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EVALUATING THE ORGANIZATIONAL ROI OF DIFFERENT COLLABORATIVE STRATEGIES

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1. Introduction

Due to the difficulties of assessing the collaborative performance of different collaborative strategies, most companies lack a clear collaborative philosophy. The body of literature supporting collaborative philosophy is limited, but the concept of developing a company philosophy was emphasised by Marwin Bower in his book The Will to Manage from 1966 [Bower 2003; excerpt]: *"The literature on company philosophy is neither very extensive nor very satisfactory. But one dictionary definition of philosophy does apply: "general laws that furnish the rational explanation of anything." In this sense, a company philosophy evolves as a set of laws or guidelines that gradually become established, through trial and error or through leadership, as expected patterns of behaviour."* The concept of company philosophy can be valuable for collaboration purposes. The need to establish effective guidelines for collaboration becomes increasingly important as the complexity of available solutions increases.

Organizations engaged in dispersed engineering design collaboration have a wide range of different collaborative approaches to choose from. In addition to collocated solutions involving regular business travel, several methods and technologies exist that facilitate dispersed collaboration. These include email, teleconferencing, video conferencing, data conferencing, web-based collaborative tools, proprietary groupware tools, and electronic meeting systems [Bajwa et. al. 2003]. Collaboration is a complex process, and evaluation of different collaborative strategies is difficult. As a result, habitual practice often serves as the only guideline regarding preferred collaborative methods and tools. This paper describes a modelling tool that has been developed to evaluate the organizational ROI (return on investment) of different collaborative strategies. With regard to collaboration, an investment is here defined as (Encarta Dictionary: English, North America): *"A contribution of something such as time, energy, or effort to an activity, project, or undertaking, in the expectation of a benefit."* Although this definition is broader than the more common definitions involving pure financial considerations, it is considered more suitable for evaluating collaboration due to the subjective and intersubjective aspects of collaboration, as discussed later in this paper.

This decision-making tool has been developed to make it easier to select the most suitable collaborative strategy, in order to improve collaborative performance in any given situation. This model is based on a knowledge perspective developed by Wilber [Wilber 2001] and models of performance measurement [O'Donnell and Duffy 2001, Haffey and Duffy 2003] using collaborative effectiveness, efficiency and appropriateness as the primary measures for different groups of stakeholders. These stakeholders are classified in a structure consisting of five layers of collaborative presence. The model accepts input data relevant for collaborative team performance, as well as data indicating how the team collaboration affects the rest of the organization, according to the layer structure. The model provides a comprehensive set of output data, and a holistic view of the different collaborative strategies as a basis for better decision making processes.

2. Methods

Previous research in engineering design collaboration indicates that very few companies explore and evaluate available solutions for engineering collaboration through systematic analyses of available methods and technologies. In general, the choice of such technologies may depend upon the amount of information required, how fast is it required, the effectiveness of communication required, and the efficiency of communication required [Bajwa et. al. 2003]. What collaborative strategy to pursue for what purpose, when, for what reasons, and for whom hence remains a mystery. Collaborative strategies should be evaluated; otherwise it is likely that the collaborative solutions offered will provide a poor fit with the overall situation. The choice of collaborative methods and tools is usually based on intuition and previous experience through habitual practice, which limits potential improvements in collaborative efficiency and effectiveness as a result of using analytical tools that point out collaborative problems. As a result, decision makers have no effective and systematic ways of evaluating the costs and benefits different collaborative strategies and scenarios imply for their organizations. Some costs and benefits are tangible and directly related to the activities of team members, and these are usually easy to manage. Others are intangible, related to non-team members, or both. This makes them difficult to evaluate and manage. The model described in this paper transforms complex input data to relevant output data, by increasing the transparency of the collaborative processes. This is accomplished by addressing the inherent asymmetry in benefits and costs for different stakeholders. The model increases the transparency of tangibles and intangibles for team members and non-team members respectively, by identifying and structuring costs and benefits.

2.1 Type of research

In “The eye of the spirit” [Wilber 2001], knowledge about the world is explained as an integrated process. He shows that any phenomenon can be looked upon in four ways, as displayed in figure 1; in an interior and an exterior fashion, and in a collective and an individual fashion.

