Improving the Reliability of Design Information for Procurement and Construction

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Abstract

This paper describes an approach, called 'Flow', for scheduling design work based on the flow of information between a project team, and which acknowledges the iterative nature of the process. This then allows information to be tracked as it develops towards key project milestones such as design release for procurement and construction. The paper describes how the root causes behind delays in information delivery can be seen, how the timing of design decisions can impact on design delivery, and how the true value of the design can be measured at any point in time.

1. Introduction

The design process is complex. Its complexity comes from the nature of the process which is very different to a construction process. Firstly, design is an iterative process meaning that that design solutions emerge through refinement over time. Judging and managing the time spent refining the design solution, and the quality enhancements in the design solution which result from ongoing refinement is not always easy. Secondly, design is driven by the exchange of information (both internally and externally) and it is not always straight-forward to assess the quality of information as it is to judge the quality of construction work. Thirdly the design process is defined as a series of stages and sub-problems which make understanding of each aspect easier but sometimes the understanding of the whole more difficult. Finally, the design process can involve a huge number of stakeholders who are rarely expert in all aspects of the design and construction process.

2. The Flow Methodology

The Flow methodology comprises the four stages shown in Figure. 1. In the first stage, the scope of

the design process and dependencies between activities are defined. In the second, the sequence of the process is determined based on the dependencies between activities and the iteration within the process. The third stage entails the representation of the design process in the form of a programme, enabling the integration of the design process with procurement and construction. It is in the fourth stage where the design process is monitored and the flow of work is controlled.

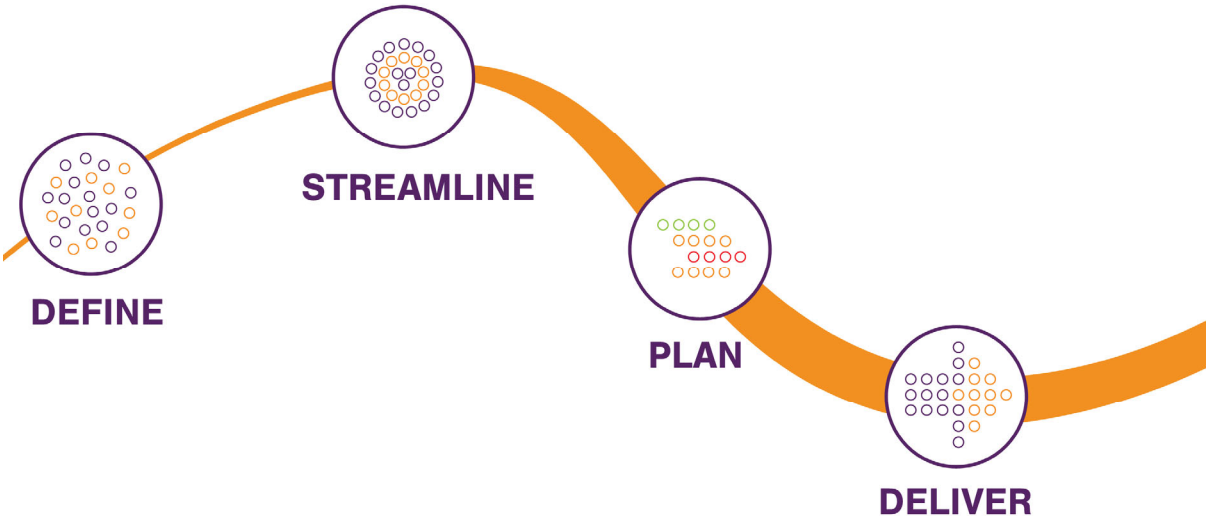

Figure 1. The four stages of the Flow methodology.

3. The Stages of the Flow Methodology

3.1 Defining the design process

Clearly to define the full scope of a design project in terms of the activities required and the dependencies between them is a time-consuming process. As far back as the Egan report the design process was identified as repeatable[1]. It has been possible to define the design process generically, with a data-library that is being expanded continuously as more projects are planned and, consequently, more parts of the process are added.

3.2 Process sequencing

A matrix approach to sequencing the design process is used (Figure. 2). A sequence of activities is calculated which minimises the iteration in the design process and ensures any assumptions which the team need to make are ones which can be made with confidence. This is achieved by weighting the dependencies between activities on a three-point scale; critical, important or ‘nice to have’. The calculation of a sequence, including clusters of inter-related tasks, prioritises the availability of outputs associated with the most critical dependencies.

