

PROJECT REPORTING AND COMPLEXITY

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All project life cycles from the shortest to the longest demand from the project teams some type of reporting. Currently the construction industry perceives reporting as a bureaucratic contractual process that occurs as and when demanded by the Client or the Senior Manager. It does not contribute to the degree that it should to the decision making process and frequently the fast pace of the project makes the reporting process redundant. Reporting, as part of the *written form* of communication within the project system, is considered as the means of interconnecting the numerous activities that contribute towards the delivery of the project and the actors that are involved in the project. The interconnections or interrelations are established through the report writers (encoders) and the recipients of the reports (decoders) and these are affected by a number of factors. These factors and the number of interconnections introduce complexity. In this paper the authors will review current literature in project reporting and will present examples of reporting features that contribute to project complexity. They will discuss some of the key reporting attributes under the context of complexity and will propose a conceptual approach to minimise complexity driven in projects through reports.

Keywords: communication, complexity, information management, project reporting.

INTRODUCTION

Construction projects are typically characterised by complexity, under time and/or cost pressure and requiring creativity and cooperation (Morris and Hugh 1987, Thompson 1967, Bertelsen 2004). To mitigate the effect of such complexity the execution of construction projects relies on the effective structuring and integration of several sub-systems. From the number of project sub-systems, within project management, the reporting sub-system is seen as a feedback mechanism. A number of authors define actions to be taken in formulating the appropriate approach. In practice, reporting often presents considerable difficulty and it is perceived as a bureaucratic process that does not contribute to the decision making.

The interconnections and the factors affecting reporting accentuate the level of complexity and often militate against the efficient management of the project. The issues associated with the influence that these interconnections have on the project performance have not received extensive attention. This is because these issues are closely tied up with the individuals and their organisations, and so remain esoteric. The authors herein will review the interconnection and the reporting process within the projects, present examples of reporting features that contribute to the complexity and propose a conceptual approach to minimise it.

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CURRENT REPORTING PRACTICES

Project reporting and communication, at least theoretically, involves extensive investment in time from the project manager and the team. For example Prichard (2004), argues that the Project Management Institute (PMI) certification exam suggests that 90% of the Project Manager's time is invested in communication. Such an extensive time devoted to communication highlights the need for, and importance of clear messages and reporting during the life of the project. Reiss (1995), Lock and Harrison (2004), Pritchard (2004), Turner (1999), collectively present the required aspects, the details for information, the manner and the content, as well as the required ability to design the project documentation and the process. They argue that the *report* should be made against the *plan* – (a common plan), have defined criteria, issued at defined intervals, discussed at formal meetings and that tools should be simple and friendly. For example Pritchard (2004) indicates that reports afford insight on the current standing of the project, as well as the effort taken to get it to its current stage. The literature on reporting identifies issues involving 1) *organisation and/or project structure and roles*, 2) *structure of data*, 3) *corporate requirements*, 4) *contract law and procedural demands*, 4) *people issues*, 5) *software and technology intricacies*, and 7) *information / communication inadequacies*. Each of these issues is briefly reviewed in some more detail in the subsequent sections.

Structure and Roles

The APM BoK (2000) in sections 36, 66, and 67 provides brief guidance on information management, the organisational structure, the roles and communication respectively. Whilst this guidance is at high level and easily accessible there is evidence that in practice this is not followed. Moore (2002) and Pritchard (2004) indicate that reporting, as part of the data-gathering process, affects and influences the project's organisational structure. Likewise, without structured, data people will report progress in a way that puts them in the best light (Turner 1999).

Corporate requirements

Regulatory activities (Miller and Rise 1970) are concerned with information (Moore 2002). These activities in any project will have to be defined and supported by the appropriate organisational and data structure and the project information system. Also the corporate approach to Project reporting Vs Financial reporting and the relevant interfaces affect project reporting. Simple establishment of protocols (Pritchard 2004) and reporting at each level of the structure (Turner 1999) should integrate information, however in many cases these serve only a bureaucratic process and nothing further. Financial 'engineering' takes over at the interfaces to replace information that comes from the project reports. This is noticed by the teams who then filter further the information from projects.

Contract and Procedures

Contractual obligations and strict procedures also make reporting seen by practitioners more like a bureaucratic process rather than a management tool that supports the decision making process. Institutions and in some cases government departments, issue instructions and apply pressure to companies and personnel to carry out processes that on many occasions do not consider prevailing conditions, thus creating confusion and introduce/increase conflict. The flexibility required to define the project specific documentation and the reporting process has been removed from the project management process.