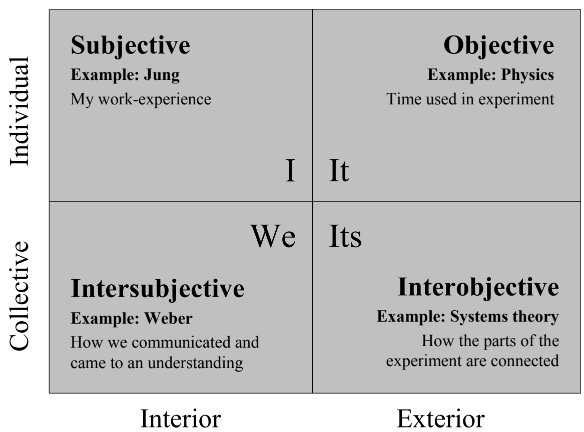

Figure 1. Four ways of looking upon phenomena [Wilber 2001]

As displayed in figure 1, looking upon a phenomenon in 1) an internal and individual fashion is a subjective analysis, 2) as exterior and individual is an objective analysis, 3) as internal and collective is an intersubjective analysis, and 4) as external and collective is an interobjective analysis. As dispersed collaboration involves people, objects and relations between these, all four views are necessary to facilitate a full, comprehensive analysis of the different aspects of collaboration. The model therefore integrates all four ways of looking at phenomena, by capturing both quantitative data such as time (for use in objective and interobjective analyses), as well as qualitative data (for use in subjective and intersubjective analyses).

2.2 Layers of collaborative presence; stakeholder analysis and asymmetry aspects

The ROI modelling tool described in this paper is designed to offer improved decision making support for proper choice of collaborative strategy, based on common decision making metrics such as time, cost and effectiveness. Benefits include increased transparency of the magnitude and distribution of benefits and costs; who benefits from what, when, where & why. In order to facilitate evaluation of overall collaborative performance of different collaborative strategies and approaches, a layer structure has been developed. This layer structure, consisting of five layers of collaborative presence, is used to categorize different groups of stakeholders in complex team structures. This structure is designed to increase the transparency of different stakeholders, and to highlight asymmetry aspects, in particular uneven distribution of collaborative benefits and costs. The structure is based on the assumption that some stakeholders have a greater exposure towards team collaboration than others, and are more willing to invest time and other resources in order to make the team collaboration more effective and efficient.

Table 1. Layers of collaborative presence

Layer	Type	Example
1	Internal participant	Collocated core team member, directly involved in team activities
2	Internal participant	Distributed team member, directly involved in team activities
3	External participant	Occasional contributor, involved in team activities on a temporary basis
4	Non-participant	Not directly involved in team activities, but indirectly affected by them
5	Non-stakeholder	Neither directly involved in team activities nor indirectly affected by them

Layer one stakeholders are most likely to accept the highest levels of involvement and efforts, often as members of an on-site collocated core team [David and Lloyd 2001]. Layer two stakeholders have a high degree of involvement, as permanent, distributed team members. Layer three stakeholders have a low to medium degree of involvement, typically as occasional contributors. Layer four stakeholders do not participate directly in team activities. However, they are affected by being involved with one or more team participants, perhaps on other projects. They affect or are affected by the team's use of resources, collaborative spaces et cetera. These stakeholders may also be affected by collaboration initiatives because of reduced availability for other inquiries, a category of hidden collaborative costs addressed in the model by increasing the transparency of proximity and presence. Layer five consists of those neither involved in nor affected by team activities, outside the boundaries of the collaboration. Most existing research addresses homogenous teams. However, technology and project execution principles have changed the conditions influencing team composition mechanisms, and heterogeneous teams are becoming more common [David and Lloyd 2001]. As projects conditions change as they evolve through their lifecycle, any status as an internal or external participant or stakeholder should be regarded as temporary. While intra-layer collaboration can be described as being symmetrical, inter-layer collaboration is asymmetrical by nature, as the users typically have different degrees of involvement, differentiated access to tools and collaborative resources et cetera. In addition, roles are often different, and examples of asymmetry issues resulting from interaction between different layers include interruptions and availability issues.

2.3 Data collection

The model is developed as a decision making tool regarding what collaborative strategies to pursue for any given task, by evaluating the organizational ROI in teams composed of different stakeholders as described in table 1. However, the experiment described in this paper has been designed to highlight central aspects of the model, and it is simplified in team structure as well as in tasks to be performed.

Data has been collected through an experiment consisting of four sessions scheduled to last for 20 minutes, exploring the same set of collaborative tasks in four different collaborative scenarios, as displayed in table 2. Data from the sessions were subsequently entered into the model.

