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# Socio-organo complexity and project performance

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**Abstract**

Technical complexity has always been considered a factor which affects project performance. Scheduling and other mechanisms have been proposed which allow for the management of these effects. However, the effect of the complexity of interconnections, and in particular those caused by social interfaces and boundaries between the various teams, have not been investigated. Socio-organo complexity is caused by interconnections which if not managed could lead to a reduction in performance. Understanding the characteristics of complexity of interconnections, how these affect project schedule performance and what deductions can be extracted, will enable the development and implementation of innovative actions and tools that will support the management of the effects of complexity through the respective processes. The authors present results of five case studies, with UK construction organisations, which demonstrate that the effects of socio-organo complexity of interconnections have similarities with the behaviour of underdamped control systems. The results from the study have significant implications for the way socio-organisational issues are managed but will also enable parallels to be drawn between the fields of project management and control systems.


*Keywords:* Complexity; Interconnections; Projects; Performance; Control systems

## 1. Introduction

Construction projects, and in particular mega projects, often involve a large number of parties and subsequently interconnections. These interconnections can generate complexity which, however, has defined characteristics (Lucas, 2000b). Complexity on projects has been researched extensively in the last decade and a number of proposals have been made in terms of managing its effects (Gidado, 1996; Williams, 2002; Lillieskold and Ekstedt, 2003; Geraldi, 2008; Girmscheid and Brockmann, 2008). In terms of the relationship between complexity and project schedule performance and although heuristic considerations exist, which suggest an exponentially decaying/inverse correlation, very little has been done in identifying the exact relationship. Furthermore, most of the studies have been carried out on the technical side and very little has been investigated in terms of the socio-organisational aspects of complexity of interconnections and its effects, especially when implementing processes such as selecting team members, structuring the project team, or the management style adopted. Within this paper the authors present the results from five case studies investigating the effect of socio-organo complexity on project schedule performance. The case studies, part of a wider study into socio-organo complexity, were carried out in the UK construction industry with some major organisations. The results indicate that the relationship, although one of an inverse correlation, does not resemble a straightforward exponential decay curve but rather one of an underdamped transient motion. The verification of this relationship not only confirms the non-linearity of project management, especially regarding socio-organisational issues, but it can also be proven very powerful considering the potential extrapolation and implementation of techniques already proven in the field of systems control.

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## 2. Background

The management of projects transpires in a complex environment (Bertelsen, 2004). The application of complexity theory to the management of projects can, therefore, enable the systematic consideration of the conditions that give rise to such complexity. A number of authors have indicated that interfaces generate complexity (Baccarini, 1996; Gidado, 1996; Williams, 2002), however complexity can be associated more with the interconnection structures that link various objects and not the objects themselves (Lucas, 2000a). As a result, considering the prevailing conditions in projects the argument can be easily juxtaposed to the project environment. In one sense, project management can be considered as optimisation of the structuring of the interconnections that link up the delivery systems and subsystems. Understanding the characteristics of these interconnections, especially from a socio-organisational standpoint and how these affect the project performance, can contribute to the design of more efficient project delivery systems. In particular, it should enable project managers to respond with the necessary actions and improve the setting up of projects, the management style adopted and the decision-making process. Lucas (2000b) has suggested that complexity arising from interconnections reflects distinct characteristics. The 16 characteristics directly relevant have been mapped onto project conditions and detailed description has been presented in Antoniadis et al. (2006).

Construction projects are typically characterised by complexity; under time and/or cost pressure and requiring both creativity and cooperation and which, for most projects, reflects a dynamic process involving non-linear procedures (Bertelsen, 2004). Previous analyses of complexity in construction projects have been conducted mainly from a technical perspective (Gidado, 1996; Lillieskold and Ekstedt, 2003) and not directly addressing the effects of complexity on project schedule performance. Only recently has the subject of complexity been linked to non-technical project aspects such as communication, behavioural and social issues (Geraldi, 2008; Girmscheid and Brockmann, 2008), again though not directly linked to the effects of socio-organo complexity of interconnections on project schedule performance.

Empirically/heuristically it is presumed that as complexity increases performance drops (inverse correlation) and the expected graphical output resembles that of an exponentially decaying curve (e.g. $e^{-x}$) or a curve similar to an overdamped system such as that presented in Fig. 1 below. Fig. 1, depicts the theoretical harmonic oscillations of systems as these come under the influence of various damping devices.

The overall concept of motion represented in Fig. 1 can be described by the equation:

$$\frac{d^2x(t)}{d^2t} + 2\zeta\omega_n\frac{dx(t)}{dt} + \omega_n^2 x(t) = 0 \quad (1)$$

Using the equation of motion (Eq. 1) the graphs depicted above (Fig. 1) are a combination of two motions (Beards, 1981) which are expressed by the general mathematical function:

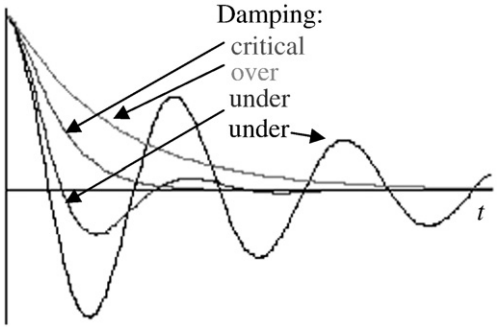


Fig. 1. Harmonic oscillator with damping. Various cases are depicted, from underdamped to overdamped. As presented in http://www.scar.utoronto.ca/~pat/fun/NEWT1D/PDF/OSCDAMP.PDF.

$$x = \left[Ae^{(-\zeta\omega t)}\right]\left[\sin\left(\omega\left(\sqrt{\left(1-\zeta^2 t\right)}\right) + a\right)\right] \quad (2)$$

where:

- $\omega$ = undamped natural frequency
- $\zeta$ = damping ratio

The first part of Eq. (2), $[Ae^{(-\zeta\omega t)}]$, expresses the exponential decay element and the second part, $[\sin(\omega(\sqrt{(1-\zeta^2 t)})+a)]$, expresses the circular frequency element (Beards, 1981).

Therefore, depending on the outcome of the investigation there could be some correlation between the effect of socio-organo complexity of interconnections onto project schedule performance and the effect of damping on transient motion. Also, since much of the socio-organisational complexity is associated with the organising and the management of projects these areas form the focus of investigation in this paper.

## 3. The investigation

The review established the need for further investigation of the relationship between socio-organo complexity of interconnections, in particular the processes of selecting team members, structuring project teams and the management style adopted, and project schedule performance. Therefore the following Study Question (SQ) was formulated:

SQ 1: Socio-organo complexity of interconnections is inversely correlated to project schedule performance.

In order to investigate the above question it was decided to conduct a carefully developed, closed design (Yin, 2003), multiple case study approach, for 9 weeks or two project reporting periods, with an adaptive and flexible feedback mechanism. The importance of implementing multiple case studies was based on the fact that:

- Fears of uniqueness and artificial conditions surrounding the case(s) are minimised; and
- To enable literal replication logic (Yin, 2003).