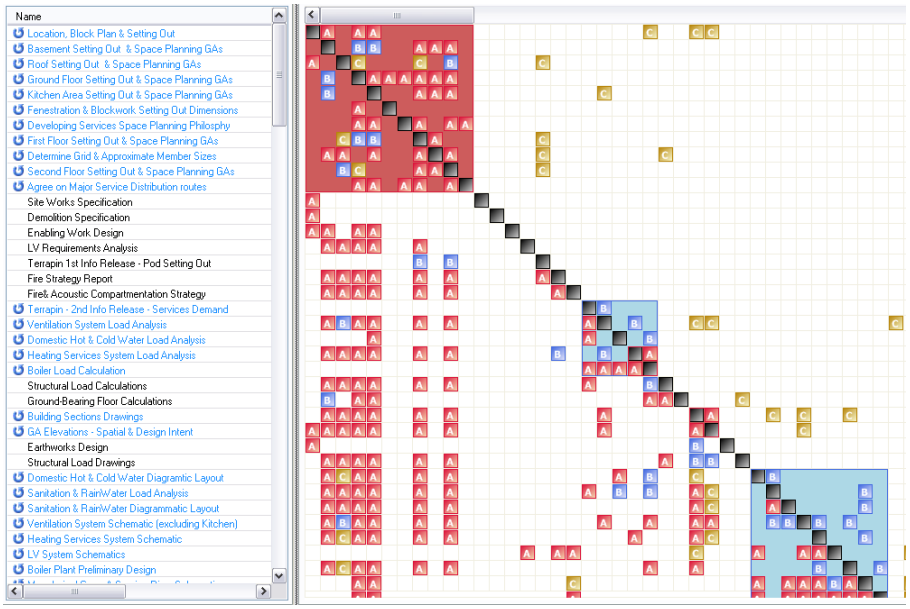

Figure 2: The design process being sequenced in the matrix

The interdependent, iterative groups of activities which remain in the process following sequencing are typically multi-disciplinary. They represent points in the design process where design team members should work concurrently to solve the interdependent problem. Usually they also represent elements of the construction, and therefore of the design output, which require co-ordination.

3.3 Programming

The sequenced design process must be represented in a programme so that design delivery dates can be seen alongside construction and procurement target dates. The optimised process is usually imported into the project management tool which the project's Planner is using to maintain the construction programme.

3.4 Controlling the design workflow

All too often deviation from the agreed design programme means that very quickly it does not accurately represent the design process being undertaken. It is then close to impossible to implement action to get the process back to the target programme and the deviation increases to the point where the programme is meaningless. Our experience is that many conventionally planned projects suffer from this problem which contributes to the general lack of confidence in design programmes. Therefore, having produced a target design programme, the design process needs to be controlled. Flow incorporates an approach to process control, based on Lean Production methods which pre-empts deviation from the target programme by analysing constraints, which then allows the programme to be kept up-to-date and used in meaningful way with potential risks to the project being mitigated in advance[2].

4. Practical Implementation

4.1 A facilitated approach to planning

Often, very little time is dedicated to planning the design stages of a project. This is in part due to the shortage of knowledge about the design stages within any single organisation or individual involved but also because design teams sometimes get insufficient notice of contract award and, therefore, are hurried into design production without adequate set-up time. These problems can be overcome by involving all design disciplines in the planning process so that their combined knowledge is captured,

and by planning the planning process itself so that it happens quickly after contract award (or preferably before it). This suggests a facilitated approach to design planning.

4.2 Dealing with iteration

The approach identifies iteration within the design process. This in turn must be represented on a programme. Usually this is achieved by grouping activities together in the programme and running them concurrently over a period of time which is deemed necessary to develop a co-ordinated design solution, thus representing the concurrent, cross-disciplinary working that is needed to develop the co-ordinated outputs from the interdependent activities.

The more significant challenge (and opportunity) lies in defining tactics to manage the design team as they work concurrently on an interdependent design problem. There is no single solution as the number or activities and deliverables, number of team members involved, and time required to develop the design will dictate the most suitable approach. What is important is that each of these issues is thought about in turn and that an appropriate approach is put in place. Recording this in the form of a procedure or method statement focuses the design team on these iterative co-ordination problems and provides a guide for undertaking the work during each period of concurrent working.

