Title: Can multi-agent systems help us to understand team-working?
Type: Focused paper
Category: Organisational development/ change
Summary: This paper describes an ongoing research project which aims to use Multi-Agent Systems (MAS) to simulate team-working behaviours **and cognitions** in engineering design teams. **Although r**esearchers from other disciplines have successfully used MAS to model and simulate seemingly complex behaviours -- **through the application of** simple rules **--** this **invaluable** technology is **currently** underutilised in psychology.
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Objectives

This project aims to **use multi-agent systems (MAS)** to **model and simulate** engineering teams operating within two large, **UK-based manufacturing** organisations. **In so doing, it** seeks to: 1) Integrate expertise in occupational psychology, engineering and computer science. 2) **Enhance links between** theory and practice in occupational psychology. 3) Develop long-term capability to understand and explain organisational issues. 4) Produce a model to help organisations make better informed decisions, and reduce the risks associated with organisational change.

Design

Team-working **yields many benefits for** organisations, but also poses risks and costs. **Although p**sychologists have made invaluable contributions to our understanding of **team** processes, the nature of team-working continues to evolve. Dispersed 'multi-disciplinary' teams, operating within **multi-team environments, have** now **become** common**place and** such changes have **influenced** communication patterns and the relationships that **they have** with variables such as trust, goal commitment and shared mental models (SMMs). **In order to successfully examine such new ways of working, we propose the use of MAS** (see Wooldridge and Jennings 1995)**. Unlike the relatively 'static' statistical analyses that are often conducted by psychologists, MAS is dynamic in that time elapses in the model as the simulations are run. Such models also permit the incorporation of life-like random elements which, when coupled with such dynamism, enable unpredictable behaviours to emerge, thereby mimicking reality.**

MAS is used to explore the ways in which 'micro'-level behaviours affect 'macro'-level processes. In MAS, behaviours are determined by 'rules'. Once rules are programmed, a simulation will run over 'time', during which, these relationships feed back into each other, affecting the model's outputs. For example, biologists have demonstrated how flocking behaviour in birds, can be attributed to each bird behaving independently, in accordance with 3 simple rules (Reynolds, 1987).

Given these characteristics, we feel that MAS is underutilized in the social sciences, and the modelling of human behaviour and cognition is in its infancy. Our research aim **is therefore to address this omission by using** MAS to simulate team-working processes, **and the associated** behaviours and cognitions.

Methods and Results

The initial phases of the project have focused on developing the basic framework for a working team and the development of the MAS computing model (see Crowder et al, 2008 for technical details). Following a review of **previous research in the fields of** psycholog**y**, computer modelling and engineering literatures, **key independent** variables were identified at **three** levels: individual (e.g. competence, goal commitment); team (e.g. communication, SMMs, trust); task (e.g. **problem solving demand**)**. Furthermore, dependent variables such as** time, cost and quality **were also identified**. A preliminary **theoretical** framework for the model was then developed, based on hypothesised relationships between variables **from the research literature**. **For example, the hypothesized positive relationship between communication frequency and SMM similarity is expected to be moderated by the type of media used (e.g. email, telephone, face-to-face). Furthermore, this in turn is expected to be moderated by the equivocality of the information being relayed.**

Fieldwork is now underway, to enable us to populate the model with 'real' data. **The** leaders from 50 engineering teams **will first complete a questionnaire about their team and participate in a 30-minute semi-structured interview. Next, an** 87-item, **psychometrically-sound** questionnaire is then administered to **the members of each team, as defined by their team leader in the initial data. Traditional statistical analysis techniques are then used to analyse the data and inform the rules and equations for the computer model. Such data** will be incorporated into the model gradually, thereby enabling the hypothesized relationships to be explored and validated. The complexity of the model will **then** be gradually increased, while maintaining the required accuracy.

Further data collection **-- using interviews and observation --** is planned **in order** to develop, enrich and refine the model further. Once current working processes can be accurately modelled, this capability will **then** be used to **simulate** future processes and scenarios with a view to ensuring that they are high-performing.

Conclusions

Multi-agent systems have the potential to make a **powerful** contribution to our field**. W**e believe that this research **serves** to **enhance the links between** theory and practice in occupational psychology, and will help us to better understand the nature of team-working. More generally, if we can begin to understand the 'rules' governing **such** cognitions and behaviours, this **would enable organisations** to test alternative **change** scenarios *in silico.* Not only would this improve the quality of information underpinning system design and management within organisations, this would also significantly reduce the risks and costs associated with organisational change.

References

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