People issues

The restrictions and obligations imposed raise a number of people issues, given that reporting is part of the regulatory activities (Miller and Rice 1970). This is also accentuated by the fact that management activities are frequently perceived as a non-value generating provider of services (Singo 1988). Impartiality, peer as well as management pressure and acceptance of tools (Jaafari and Manivong 1998 and Stephenson and Scrimshaw 2003) contribute to the list of problems. Turner 2005: 14 states “*a manager in IBM told me that junior people may avoid making honest reports in project reviews for fear of upsetting middle managers*”. Also Dickson (2005) identified this as a common reason for project failure. Management and briefing of stakeholders should also be considered carefully.

Software and Technology

The use of a number of different software packages and the different approach in providing support to Project Management functions causes problems (Jaafari and Manivong 1998). This is neither effective nor efficient for the following reasons (some of them are mentioned by Jaafari and Manivong 1998 and Turner 1999):

- Duplication of effort by a number of parties,
- Multiple data entries, each using their own data modelling and structure,
- Difficulties in coordination of information across the software packages,
- Lack of integrated (compounded effect) analysis,
- Increase of complexity due to the increase of the number of interconnections,
- Reduced accuracy of transfer of realistic as well as actual information,
- Large number of iterations of encoding and decoding information,
- Manipulation of information to suit the requirements.

Also in many occasions it is the peoples’ behaviour and acceptance of the tools and systems used that is of greater importance. Jaafari and Manivong (1998) indicate that there is a great deal of ground to be covered in terms of getting near minimising complexity with the application of technology. In addition there are conflicting views in the current literature regarding transferability of data between software tools with Pritchard (2004) saying it is recommended whereas Jaafari and Manivong (1998) suggesting that it should be avoided as this can increase complexity.

Communication

Information, communication and the importance of interconnections in projects is also highlighted in both PMI BoK (2000), Chapter 10 and APM BoK, Topic 70. Pritchard 2004 and Gareis and Huemann (2000) also mention the development of a protocol of communication and other documentation that will create the links, the structure and describe the flow of information. This flow is bi-directional (Ford and Sterman 2005) and therefore is governed by the formula (n^2-n) , where ‘n’ is the number of information nodes - senders, receivers. In this bi-directional flow Pritchard (2004) identified the following factors; filters, which are used by the encoders and decoders, the message, which is formulated by the encoders and deciphered by the decoders and the medium, usually the software or the tools used, which carries the message. Therefore each bi-directional communication line carries and possibly amplifies or even transforms these three variables. Further on Prichard (2004) classifies the

number of communication problems that one could come across under three categories, a) encoder or decoder, b) message and c) medium problems. Some of those problems are listed below and the authors provide an indication of a possible outcome.

Sender / receiver problems: “*The message is received in a format that is not understood*”; therefore complexity and confusion arises, or “*The message is received but misinterpreted*”; resulting in increased complexity.

Message problem: “*The message is in the wrong language*”, e.g. jargon used by sender; therefore again confusion and complexity arises.

Considering the bidirectional flow of information, the factors that influence reporting and the interdependency of the information nodes one can immediately understand how easily complexity can arise (Williams 1999) and therefore reporting becomes an even more difficult process. Increased concurrency also increases complexity.

ASSERTIONS

The following examples will present some of the above mentioned issues and complexities:

Software and Technology

Jaafari and Manivong (1998) explore a number of possibilities for creating a structure for communication, however, after investigating a number of options, from systems evolving through linking to intelligent agents, establish a specific product and/or configuration model of a project as a basis for the system design, where “information sets will determine the physical nature of the end facility”. A similar approach was followed with some considerable success on the construction of a major facility in UK (Antoniadis 2004). However, as the project progressed and due to other company protocols, some problems arose when attempting to monitor contingencies.

Also it is obvious that the clarity of the message is diluted when this is not conveyed by the tool that produced it. This was identified and the practice of transferring information to and the use of spreadsheets was challenged by the Commercial Director of a major UK Organisation. On another instance, at a major programme of works, when data were transferred from the scheduling tool to a spreadsheet, complexity and confusion was generated between all the parties.

Structures and roles

On another major programme of works in UK contractual requirements imposed a number of reports by ‘setting’ a reporting schedule. Lack of clarity, structure and roles as well as the generalisation and the attachment to contract documentation did not support the whole purpose of reporting. Within a short period consultants were asked to look into problems with reporting and establish proper processes and reports.

