10 distinct phases (0-9) and categorises them within 4 broad stages: Pre-project, Pre-construction, Construction and Post-construction/Completion stages (Aouad et al, 1999).

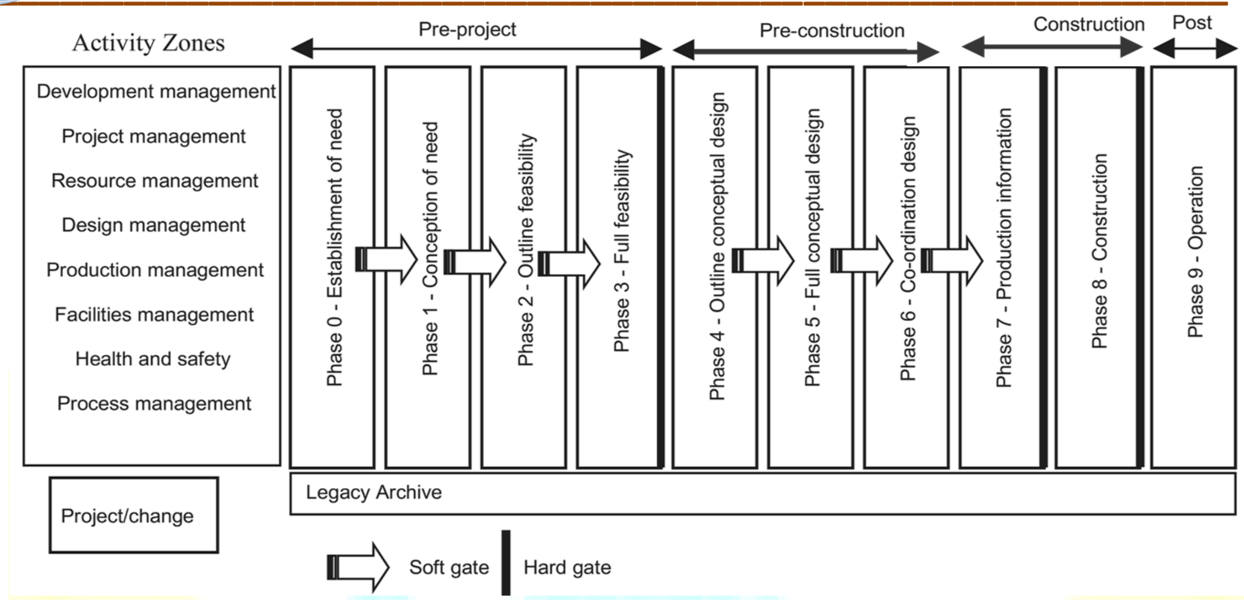

Figure 3: The Process Protocol (*source: Auoad et al, 1999)*

6.1 Pre-Project Stage (Phases 0-3)

The Pre-Project phase is a strategic stage which aims to justify and layout all the client's needs in terms of benefits to be achievement on the project (Kagioglou et al, 1998). As the project progress through phases 0-3, the client's needs are also progressively satisfied and assessed with the aim of determining the need for a construction project solution and securing outline financial authority to proceed to the Pre-Construction phases.

It has been argued that most contemporary models of the design and construction process give scant consideration to establishing the client's needs (Aouad et al, 1999). Therefore, the Process protocol concentrates at the front-end so that costly and time consuming mistakes at the later stages can be eliminated (Kagioglou et al, 1998).

6.2 Pre-Construction Stage (Phases 4-6)

After outline financial approval has been given, the next stage is the Pre-Construction where the established client's need is developed into an appropriate design solution – the full extent of the works has been defined and the associated risks understood. The sole aim of this stage is to secure full financial authority to proceed to commence construction

6.3 Construction Stage (Phases 7-8)

This stage is concerned with the production of the project solution. The full benefits of co-ordination and communication achieved earlier in the process will be fully realized and any changes in the client's requirement will be minimal.

6.4 Post-Construction/Completion Stage (Phase 9)

During the Post-Construction stage, the process protocol aims to continually monitor and manage the maintenance needs of the constructed facility. This stage is made less complicated as facilities management specialists have been fully involved at earlier stages of the project.

