Chapter 20

Using Network Analysis and Visualization to Analyze Problematic Enterprise Information Systems

David Greenwood
University of St. Andrews, UK

Ian Sommerville
University of St. Andrews, UK

ABSTRACT

Society is demanding larger and more complex information systems to support increasingly complex and critical organisational work. Whilst troubleshooting socio-technical issues in small-to-medium scale situations may be achievable using approaches such as ethnography, troubleshooting enterprise scale situations is an open research question because of the overwhelming number of socio-technical elements and interactions involved. This paper demonstrates proof-of-concept tools for network analysis and visualisation that may provide a promising avenue for identifying problematic elements and interactions among an overwhelming number of socio-technical elements. The findings indicate that computers may be used to aid the analysis of problematic large-scale complex socio-technical situations by using analytical techniques to highlighting elements, or groups of interacting elements, that are important to the overall outcome of a problematic situation.

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1. INTRODUCTION

Systems science has long since been applied to the study and troubleshooting of socio-technical systems. The conceptual reframing of work organizations in terms of socio-technical systems came with the publication of Eric Trist’s (1950) “The Relations of Social and Technical Systems in Coal-Mining” (Trist, 1981). This research arose due to ‘human relations’ problems arising from technocratic technology led work transformation approaches practiced during the era. Between 1950–1970 studies and action research evolved a set of socio-technical design principles to maximise productivity by optimising the organisation of workers and equipment rather than using Tayloristic principles to organise workers around equipment (Trist, 1981; Clegg, 2000). Whilst these insights and design principles were derived from studies and action research in industrial settings such as coalmines, textile factories, automotive manufacturing and power plants, similar problems were observed in office based work environments once information technology had been introduced (Ackoff, 1967; Mumford, Mercer et al., 1972; Bostrom & Heinen, 1977).

Problems associated with technocratic technology led work transformation have never been resolved. For example, Doherty and King (2001, 2005) and Doherty, King et al. (2003) report that socio-technical issues are still common when information systems are implemented. In the 1990s we even witnessed the popularity and ‘mixed results’ associated business process reengineering – a form of technocratic technology led work transformation (O’Neill & Sohal, 1999; Mumford, 2006). These problems are arguably more acute today than ever before as society is demanding the development of larger and more complex information systems to support increasingly complex and critical organizational work (Bullock & Cliff, 2004; RAE, 2004; Baxter & Sommerville, 2011). Whilst analysing socio-technical issues in small-to-medium scale situations may be achievable using approaches such as rapid ethnography (Mullen 2000) combined with a theoretical framework such as distributed cognition (Hutchins, 1995) or activity systems theory (Engestrom, 2000); analysing enterprise scale situations is an open research question because of the overwhelming number of socio-technical elements and interactions involved (RAE, 2004).

In recent years a new set of tools and techniques from complexity science has become available to socio-technical systems scientists and engineers. Advances in complex network analysis may provide a fertile territory for exploration as in the past these techniques were only accessible to mathematicians and computer scientists. Complex network analysis has enabled physicists, chemists, epidemiologists and social scientists to study systems comprising thousands and millions of nodes in applications as wide ranging as social network analysis to metabolic pathways. We believe that these techniques may be of practical use to the analysis of problematic socio-technical systems in organizational settings.

We demonstrate, via means of a case study comprising 30+ nodes and 50+ interactions, proof-of-concept tools for network analysis and visualisation that may provide a promising avenue for identifying problematic elements and interactions amongst an overwhelming number of socio-technical elements. We demonstrate the potential of this approach by showing that: i) a problematic situation may be represented as a directed graph such that the elements in the situation are represented as nodes, and interactions between nodes as edges; ii) that eigenvector centrality, a well established measure of node importance, may be used to rank the importance of elements in a situation and that highly ranked elements match those identified as important by a human analyst; iii) the ‘complexity’ of a situation, or a part of a situation, may be characterised using a feedback degree score which provides an indication of the
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