Corporate requirements (Project reporting Vs Other reporting)

Misrepresentation of project information is one of the major reasons for causing confusion and complexity, in the case of government interference / ‘*strategic misrepresentation*’ (Flyvberg 2006), the most renown example has been that of reporting during hurricane Katrina.

At company level also there is continuous pressure on projects, usually by finance departments at the end of the financial year, to manipulate the information to suit the requirements – internal or external.

COMPLEXITY

Project management exists in a complex environment (Thompson 1967, Bertelsen 2004) therefore reporting, as a subsystem, will also exist in this environment and will be affected by the characteristics of complexity. The application of complexity theory is to enable the systematic review of the inter-connections. Lucas (2000a) states that complexity is the study of the interconnections of systems and change and that “*it is the interactions of structures that are important not which objects are interacting*” (Lucas 2000b). Reporting acts as such a means of interconnecting systems and subsystems within Project Management. This is achieved through the known forms of communication, and can be perceived as the means of carrying forward, concealing and in some cases increasing, complexity. If we analyse and understand these characteristics we should be able to respond with the necessary actions, improve the decision-making process, the output and above all improve confidence in reporting.

From the extensive work that Lucas (2000a) has carried out we list below the 16 distinct characteristics of complexity that he has identified with a brief description. These characteristics have been grouped by the authors (see column 1, Table 1) in order to classify each characteristic for further analysis in Table 2.

Table 1: Complexity Characteristics based on Lucas (2000a)

Group	Characteristics	Brief Description
Conditional	Autonomous agents	Complex systems are generally composed of independent or autonomous agents (not the identical parts often assumed in science). All of these agents are regarded as equally valuable in the operation of the system
	Instability	Over the long term stepped evolution or catastrophes will exist (similar to punctuated equilibria). Sudden swaps between attractors become possible as the system parameters approach the boundaries of the attractors
	Non-equilibrium	Energy flows will drive the system away from an equilibrium position and establish semi-stable modes as dynamic attractors
	Non-linear Attractors	Complex system outputs are not proportional to their inputs Self-organization relates to the presence in the system of dynamical attractors
Developmental	Co-evolution	The parts are regarded as evolving in conjunction with each other in order to fit into a wider system environment
	Self-modification	Parts can change their associations or connectivity freely - either randomly or by evolved learning procedures
	Self-reproduction	Usually these systems have an ability to clone identical or edited copies
	Downward Causation	The existence and properties of the parts themselves are affected by the emergent properties (or higher level systemic features) of the whole
	Mutability	Random internal changes (mutations) or innovations typically occur in these systems.
	Non-uniform	Each part evolves separately, giving a diversity in rule or task space
	Emergence	The properties of the overall system will be expected to contain functions that do not exist at part level
Behavioural	Phase changes	Feedback processes lead to phase changes, sudden jumps in system properties
	Unpredictability	In such interacting systems a chaotic sensitivity to initial conditions can occur
	Non-standard	... initially homogenous systems will develop self-organizing structures dynamically
	Undefined values	The meaning of the system's interface with the environment is not initially specified and this must evolve

Table 2 below represents a simple classification of reporting and/or project management features against selected complexity characteristics in order to demonstrate applicability.

Table 2: Classification of project features against complexity characteristics

Autonomous agents	representing self-organisation of individual agents, the various parties to a project, within the system, who obey different rules, or local instructions, instead of following central laws.
Non-standard Downward causation	demonstrating the dynamic development of self-organisation within projects. the property that describes how the parts are constraint from the higher level features and which become boundary conditions ‘ <i>on the freedom of the parts</i> ’. Therefore in terms of the reporting it could be easily described as the setting of the WBS, and the other project structures.
Self-reproduction	systems replicate and thus copy ‘errors’, from one project to the next. These errors allow new system structures to evolve as well as adaptation to new boundary conditions. Therefore there is a requirement for flexibility.
Undefined values	systems that interface with the environment must evolve and thus demand the early establishment of dynamic communications.
Non-equilibrium, non-uniform	The later signifies the fact that complex systems, projects, evolve separately and the former the fact that influences within the system will drive it away from the equilibrium and establish dynamic attractors.
Self modification	the parts, teams and members, have the flexibility to change their associations freely.

ANALYSIS

From the brief description of the complexity characteristics in Table 1 and the points raised under current reporting practices, a review of the issues raised was carried out. On the table below an indication is given about which characteristics affect which particular reporting issue. The table below also indicates an initial but non-exhaustive cross-linking.