4.3 Integrating design with procurement & construction

When integrating a design programme with a construction / procurement programme, information and document release dates must be tied into dates when those same deliverables are required for tender or construction. Of course this requires a mapping between the design process and the Work Packages which typically give the construction programme its structure. Rarely does all the required design information meet with the target construction dates, particularly around the early elements of construction. In these cases, design must be expedited through the introduction of assumptions and fixity. The assumptions / fixes and their effects can be observed in the matrix stage in Flow to ensure that only the necessary ones are made. Just as important is that these decisions are made collectively, not unilaterally or left implicit by one party.

Where required design information does not meet with target tender dates it is not always necessary to introduce assumptions to ensure that all design information is available. Rather, tender information can be released incomplete and assumptions can be made in the pricing which can then be firmed up later. Analysis such as that shown in figure 3 allows the procurement team to clearly see: (i) the remaining time required to achieve 100% complete design information; (ii) the completeness of information on the target tender date; and (iii) an indication of cost certainty based on that level of completeness. Of course it is important to understand which information is missing and the impact of this upon achieving adequate cost certainty. However, when this level of understanding is required, supplementary analysis can be introduced to augment the indication given in (iii) above.

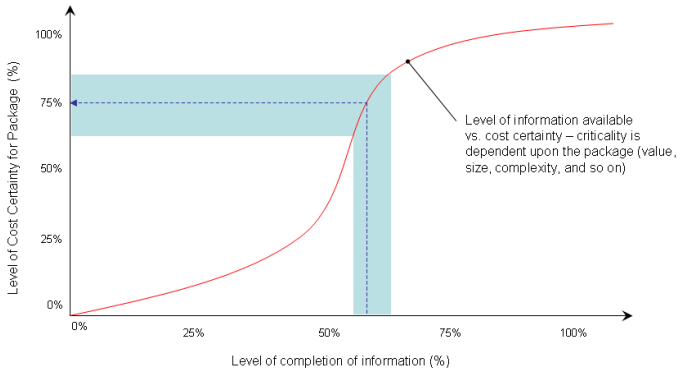

Figure 3. The relationship between design information completeness and cost certainty

4.4 Managing constraints and measuring progress

As described earlier, when managing a design project, it is important to understand where the process is deviating from the programme as a result of constraints so that action can be taken. An output of implementing Flow are reports on forthcoming activities produced at set periods for each design team member, typically fortnightly. These cover the designers' 'work plans' (activities to be undertaken in the next period) and 'look-ahead schedules' (activities due immediately following the next period), applying to design the 'Last Planner' technique used in construction[3]. The reports, which are in the form of to-do lists, are much easier for the design team to digest than a detailed programme which may have been changed in fairly subtle ways.

Designers are asked to identify any forthcoming activities which they are constrained from completing due to lack of resources, incomplete information, and so on, along with the 'root-cause' of the problem. Where these constraints exist, activities are not promoted from the look-ahead schedule to the work plan. This means that in any period the designers are only asked to undertake activities which are free of constraints and which, therefore, they are able to complete without delay. In the meantime, any constraints are removed so that those activities can be completed in the next work plan period. Trends in constraints can be tracked so that recurring problems can be pinpointed and addressed.

At the end of each work-plan period (which is the point where constraint-free activities in the look-ahead schedule are promoted to the next period's work plan), the design team report the progress made and the status of any constraints. Progress on each activity is reported as either '% complete' or 'expected completion date' since it is widely recognised that effort and time do not necessarily share a directly proportional relationship (figure 4).

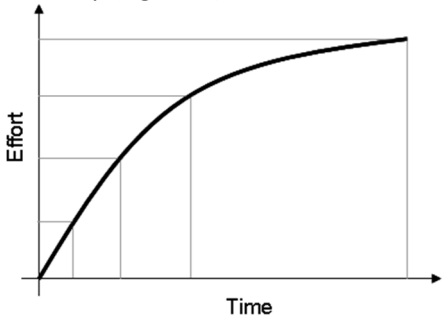

Figure 4. Typical profile of effort versus time for a single design activity

Overall progress in a project is measured in a number of ways:

(i) the proportion of overall time or effort accounted for;

(ii) the rate at which documentation, such as drawings and specifications, or design information is produced;

(iii) the proportion of activities due for completion which are completed ('percentage planned complete') or the proportion of activities due to be progressed which have been ('work in progress') (Fig. 5).