Table 2. Collaborative strategies explored – four different scenarios

Strategy	Description of scenario
Data conferencing	This scenario included the use of desktop data conferencing systems for application sharing, file transfer, whiteboard, audio and video conferencing purposes. Only standard hardware was used in this scenario (PC, mouse, headset).
Physual designing	The collaborative concept physual designing [Kristensen 2003] used an advanced collaborative arena for conceptual engineering design work. Equipment includes two Tablet PCs, a telephone conferencing system, a large, interactive screen (eBeam) for sketching, two projectors, and two cameras (including one with remote controllable pan/tilt/zoom via web) for viewing physical artefacts and paper-based sketches.
Telephone conferencing	This scenario used the most basic collaborative methods, consisting of telephone and email only. The tools used in this scenario dictated a sequential design approach.
Collocated designing	In this scenario, the participants gathered physically after an initial phone call. The experiment simulated that the participants were in the same building, but on different floors. Prototypes were available, and these were used extensively during the conceptual work. All tools from the other scenarios were available, but their use was very limited.

The sessions included concept development with the aim of improving certain characteristics of a product. This involved a review of the current design, drafting, discussion and decision making. More specifically, it involved showing two drawings, commenting and explaining these, making annotations where appropriate, proposing design changes through brainstorming and sketching. Finally, the sessions involved making a decision about what design changes to be made. In each of the sessions, moderate time extensions were allowed where this was necessary for adequate goal fulfilment, as this is captured by the model. During the sessions, the team sought a balance between effectiveness, efficiency, time and cost. A finished student project was used as the basis for the experiment. For all strategies explored the experiment used two team members, a session initiator (owner) and an external resource (expert). Typically the session would start with an introduction like the following: *Initiator: "Hello Jens, it's Kjetil in R&D. Happy new year! I have this design problem I'm struggling with, and I could really use your expertise. Do you have some twenty minutes time to help?" Resource: "Sure, what exactly are we talking about here?"*

Data collected includes a combination of subjective, objective, intersubjective and interobjective data for the six dimensions time, effectiveness, flow, presence, appropriateness and resources. Based on figure 1, the views used for the final analysis for each of the six dimensions explored are indicated with grey fields in figure 2.

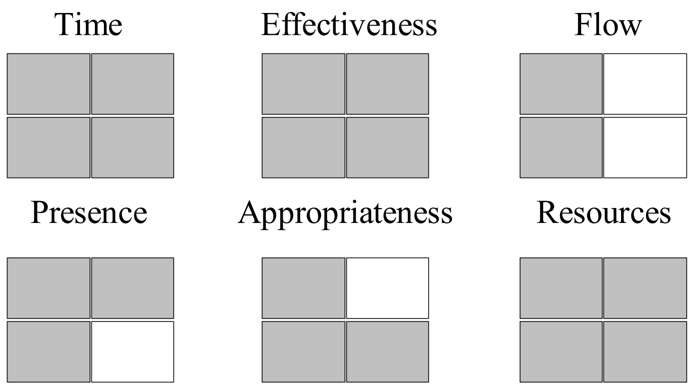

Figure 2. Emphasising different views for different dimensions

Not all views were considered for all dimensions, either because they were not identified as relevant (objective and interobjective data for flow and interobjective data for presence), or because of evaluation difficulties (objective data for appropriateness). Data were collected through questionnaires, observations and interviews with test subjects. Semantic differential scales with score 1-7 and forced ranking scales with score 1-4 [Cooper and Schindler 1998] were used to evaluate subjective measures and intersubjective measures respectively, while interobjective data were collected using direct observation. Objective data such as time, wages et cetera were either measured or collected from time sheets and other sources.

Both subjects had previous experience in all collaborative scenarios. There was therefore no observable learning effect in using the tools and methods. In addition, to prevent any learning effects in the design process, the subjects followed a closely defined script mimicking the development and evaluation of different concepts. Due to the use of this script, the experiment only evaluated the ability to carry out a sequence of processes, while it did not evaluate correlations between collaborative approach and creativity. Previous experiments have revealed differences in process transparency and ambiguity for different collaborative scenarios, namely collocated design work, data conferencing and physual designing [Hildre et. al. 2000, 2001, Kristensen 2003]. However, this model does not provide verified data for complex industrial projects where the processes change significantly during the duration of the project.

3. Results

Available data were analysed and grouped as subjective, objective, intersubjective, or interobjective data respectively. Overall, the model displays multiple aspects of collaboration for quick comparison between the different strategies explored. As a decision-making tool, the model makes it possible to quickly navigate different strategies and make decisions based on robust, comprehensive data that can be coupled with individual preferences and contextual factors. Regarding subjective data, an excerpt of main results is displayed in figure 3. Note that the graphs for physual designing and collocated designing follow each other closely.