7 Adopting the GDCPP on the CTG project

The Process Protocol comes with an IT tool which will enable companies customise their project processes and provide a software interface for process information management (Wu et al, 2000). The PP2 toolkit is comprised of Process Map Creation tool and the Process Information Management tool. The former will be use the map the phases of the CTG project and the latter will be used to manage the process and project information. However, within the scope of this report, only the process maps will be demonstrated. The development (design and construction) of the CTG project will incorporate all the nine phases of the Process Protocol starting from 'Demonstrating the need' of the project to the 'Operations and Management' phase (see Figure 5.1).

7.1 Demonstrating the need (Phases 0)

The Department for Business Innovation and Skills went through this stage by setting up an internal team in its organisation to develop the statement, justify the need and prepare the Initial Business Case (OBC) for CTG. They set up communication strategies using FUSION, an IT tool where all participants on the project can communicate, upload and download project documents, announce project issues etc. to develop the statement of need, the internal team generated possible risks to the project and suggested ways mitigating them. This risk register will be revised and updated throughout the phases of the project. At the end of this phase, they developed a Process Execution Plan – the first of which was to appoint consultants who will prepare the 'Design brief'. Part of the consultants appointed were; Skanska Construction and G&C Ltd who will give design and construction inputs; Baqus Group, for cost inputs; Alamai Northern Construction Ltd, for project Management skills; Mott McDonald, for structural engineering inputs; Balfour Beatty Services, for Mechanical and Electrical services inputs; and SOS FM, for facilities management inputs. These appointed consultants were set up in multi-functional teams to perform the functions within the activity zones of the Process Protocol Framework.

A Phase review was conducted with the client who enabled that all the items at this stage were captured and nothing was left to be done. A Phase review was defined by Wu et al (2000) as a review that assures a high level quality performance by the multi-functional teams at each phase of the project. The Phase Review report will include key deliverables for the appropriate phase as identified by the project process map

The process map for this stage is shown in Appendix 8. However, it is not until after the Department for Business Innovation and Skills (DBIS) developed their statement of need, was G&C Ltd (the Contractor to be) appointed to be part of the project team to give design and construction inputs.

7.2 Conception of Need (Phases 1)

At this stage, the consultants considered site environment issues, assessed stakeholder impact and incorporated the needs into a feasible design brief. Some of the issues considered were those of balancing safety, security, teaming, operating efficiently, life-cycle costs, investment appraisal and risks. In the end, the project team suggested a couple of procurement options including D&B as the most favourable option. A whole-life project view is advocated by the users of the Process Protocol therefore, the facilities management team developed an initial facilities plan which was incorporated into the design brief. A Phase review was held at this stage as well. See Appendix 8 for the process map.

Given the above advantages, organisations should adopt the GDCPP in order to achieve some of these benefits within the processes. Some of these benefits as given by Tzortzopoulos and Sexton (2005) are shown in Table 7 below.

8 Limitations of the Process Protocol

- The process protocol does not have standardized process flow tailored to the different procurement systems.
- It does not state what flow suits a particular contract
- It's too complicated and difficult or too much work to implement on small projects.
- It may take too much time to learn before implementation begins. This may cause time overrun on projects
- So many repetitions of activities and reviews that causes wastage of time and uninteresting to use. This could be a de-motivating for the project team members.

Table 2: Benefits of adopting the GDCPP

Espoused benefits for the organisation	Espoused benefits for the process	Espoused benefits for the client
Competitiveness Consistency through replication Optimise predictability Support partnering and contractual arrangements Basis for IT systems Educate new employees	Less time and costs Better planning Better and timely information exchanges Better communications Reduce errors and rework Benchmark for improvement	Better product quality Fitness for purpose Delivered on time Delivered to costs

8.1 Moving towards the GDCPP

It is important to have an Implementation process when adopting this model. Cooper (2001) as cited by Tzortzopoulos and Sexton (2005), proposes an implementation process model of three stages. They are:

(1) Defining process requirements.

(2) Designing the process.

(3) Implementing it through training, internal marketing, and having a process "owner".

However, a successful implementation will require a proper change management plan as discussed by Kotter (1996), strong leadership and adequate motivation.

