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A descriptive model of collaboration to underpin a collaboration profiling methodology

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Abstract. We have developed an explanatory, descriptive model broad enough to reflect the different elements of collaborative work which are part of commercial and public organisations. Our model aims to establish a structured representation of the attributes which influence and form part of collaborative work. It is predominantly based on the existing literature on computer supported cooperative work, distributed cognition, education, social and organisational psychology, management science, and collaboration within healthcare teams; and is additionally supported by our experience of working with a range of industrial organisations. We applied the model in a practical way to underpin the concepts of a new methodology called CoScope, which was designed to assess the collaboration capability of organisations. The methodology focuses on the extent to which

the fundamental conditions for collaboration are created, sustained and standardised across teams and organisations.

1 Identifying the constituent factors of collaboration

The work presented in this paper was carried out within the context of the CoSpaces project - a European Commission funded Integrated Project developing innovative collaborative working solutions that are responsive to the needs of designers and engineers in the aerospace, automotive and construction industries.

Human factors researchers were tasked with developing a descriptive model to provide a simplified representation of the main factors which form and influence collaborative work. Such a model could give teams a clear overview of the areas which impact on their collaboration and overall performance and provide a framework for defining user requirements for collaborative technologies/working structures and can subsequently inform change management strategies and evaluation.

CoSpaces technology will support collaboration at different levels, from small teams to larger project teams working across numerous international organisations. Our understanding of what it means to collaborate must, therefore, have the flexibility to embrace interpersonal relationships and the factors that drive people to work together successfully, and also higher level organisational aspects of the collaborative working environment.

Our first step towards a model of collaborative work involved conducting a trans-disciplinary review of collaborative working, and of the factors or activities which define it, and then structuring our findings in a way that became the basis for a descriptive model of collaborative work (Patel et al. 2009). The review included literature from computer supported cooperative work, psychology, management science, computer science, collaborative engineering, cognitive ergonomics, healthcare and education.

The literature identified: existing models and frameworks which describe collaboration and its processes (e.g. Gutwin and Greenberg, 2000; Harvey and Koubek, 2000; Neale et al., 2004; Weiseth et al., 2006), team effectiveness/team collaboration models (e.g. Campion et al., 1993; Hackman, 1987; McNeese et al., 2000; Salas et al., 2005a;), and attributes of successful collaboration (e.g. Mattessich and Monsey, 1992; Montiel-Overall, 2005; San Martín-Rodríguez et al., 2005).

Models have focused on different influential factors, tasks and processes, and on different levels of interaction. Of the few existing models proposed seeking to

structure the factors influencing collaboration, there is a tendency towards simplicity or to focus on only a small part of collaborative work.

This literature base was extended and tested against outcomes from our empirical work with industrial teams, and findings from workshops and expert brainstorming sessions (Wilson et al., 2009a). We analysed collaborative work on selected activities at CoSpaces user partner sites through semi-structured interviews, carried out as part of scenario development during the user requirements elicitation phase of the project (Wilson et al., 2009a). This helped us to gain an understanding of how teams work collaboratively, the problems they face, the critical success factors and so on. These user scenarios provided compelling examples of the factors highlighted in our literature review.

2 Representational form of the descriptive model

The review highlighted factors which were consistently discussed in the literature as forming or influencing collaborative work. We isolated seven main categories of factors involved in collaborative work: Individuals, Teams, Interaction Processes, Tasks, Support, Context, and Overarching Factors (which are relevant across two or more of the previous factors, e.g. goals are associated with individuals, teams, tasks and organisations). Based on feedback from focus groups, we decided on a 'web' representation for our model (see Figure 1).

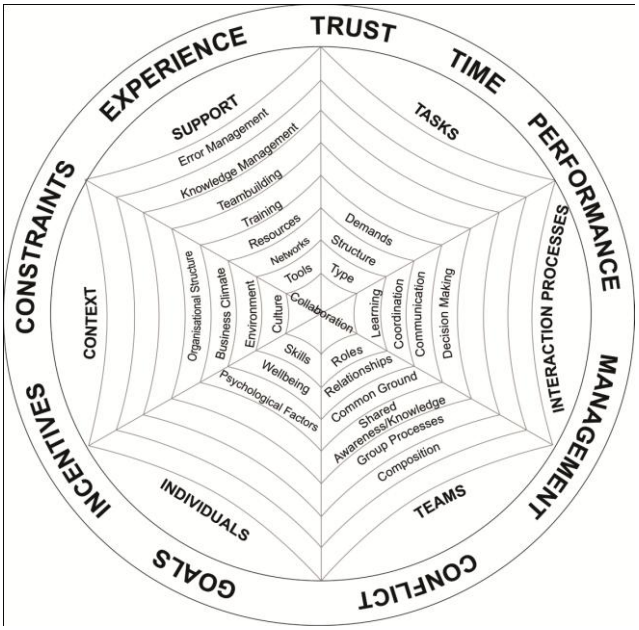

Figure 1. The CoSpaces model of collaborative work.