Table 3: Cross reference of reporting issues and complexity characteristics

Organisational Structure	Affected by Self-modification, autonomous agents and instability
Roles within the organisations and the project teams	Affected by Mutability and instability
Structure of data	Affected by Downward causation and unpredictability
Corporate requirements	Affected by Phase changes
Procedural and contract law requirements	Affected by Unpredictability as the sensitivity of the initial conditions (Law, Institutions) affects the project set up
People issues	Affected by Co-evolution, unpredictability and non-standard
Software and technology	Affected by Non-linear, attractors and self-reproduction
Information and Communication	Affected by Attractors, phase changes and instability
Project characteristics e.g. monetary size and frequency of reporting	Affected by unpredictability, non-standard, undefined values, non-equilibrium, non-linear (and in the case of weekly reporting it acts in a reverse way instead off increasing value it reduces it.), co-evolution

Having identified the particular complexity characteristics we will proceed to propose appropriate actions in order to improve the reporting subsystem.

RESOLVING REPORTING COMPLEXITY

From the review and analysis it can be seen that reporting as a process can be analysed and reviewed in the context of complexity.

Communication and information flow, which generates reports, is not only coming into and flowing out of the process, but it is also created within and by the process and is affected by complexity. Figure 1 below gives a diagrammatic representation.

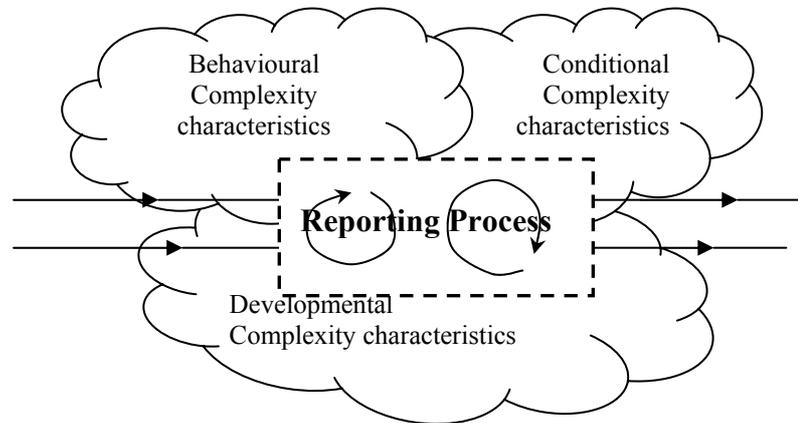


Figure 1: Diagrammatic representation of the effects on reporting process.

When structuring the project organisation, consideration should be given to the individual parties that contribute to the project, the agents that equally contribute to the execution of the project. Dictating the output might not be appropriate because it does not permit self-modification and it will induce instability. Instead the level of required information can be standardised by introducing the established project management structures down to a certain level. By introducing downward causation, to a certain level, the undefined values (interfaces) are established from a very early stage and the autonomous agents are able to self-modify their corporate reports to the project requirements. Also allowing for flexibility at the lower level, the various parties, in cooperation with the project team, will be able to mutate and co-evolve creating a linked system of information at the lowest level, where measurable information exists. From the project management side the structured information will allow for drilling-down, or rolling-up to various levels minimising the occurrence of filtering. It will also increase confidence of the various stakeholders. The stakeholders will have to be introduced to and trained on the reporting structure.

The project team will also have to consider the level at which information is addressed to, its density and/or level of complication. This will adjust the levels of non-equilibrium, which if not monitored will tend to drive the system away from the equilibrium position. It will also adjust the level of acceptance from the parties outside the project, both client and individual organisations. However, these energy flows vary during the life of the project, with different parties starting at different stages and changes happening to the recipients – decoders. Therefore the team will have to introduce dynamic attractors, experienced project support personnel that will monitor continuously the system and make the necessary adjustments/changes and control instability. As these attractors sense chaotic actions in their boundaries they intervene to advise and introduce stability within their own sphere. As the project environment becomes more complex and demanding the importance of the project information system been flexible, instantaneous, comprehensive and intelligent is

paramount (Jaafari and Manivong 1998) and the attractors could enable such activity. The creation of a flexible and structured information system will accommodate these demands but will also remove the threat of duplication of effort, the number of different filters and levels of noise introduced from the different agents, the use of different software tools. The availability of web based collaborative tools enables all mentioned here as well as providing the non-linearity which should exist in any reporting system.