9 Production Management Principles

The construction industry is plagued with the inefficiency, time and cost overruns, lack of collaboration and team work which results to low quality buildings and dissatisfied clients (Latham, 1994; Egan, 1998). It is therefore imperative to change the way things are done in the construction industry. In the past decades, the manufacturing industry has obtained great results in the area of productivity improvement through the mastery of operational excellence and production philosophies (Lee et al, 1999; Akinci et al, 1998). According to Liker (2004) this operational excellence is based on tools and quality improvement methods such as Just-In-Time (JIT), one-piece-flow, continuous improvement, transformation, flow and value (TFV) etc. These philosophies are led by the concept of 'Lean Production'. Lean production is concerned with eliminating waste, providing value and providing a basis for continuous improvement within the production system.

Liker (2004) advocates that when providing a service or product, 'value' should be defined only from the customer's point of view. Only through the customer's eyes can a process be observed and a clear separation be made between value-adding and non-value-adding steps. The Toyota Production System has identified seven major types of non-value-adding waste in business and manufacturing processes. They are;

Table 3: Waste in a Production Line

What a Waste!		
Sl no	Waste Category	Illustration
1	Overproduction	Excess pouring of conceret
2	Waiting	Waiting for the dumper
3	Transporting	Material movement due to space shortage
4	Inappropriate Processing	Excess cement in the concrete
5	Unnecessay Inventory	overstocking of steel
6	Unnecessary Motion	Disregard for physical effort of contract workmen
7	Defects	Surface defects requiring repairs

The last is **Unused Employee Creativity** which was later added Liker himself. However, Lee et al, (1999) have iterated the works of several writers who identified a number of wastes within construction. They are;

- Delay times
- Quality costs
- Lack of safety
- Rework
- Unnecessary transport trips
- Long distances
- Improper choice of management of methods or equipments, and
- Poor constructability

Below is the evaluation of the Key production activities within the CTG Project relating to the design stage, and the procurement, and installation of the Supercomputers. See Appendix xxx for map.

9.1 Key production activities within the CTG project

The stated goal for the Centre for Technology in Governance facility was to support the design and testing of nuclear weapons through the use of Super computers applications and on-line services. This was made explicitly clear even on the client's brief. As the project team meet weekly to develop the design, many factors where centred on this key production activity. The area in which the computers were to fit had to be design to specification. Nothing was to be missed. The design for the computer rooms required inputs from people of different specialty on the project team. The electrical and internet networking subcontractors had to work hand-in-hand with the design team to get it right the first time. This is because; any mistake in the design will mean computers will not fit into their positions properly. This will require 'rework' and temporal storage of the computers on site until work is done. However, the project team had a perfect design and both client's and planning permissions where obtained. The contractor then procured the work packages including the supercomputers work package. In the end, the subcontractor was appointed and materials order was issued. The problem was that the computers were being transported from long distances, stored on site and installed on a later date (See Appendix 13 for map) . The principles of production iterated above clearly shows that transporting materials on long distances is waste. This may not only cause waste in time and money but also could cause damage to the computers being transported. To eliminate the issue of storage, production management experts advocate the use of Just-in-time (JIT).

On the map, the value-adding and the non-value-adding activities have been identified and can be seen in below.

Table 4: Non-value-adding Activities in CTG Supercomputer installations

Non value adding activity	Solution
• Too many approval stages	Reduce number of approval levels and empower workers
• Distribution of tender documents	-
• Receiving tenders from subcontractors	-
• Getting client's approval on subcontractor selection	-
• Preparation of order form	-
• Transportation of computers	Reduce transportation distances
• Storing computers	Use Just-In-Time principles
• Moving computers from store to placement positions	Use Just-In-Time principles
• Inspection	Use Just-In-Time principles

9.2 Suggestions for improvement

- The first task in any production endeavour is "production system design". This was a statement made by Ballard et al, (2001). They advocate the 'production systems design', a systems theory approach which allows an organisation to look at its production line from a total concept point of view, from design to operations. That is, from decision regarding who is to be involved in what roles to decisions regarding how the physical work will be accomplished. This is in line with Koskela's (1997) Transformation/Flow/Value (TFV) theory. This theory argues that the whole is greater than the sum of its parts.