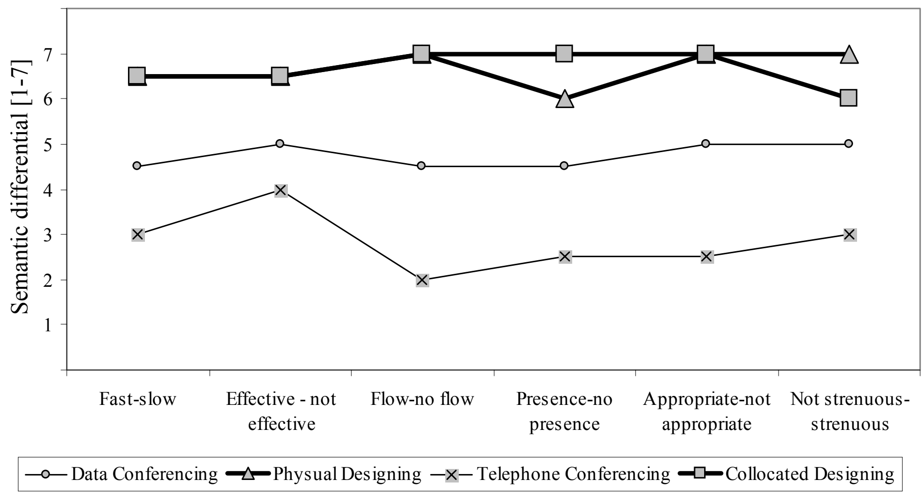

Figure 3. Subjective data

An excerpt of main results for intersubjective data is displayed in figure 4. This view also favours physual designing and collocated designing, but their rank varies across the six dimensions. Data conferencing is ranked high for some dimensions. The legend is the same as above for quick comparison.

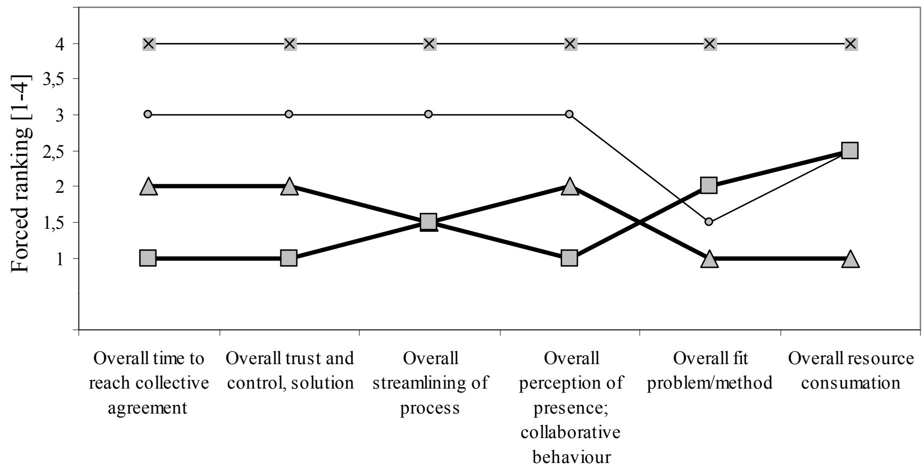

Figure 4. Intersubjective data

Regarding objective and interobjective data, many of these are binary (yes/no), and they are displayed in table format for easy overview and comparison. Both objective and interobjective data are included. In the table, the dimensions time (T), effectiveness (E), presence (P), appropriateness (A) and resources (R) are indicated together with the data types objective (O) and interobjective (IO). No objective or interobjective data exists for the flow dimension.

Table 3. Summary of objective and interobjective data

Description	Data type	Data conferencing	Physual designing	Telephone conferencing	Collocated designing
Process free of IT problems	T/IO	Yes	Yes	Yes	Yes
Overall goal obtainment	E/IO	Yes	Yes	Yes	Yes
Overall tool / method availability	A/IO	Yes	Yes	No	Yes
Assistance-free collaboration	R/IO	Yes	Yes	Yes	Yes
Team time (mm:ss)	T/O	22:30	17:30	21:30	13:00
Process capability	E/O	Yes	Yes	No	Yes
Locations (distributed)	P/O	Yes	Yes	Yes	No
Team cost: Wages, telephone, IT	R/O	14.94 €	12.54 €	15.39 €	9.07 €
Team cost: Comparison	R/O	+65%	+38%	+70%	Reference

In table 3, collocated designing is chosen as the reference or basis for comparison of team cost for the featured scenarios. The results only relates to the specific situation in the four scenarios compared in this experiment. If the participants had been located in different cities or countries, this would clearly have affected the results, including the choice of reference.