The project team will need to prepare and discuss a Stakeholder Analysis matrix, using Power Vs Level of Interest and Power Vs Level of Influence matrices. This will give a clear indication of interconnections, boundaries and the Stakeholders' required level of information. The continuous review of the stakeholders' requirements, including changes of the players, will allow for reduction of instability due to changes in the parameters. The analysis also should include requirements dependant on the project characteristics. For example if the project is small, e.g. 13 weeks duration and below £5M, the agents will need to define the frequency of reporting.

With regard to frequency and content the team should examine and critically discuss with the decoder the deliverable (report) in terms of value adding, content or 'how new are the news', and level of detail. Considering single page reporting - dashboard approach, utilisation and necessity versus contract requirements.

All the definitions and descriptions of structures, coding, frequency and media to be used should be described in the standard project management documentation. In particular the communication plan should be part of the Project Control Handbook (Antoniadis 2004), which describes all the necessary processes as well as the interfaces with and within the project environment.

On the behavioural side, the agents react not only to the content but also on the way information is presented, the 'texture' of the message as well as the (management) level that has been included in the output, resulting in the occurrence of instability and conflict. Encoders will have to consider that behaviours change when things are put in paper. Project team members consider that anything on paper is a contractual action and relationships change, unpredictability and filtering increase, complexity propagates and the level of performance decreases.

Duplication of effort between autonomous agents must also be reduced. There is no worse de-motivating factor than knowing that someone else is producing the same report, or that the report will not be even read, or that some form of manipulation of information will occur. In this case self-reproduction is the biggest threat to the project. At a similar level it is unreasonable to have personnel employed solely for chasing progress information. The message is diluted as the encoder is not the real owner/the source of the information. This type of differentiation does not contribute to the improvement of the system, or the reduction of complexity. In a similar manner interventions by more senior personnel should be minimised. Above all it should be accepted that reporting is not just a contractual obligation but that it is also about trust, truth, patients and understanding, and not over-reacting.

Discussion

There is a requirement for flexibility in reporting, however by fixing the outputs we are restricting evolution of the subsystem as the project progresses. It is the regulation of the boundaries, the minimisation of influencing factors and the software systems used that control the level of reporting complexity in projects. We can thus deduce

that the level of complexity increases, when requests from various parties are not coordinated nor standardised, the frequency of reporting does not fit the systems available, nor the timetable, the systems used do not minimise/reduce duplication of effort, the boundaries are not regulated, the interconnections and their critical factors are not appreciated, nor understood, the communication channels are not kept to a manageable level.

Project Managers (PMs), who have to respond to the contractual demands should be able to review the process and take appropriate action(s). Also institutions that enforce the process will have to reconsider the 'practice' of reporting and provide appropriate guidance. Is there a ready made solution that can be given to PMs so that they can overcome the problems and avoid complexity? Equifinality teaches us that there is not a single solution to a problem, and if each project and project manager are different then there is not one simple solution and above all there should not be one standardised answer, because this will only cause more problems. PMs using their experience, and with guidance from more senior personnel, should consider the project intricacies, the stakeholders' expectations (in terms of reporting), the level of comfort of the client, the other members of the project team (from the different parties) and then formulate a strategy. This strategy must be discussed with the client, the decoder, and the other parties that contribute to the generation of the information, the other encoders. This will reduce filtering, and therefore minimise complexity.

CONCLUSION

With the current approach to reporting, there is no other possible outcome but for the PM to be economic with the truth and the real message. If the news is not good, the output is filtered to such an extent that it is becoming unrecognisable, the interconnection(s) become frustrated and conflict inevitably occurs. Complexity has prevailed because its characteristics have not been considered.

At higher, than the project level, reporting should act as an error adjustment mechanism and a tool for decision making. At project level and depending on the size of the project, the agents will need to consider the input from the other agents, the effect of non-linearity, how each agent co-evolves and that mutability needs to occur in order for the project to fit the wider project environment. The experience of the team, the understanding of complexity characteristics, and above all awareness of the behaviours, must be used in order to establish the necessity for attractors which will prevent instability. The undefined values must be minimised, however all agents must understand that emergence needs to occur at project level. If these characteristics are not considered, reporting becomes a bureaucratic process and a carrier of complexity and conflict.

Further research is required to determine, the type and sources of information, the identification of appropriate attractors and the suitable technology (web based tools) which will automate the process as much as possible.

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