Table 5: Transformation and Flow Relationship (Koskela, 1997)

	Transformation view	Flow view
Conceptualization of production	As a transformation of inputs into outputs	As a flow of material, composed of transformation, inspection, moving and waiting
Main principles	Hierarchical decomposition; control and optimization of decomposed activities	Elimination of waste (non-transformation activities); time reduction; variability reduction
Methods and practices	Work breakdown structure, MRP, Organizational Responsibility Chart	Continuous flow, pull production control, continuous improvement
Practical contribution	Taking care of what has to be done	Taking care that what is unnecessary is done as little as possible
Suggested name for practical application of the view	Task management	Flow management

- In order to eliminate waste, one step used by the prominent Toyota Company Leader – Taichi Ohno, is 'mapping'. Ohno spent a great deal of time learning to map the activities on his production line which enabled him to identify the activities that added value to the product and got rid of the non-value-adding activities (Liker, 2004).

- Another method is the use of conventional process analysis tools. Process analysis focuses on elimination of waste, irrationalities, and inconsistencies (Lee et al, 1999).
- A concept widely used and accepted in most industries which focuses on the elimination of wastes of waiting and overproduction is the Just-in-time (JIT) concept. JIT delivery is concerned with supplying the right material, in the right quality, at the right time and in the right amount at every step in the process (Liker, 2004; Tommelein and Li, 1997).
- Use the pull system to draw resources and materials where they are needed to avoid high levels of inventory or possible elimination of storage on site.

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10.1 Appendix 1

Table 3.1.1 RIBA Plan of Works (RIBA, 2008)

RIBA Work Stages			Description of key tasks	OGC Gateways
Preperation	A	Appraisal	Identification of client's needs and objectives, business case and possible constraints on development. Preparation of feasibility studies and assessment of options to enable the client to decide whether to proceed.	1 Business justification
	B	Design Brief	Development of initial statement of requirements into the Design Brief by or on behalf of the client confirming key requirements and constraints. Identification of procurement method, procedures, organisational structure and range of consultants and others to be engaged for the project.	2 Procurement strategy
Design	C	Concept	Implementation of Design Brief and preparation of additional data. Preparation of Concept Design including outline proposals for structural and building services systems, outline specifications and preliminary cost plan. Review of procurement route.	3A Design Brief and Concept Approval
	D	Design Development	Development of concept design to include structural and building services systems, updated outline specifications and cost plan. Completion of Project Brief. *Application for detailed planning permission.*	
	E	Technical Design	Preparation of technical design(s) and specifications, sufficient to co-ordinate components and elements of the project and *information for statutory standards and construction safety.*	3B Detailed Design
Pre-Construction	F	Production Information	F1 Preparation of production information in sufficient detail to enable a tender or tenders to be obtained. *Application for statutory approvals.* F2 *Preparation of further information for construction required under the building contract.*	
	G	Tender Documentation	*Preparation and/or collation of tender documentation in sufficient detail to enable a tender or tenders to be obtained for the project.*	
	H	Tender Action	*Identification and evaluation of potential contractors and/or specialists for the project.* *Obtaining and appraising tenders; submission of recommendations to the client.*	3C Investment decision
Construction	J	Mobilisation	Letting the building contract, appointing the contractor. Issuing of information to the contractor. Arranging site hand over to the contractor.	
	K	Construction to Practical Completion	Administration of the building contract to Practical Completion. Provision to the contractor of further Information as and when reasonably required. Review of information provided by contractors and specialists.	4 Readiness for Service
Use	L	Post Practical Completion	L1 Administration of the building contract after Practical Completion and making final inspections. L2 Assisting building user during initial occupation period. L3 Review of project performance in use.	5 Benefits evaluation

The activities in *italics* may be moved to suit project requirements, ie:

- D *Application for detailed planning approval;*
- E *Statutory standards and construction safety;*
- F1 *Application for statutory approvals;* and
- F2 *Further information for construction.*
- G+H *Invitation and appraisal of tenders*

10.2 Appendix 13: Key Production Activities – A blow up on the of Supercomputers.