The web illustrates the mutually dependent relationship between the main factors of collaboration. **Individuals** and **teams** are central to the process of collaboration, engaged in intra- and inter-group collaboration (Bratman, 1992; McNeese et al., 2000; Schrage, 1990; Sundstrom, 1999; Unsworth and West, 2000; Warner et al., 2003). They are involved in **interaction processes** (Steiner, 1972; Weiseth et al., 2006) which are required in order to work together to perform **tasks** (Harvey and Koubek, 2000; Warner et al., 2003). Providing **support** is essential for ensuring that collaborative work is effective and efficient, and that individuals and teams have access to the resources required to perform their tasks, and meet their goals and needs (Hackman, 1990; McNeese and Rentsch, 2001; Weiseth et al., 2006). **Context** forms the final segment of the web, usually dictating the individuals and teams, tasks, and support that is/are needed/provided - and thus will impact on the actual process of collaboration itself (Neale et al., 2004; Unsworth and West, 2000; Warner et al., 2003; Weiseth et al., 2006). Sub-factors associated with these main factors are shown within the web, and factors which '**overarch**' the main factors are shown circling the web.

Metaphorically, the web clearly shows the close relationships between the main factors – breaking any of the links in the web would make it weaker overall. It should be noted that the distance of the factors from the centre of the web is not of any significance. Furthermore, there is no special relationship or connection between factors which lie side by side next to each other.

3 Collaboration profiling tool

We applied the CoSpaces model and our empirical work with CoSpaces user partners in a practical way to underpin the concepts of a new methodology called CoScope, designed to assess the collaboration capability of organisations and organisational readiness for collaborative technologies across multiple dimensions. The CoScope methodology uses a collaboration profiling model which utilises methods defined in the ISO/IEC TR 15504 standard. This standard was extended to support additional processes and factors related to collaboration which were derived from the CoSpaces model. The methodology is broad enough to accommodate the different collaboration styles found in commercial and public entities.

A CoScope assessment involves three assessors carrying out a structured interview whilst recording data simultaneously. The interview involves multiple stakeholders (with different roles) working on the same project. Projects are assessed on four life cycle processes: delivery (including collecting information on information production, decision making, communication, coordination, learning and error management), team working (including roles, group processes, team composition, common ground and shared awareness), support (including knowledge management, team building, training, networks of support and tools)

and organisational processes (including trust, conflict, goals, incentives, integration and management). Some metrics associated with the project being assessed are also collected, for example, information about user satisfaction, user participation, supplier responsiveness, project duration, annual spend, return on investment etc.

The involvement of different stakeholders identifies contrasting perceptions and differing understandings of the collaborative process, and can help to improve communication and understanding of collaborative processes among team members. This method is supported by the CoScope software tool which collects the assessment data and produces collaboration capability profile graphs which are based on all stakeholder viewpoints.

CoScope focuses on the extent to which the fundamental conditions for collaboration are created, sustained and standardised across teams and organisations. For example, whether there are formalised procedures in place for error management, or whether procedures vary between teams, or whether such a process is mainly conducted ad hoc. Six process attributes are used in CoScope to measure the capability of the four organisational life cycle processes, ranging from whether certain processes or tasks are performed, to whether employees have the skills to perform these processes, and whether processes are performed consistently across the organisation and at a high level of quality.

An example of one of the questions in CoScope is: 'Are teams motivated to use new communication tools?' The assessor uses a number of statements or indicators as probes during the interview in order to determine how well the process is performed; so all the indicators potentially affect the team's motivation to use new tools. For this question the indicators are:

- Team members are aware of the limitations of current communication tools (if any)
- New communication technologies are selected according to team needs
- Benefits of new communication technologies are clearly articulated
- Team members participate in the selection of new communication technologies
- The impact of introducing new communication technologies is assessed in advance
- Appropriate strategies (e.g. phased introduction, staff training, change management) are established for introducing new communication technology

Figure 2 shows an example of one of the CoScope output graphs from an assessment carried out with an industrial project team. The graph shows the different processes assessed using CoScope and the ratings associated with the different attributes for each process. Due to limitations of time (90 minutes were available), this assessment focused on whether a process is performed, whether resources are available to support the process/task, and whether the task is planned

and if the plan is reviewed and managed). Notes were taken during the assessment to provide a record of some of the reasoning behind the ratings given to each of the criteria listed above. A summary of these notes accompanies the graphs produced by CoScope to provide a detailed assessment of the current situation to the project team. Overall, this project team is performing at the largely achieved level for the majority of areas covered in the interview.