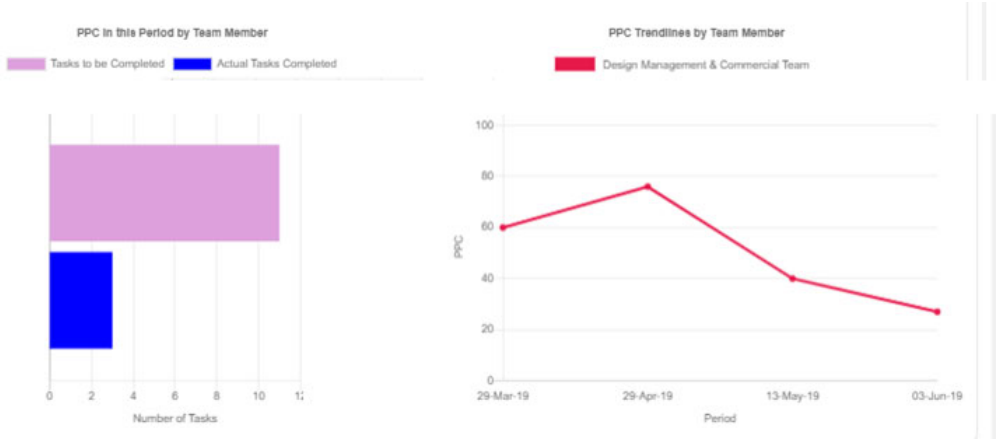

Figure 5: Example of a PPC progress report.

The first of these measures is very commonplace – it is the measure which is frequently given by scheduling tools – but gives credit to the team for all incomplete activities. This means that if all activities are 90% complete, then the overall progress of the project is 90%. Clearly this is a false level of completeness if no activity has yet been completed. The second of these measures are useful since they are very easy to validate, in particular the completion of documentation which can also be said to be a measure of design information quality if documents are being checked and approved as fit-for-purpose. The third measure is important since it reflects whether the correct things are being done and because it is only upon the completion of a design activity when all of its outputs can be said to be fully co-ordinated and complete. The measure focuses the team upon fully completing activities since a report that all activities are 90% complete scores a PPC of zero. So, the scenario where an activity's progress develops over time by 0, 50, 80, 85, 90, 95% can be replaced by 0, 50, 100%.

In reality, none of these measures gives an accurate picture of a project on its own. However, when combined they give a strong indication of the quality of the design delivery. Of course, the combination of these measures can be readily compared to a very commonplace measure: the rate at which design fee is being spent which is usually recorded on time sheets. Therefore, the application of Earned Value Management[3,4] is enabled within the design process.

5. Benefits

Robust underlying evidence of the overall impacts of Flow implementations has been gathered by an independent consultant. Two projects have been examined in detail and senior project representatives have been interviewed in a structured manner. Despite the fact that the two projects were of a different size and nature (being a circa £35M retail development and a circa £380M healthcare project) and undertaken by different teams, this process has identified largely common areas of impact:

- Flow identifies and removes "turbulence" from the project process
- It provides greater certainty of design co-ordination;
- It offers an ability to better prioritise design work;
- It integrates sub-contractor design with consultant design in an effective way;
- Management of design change is more effective than is typically the case;
- Collaboration between design team members is improved;
- Workflow control focuses the team on task completion;
- It fosters a 'self-policing' design team; and
- The relationship between delivery of outputs and design fee is made clearer.

Three stark examples of these impacts which were quantified:

- Design co-ordination - 32 week saving on achieving co-ordinated design in one complex work package;
- Change management - at least 5 man-weeks saved in avoiding the knock-on effect of a change; and
- Design outputs - c£75K saving where design fees were linked to achievement of design outputs.

It is clear from these examples that there are significant benefits to be derived from the implementation of the approach. Of course, these benefits are not derived without any sacrifice on the part of the project team. The team must be prepared to invest in the adoption of a new approach. This means staff time contributing to the design planning process and the costs of expert advice, training and the supporting tools to deploy the technique.

6. Conclusions

Despite increased awareness of the importance of an integrated design process, and some tangible steps toward achieving this goal by the industry, projects generally continue to be delivered late and over budget.

The Flow technique offers an approach to planning and controlling design processes which is more effective than is typical in current practice. Practical implementation involves a structured, facilitated approach but this provides opportunities to establish the optimal sequence of the process and to understand the interface between design and construction. The workflow stage enables the design process to be monitored and controlled effectively.

A mounting body of evidence from project implementations has revealed a range of benefits with significant impact. Many of these can help build the 'integrated team', noted as a requirement for delivering the UK Government Construction Strategy[5], through robust modelling and optimisation of the design process and coordination of information flow.

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