Using visual information analysis to explore complex patterns in the activity of designers

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The analysis of complex interlinked datasets poses a significant problem for design researchers. This is addressed by proposing an information visualisation method for analysing patterns of design activity, qualitatively and quantitatively, with respect to time. This method visualises the temporality of interrelations between interlinked variables and, as such, can be applied to a range of datasets. By providing a statistical analysis of the networks' growth the proposed method allows for the modelling of complex patterns of activity. Throughout, the method is demonstrated with respect to a fully realised example of information seeking activity. The core contribution of the proposed method is in supporting the analysis of activity with respect to both macro and micro level temporal interactions between variables.
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Their paper demonstrates a method for using information visualisation and statistical analysis to explore complex patterns in the activity of design practitioners, over time. Within design research there has been a major and long lasting research focus on the activities (Dorst & Dijkhuis, 1995; Pedgley, 2007) and behaviours (Coley, Houseman, & Roy, 2007; Hyldegard, 2009) of the design practitioner. This has been supported by a range of empirical studies (Goodman-Deane, Langdon, & Clarkson, 2010; Robinson, 2010) based on both quantitative (mainly realist or positivist) and qualitative (mainly constructivist) approaches (Lethbridge, Sim, & Singer, 2005).

Despite this research focus, much of the complexity of designer activity remains inscrutable due to the limitations of current quantitative approaches. This is particularly problematic in the context of the evolution of activity over time. Current approaches typically use protocol based techniques (Chai

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& Xiao, 2011; Gero & Mc Neill, 1998) which, Gero and Mc Neill state can be generally characterised as developed during the analysis. However, Gero and Mc Neill (1998) go on to highlight that in design this type of analysis is typically based on a segmented timeline where protocols are split up over time based on various factors, such as information activity (Robinson, 2010) or artefact use (Huet, Culley, McMahon, & Fortin, 2007). The idea of a segmented timeline is consistent with all of the major approaches to this type of analysis in the design research literature. For example, Goldschmidt and Tasta (2005) discuss the foundational work of Wang and Habraken (segmented timeline) to help contextualise design moves — steps that parse the design process into short verbalisations on a timeline. Further, Gero and Mc Neill's (1998) 'episodes' again form a decomposition over time which can themselves be segmented based on, for example, domain, micro strategy (Gero & Mc Neill, 1998) and function—behaviour—structure (Kan, Gero, & Tang, 2011). However, using this type of analysis does not readily allow for the quantitative assessment of patterns of activity or the evolving relationships between activities over time. A more detailed example of this type of issue can be found when we consider the work of Dong, Kleinsmann, and Deken (2013), whose analysis of design cognition encountered a number of interlinked variables including *team*, *architect*, *culture*, *energy* and *health*. In this case, Dong et al. chose to analyse this data using several measures including the rate and duration of each variable, a graphical representation of the subject's communication acts and a numerical analysis of the total percentages of communications and moves with respect to Dong et al.'s concept of frames. Nevertheless, despite the clear and useful contribution of Dong et al.'s work there are difficulties in linking multiple variables and identifying patterns beyond those at the individual variable level. Thus, a key limitation of current work is the analysis of multiple variables in a complex setting.

Therefore, by focussing on the common feature of this type of analysis — decomposition of the design process into distinct periods in time — the method proposed in this paper builds generalisability across research foci and analysis approaches by giving generic steps for the visual analysis of any activity based dataset decomposed over time. In this sense the proposed method is both complementary to and expands upon the ideas expressed in the development of Linkography (Goldschmidt, 1992; Kan & Gero, 2008). In this context visual information analysis offers the potential for examining protocol data in a new way to allow the quantitative analysis of these patterns and relationships (Nguyen, Steinert, Carroll, & Leifer, 2012). Despite this possibility, such an approach has not been developed for characterising activity in the context of design research.

Based on these considerations this paper proposes a method for using visual information analysis to quantitatively characterise designer activity. In this context a key contribution of the proposed method is in elucidating the temporal growth of patterns of activity — a key deficit in existing approaches.