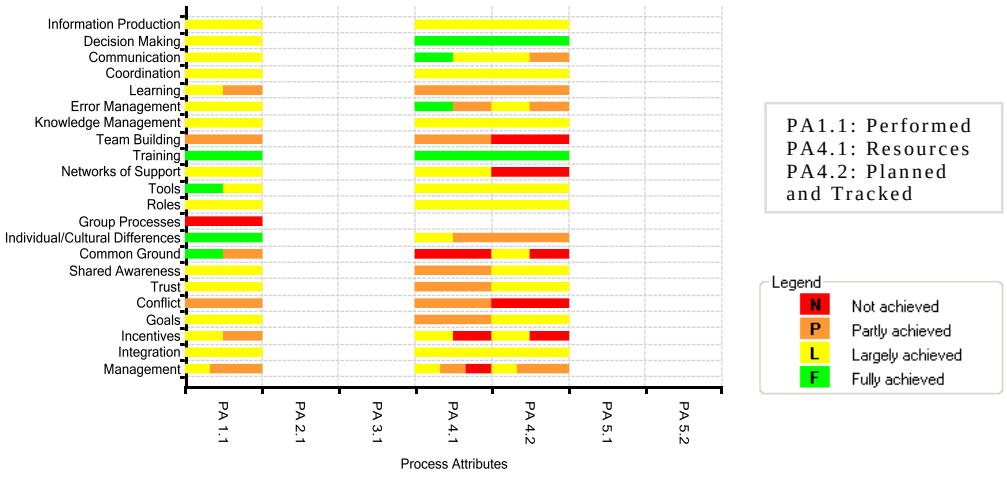

Figure 2. Process attribute ratings associated with different project lifecycle processes.

The CoScope output can highlight areas of strengths and weaknesses within a project team, providing a measure of whether organisations have in place the best conditions for collaborative work – it provides a profile of measures and attributes that indicate the maturity or sophistication of each of the most important collaboration processes as defined in the CoSpaces model. The assessment also helps to identify achievable targets for improved collaboration related to specific business needs and objectives, and identify the organisational and technical changes that will be necessary to meet those targets. This tailored approach is expected to result in greater success in the adoption of collaborative technologies and to provide substantial benefits to organisations that invest in improving collaboration.

Pilot studies have shown the CoScope methodology to be powerful in its analytical capabilities and capable of being used as a first appraisal or for a comprehensive and in-depth organisational analysis. The pilot studies highlighted areas which could be improved and thus the methodology is still under development. The time available for the pilot studies was between 90-180 minutes. A more thorough assessment of an organisation could take between three and five days. Ideally, several assessments would be conducted with different teams within an organisation, in order to generate a more comprehensive and comparative analysis of collaborative work across the organisation. Each team assessment would likely require a full day. In spending this amount of time

with a team, assessors would be able to employ all the process attributes in the tool.

CoScope can be used to re-assess collaboration following the implementation of changes and the output can be used to compare different teams within an organisation.

4 Discussion

Collaborative work is inherently complex and the factors which constitute and influence it are multiple and their importance and interactions between them vary depending on the situation. Findings from an extensive literature review and empirical work with industrial companies have fed into the development of a descriptive model of collaborative work. This model is broad enough to reflect the different elements of collaborative work which are part of commercial and public organisations. Such a model provides teams with a clear overview of the areas which impact on their collaboration and overall performance and provides a framework for defining user requirements for collaborative technologies, new collaborative working structures and support mechanisms (e.g. training) and can subsequently inform change management strategies and evaluation.

The CoSpaces model of collaborative work underpinned the concepts of the CoScope methodology which was designed to effectively assess the collaboration capability of industrial project teams across a range of dimensions, with the overall aim of providing guidance on areas which could be improved in order to enhance collaborative work. CoScope involves conducting small group semi-structured interviews with project team members who perform different roles. Such a tool could eventually support benchmarking to assess projects against each other or against themselves over time, and possibly even compare companies in the same sector against each other.

The CoSpaces model of collaborative work has been broadly accepted by the CoSpaces industrial and research partners, and by a wider industry and academic audience through training workshops that we have run at key conferences associated with the collaborative engineering, ICT and human factors communities. In addition, initial pilot studies using the CoScope methodology verified its usefulness at assessing the conditions for collaborative work, and the industrial partners involved were very positive about its practical benefits.

5 Acknowledgments

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