When combined, figures three and four and table three provides a robust, comprehensive overview of costs and benefits for each of the collaborative strategies explored. By comparing different views in the dimensions time, effectiveness, flow, presence, appropriateness and resources, the data that is most relevant for each situation can be extracted and emphasised in the decision-making process. In the experiment described above, the collaborative strategies physual designing and collocated designing were consistently rated higher than desktop data conferencing and telephone conferencing, and should be chosen for this type of collaboration when possible. When deciding between physual designing and

collocated designing, it is necessary to take individual preferences and availability of facilities into consideration, as the data is indecisive.
In situations where trust and control are important, teams should choose to arrange a collocated meeting if this is feasible without high costs. Likewise, in situations where it is favourable to integrate a meeting into an ongoing stream of activities, physual designing should be chosen because of subjective and intersubjective data indicating low overall resource consummation. As these two brief examples indicate, decision makers should use the comprehensive data available in the model as a basis for a balanced approach which takes into account available time, individual preferences, contextual factors of the overall situation, computer literacy of the participants, availability of resources and financial constraints. By doing this, it is possible to make trade-offs with a positive impact within the boundaries of the extended team. In larger projects involving split location engineering, the model also evaluates costs for non-participants such as IT personnel and others outside the boundaries of the extended team, involved with participants. It is hence possible to evaluate how the choice of collaborative strategy impacts the entire organisation. However, although the model has been developed for this purpose, it has to be refined through trial and error before it is capable of doing this with proper accuracy.
This model is based on self-assessment through collecting subjective and intersubjective data, in addition to objective and interobjective data. It therefore allows the users to make proper decisions also in situations where there are possible discrepancies between objective data and collaborators' perception of the quality of the collaboration. Such discrepancies influence the collaborators' perception of the design as well, as the design process is highly interrelated with the final design. However, as the same self-assessment remains an important characteristic of design evaluation, this should not be considered a problem. As a broad approach that includes both objective and subjective data, the model takes both fact-based reasoning and perceptions into consideration as a basis for making better decisions regarding the choice of collaborative methods to use for any given situation.

4. Conclusions

This paper contributes to collaborative research by suggesting a fundamental solution to the problems related to choosing the most effective strategy for collaborative challenges. Implementation of this strategy is facilitated by using a model that evaluates organizational ROI. The model breaks down compound data into clear, understandable metrics which display the collaborative value of different collaborative strategies, thereby increasing the transparency of collaborative costs and benefits to all stakeholders, making the stakeholders' perception of the collaboration more homogenous. This may reduce internal conflicts by providing a more holistic, uniform view of the collaborative situation. Using the model, it is possible to evaluate systems based on facts and structured comparison of costs and benefits, instead of habitual practice and somewhat blurry perceptions. This increases the transparency of asymmetries and trade-offs, and by doing this, it can become easier to gain support for asymmetric workload when the bottom-line impact can be documented.
Collaboration becomes increasingly important, and to better utilize the full potential new technologies offers, corporations engaged in collaboration can benefit from using models that increase the transparency of costs and benefits of different collaborative strategies. The model described in this paper displays distribution of costs and benefits for all stakeholders affected by team collaboration, including people not directly engaged in the collaboration themselves. One outcome of using the model is that it suggests an expanded view of team boundaries, because the choice of collaborative method affects not only the team members taking part in the team interaction themselves, but also others. An extended team represents a shift away from collaborative decisions based on intuition and habitual practice, towards providing decision support on how to allocate resources to the collaborative approaches that offer the greatest collaborative performance for a particular situation, or a defined set of collaborative goals. When accurate data are fed into the model, it can indicate areas of improvement related to time, collaborative effectiveness, flow, presence, appropriateness and resources. When relating effectiveness data with resource data, it is possible to evaluate efficiency, although a complete analysis has not been performed in the experiment described in this paper, due to its limited scope. The model should be used with caution, incorporating local practices and preferences into

consideration when evaluating the different collaborative strategies. When used over time, the model can be used to systematically develop guidelines for collaboration and ultimately to establish and maintain a collaborative philosophy, by combining interior and exterior views for individual and collective aspects of collaboration.

Suggestions for future work include validation of the model's usefulness in real projects by using comprehensive data from large industrial projects. In order to include all layers of stakeholders, it is necessary to include process mapping that tracks communication requests to and from non-participatory stakeholders, as well as interfaces with other projects.

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