INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN, ICED'09
24 - 27 AUGUST 2009, STANFORD UNIVERSITY, STANFORD, CA, USA

A STRUCTURED APPROACH TO RE-ORGANIZE FOR CREATIVITY

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ABSTRACT
One of the most difficult challenges when managing innovation is to identify the individuals within the organization that need to work closely with each other to maximize the generation of creative ideas. Typically, product development organizations group their individuals based on functional areas or specific projects (or a combination of both). Such a formal organizational structures not only shape the communication patterns among development actors but also impact the outcomes that individuals get from their interactions with others. This paper introduces a structured approach to guide managers on their decisions to form a temporary team (or task force) from which creative solutions would be demanded. Our approach exploits the notion of *creative interactions*, which recognizes that people trigger the generation of creative ideas when interacting with each other for task-related matters. As a result, the goal of our approach is to identify groups of individuals within the organization that have a history of triggering the generation of creative ideas when interacting with each other. Our approach is structured in three steps: 1) Capturing the current organizational structure; 2) Measuring creative dyadic interactions; and 3) Forming clusters of *creatives*. We illustrate our approach by implementing it in the development department of a European software firm.

Keywords: Organization design; creativity; clustering analysis; software development

INTRODUCTION
"Who shall we invite to our next series of brainstorming sessions?" "Who should be assigned into the next task force responsible for generating creative solutions for …?" These are common questions faced by managers of innovation, which are typically addressed on an ad-hoc basis rather than taking into account the realities of how the organization actually works when developing new products and services. This paper introduces a structured approach to guide managers when attempting to address this sort of questions.

One of the most important and difficult challenges that innovation managers face when assigning people to a team (or task force) is to evaluate the potential of the team to achieve high creativity performance. The challenge of "how to make the team" for high performance in research and development (R&D) organizations have been studied in the organizational literature [1][2]. This stream of work have found that managers often use demographic information such as gender, educational background, and tenure in the firm to assign people to project teams in R&D organizations. This rationale assumes that demographic data is a good indication of the resources and information that the individuals access through their social networks and that they would make available to the team (if assigned to it). The effectiveness of this approach is limited because demographic data is not necessarily correlated to the way individuals communicate to address their technical interdependences with other colleagues in the organization [2].

The literature on organizational creativity has addressed the challenge of organizing for creativity in various ways [3][4]. (We use the most widely accepted notion of creativity: the ability to produce something that is both novel and useful [3][4]).) The work of Amabile [3] pays particular attention to the role of intrinsic motivation to work on the task at hand as a significant determinant of creativity. The intrinsic motivation of the individuals to engage in the task is considered to be an important input when deciding who should be to a team that demands creative solutions [5]. Previous research on creativity has also emphasized the role of knowledge diversity to generate novel and useful ideas [6][7]. Hence, bringing people together with diverse backgrounds and experiences are likely to increase group creativity [8][9][10]. Although experimental and empirical research has provided evidence supporting these findings, they overlook the fact that individuals in established organizations are likely to be involved in many non-creative tasks that require more coordination than innovation [11][12]. Yet, such task-related interactions are likely to influence the capability of the individuals to generate creative ideas [13]. This paper contributes to this stream of work by suggesting an alternative approach to bring together individuals that are to maximize creative output.

"A product development organization is the scheme by which individuals designers and developers are linked together into groups" [14, p. 23]. Typically, product development organizations group their individuals based on functional areas or specific projects (or a combination of both). Such formal organizational structures not only shape the communication patterns among individuals within it but also the outcomes that individuals get from their interactions with others [11][12]. To understand how product development actors interact with each other to address their task interdependencies previous research has studied the relationship between the communication patterns of developers in the organization and the structure of the products they develop or the process they use to develop their products. McCord and Eppinger [15] present a design structure matrix based methodology by which they capture the integration needs of the set of teams designing a complex system (a new automobile engine) and cluster them together to maximize coordination. Morelli *et al.* [16] map process and organizational structures to predict task-related interactions. They found that task interdependency is a better predictor of technical communication than distance-based models [11]. Sosa *et al.* [12] have studied the mapping of product and organizational structures in complex products. They found that several organizational and product-related factors significantly influence the misalignment of design interfaces and team interactions. More recently, Sosa [17] use the architecture of a software product to predict the communication patterns of the organization that develops it. This paper extends this stream of work by examining the creative outcome of each dyadic interaction between individuals in their current organizational setting. More specifically, we measure how individuals trigger the generation of creative ideas on other individuals with whom they have task-related interactions in their current organizational form. Then, we use such a dyadic information as the key input to our clustering analysis which yields suggestions on how to group individuals that are likely to generate creative ideas when they interact with each other.

OUR RESEARCH APPROACH

We structure our approach in three steps (see Figure 1):

1. Capture current organizational structure. First, we capture the formal and informal structure of the organization by documenting how developers are assigned into organizational groups and how often they interact to address their task-related interdependences. By surveying all development actors in the organization, we document their actual task-related interactions onto a square (person to person) *actual communication matrix (**A**)*. The columns of the matrix are labeled with the "providers" of task-related information while the rows are labeled with the "recipients" of information. Hence, cell a_{ij} indicates that actor i "goes to" actor j to request task-related information. We sequence actors who belong to the same organizational group together in order to easily visualize interactions within organizational groups versus interactions across organizational groups. This is similar to the approach used by previous work in product development that captures the structure of development organizations in a matrix form [12][15][16][17].

2. Measure creative dyadic interactions. In product development organizations, individuals seek other colleagues to search for task-related information in order to address their task interdependences. The recipient is the actor who "goes to the source to discuss task-related matters" during the product development effort. *Creative interactions* are those in which the recipient is likely to generate novel and useful ideas after receiving technical information from the source [18]. Hence, for each interaction identified we document the level of dyadic creativity associated with it. We capture such an information in an *dyadic creativity matrix* (**D**), which uses the same sequence exhibited by the actual communication matrix (**A**) described in step 1.

3. <u>Form clusters of *creatives*</u>. There are several algorithms that can be used to cluster interaction matrices like ours [19]. The overall objective of these algorithms is to permute rows and columns of the dyadic creativity matrix (**D**) so that interactions with positive levels of dyadic creativity are clustered close to the diagonal of the matrix. This in turn form clusters of individuals who have reported positive tendencies to generate creative ideas associated with their task-related interactions. That is, we form groups of individuals who report generating creative ideas after interacting with each other for task-related matters. We document such a new organizational form in a clustered creativity matrix (**C**). This alternative organizational form suggests the groups of people that, if put together in a temporary assignment like a task force or brainstorming session, are likely to trigger creative ideas on each other based on their prior experiences interacting for task-related matters.

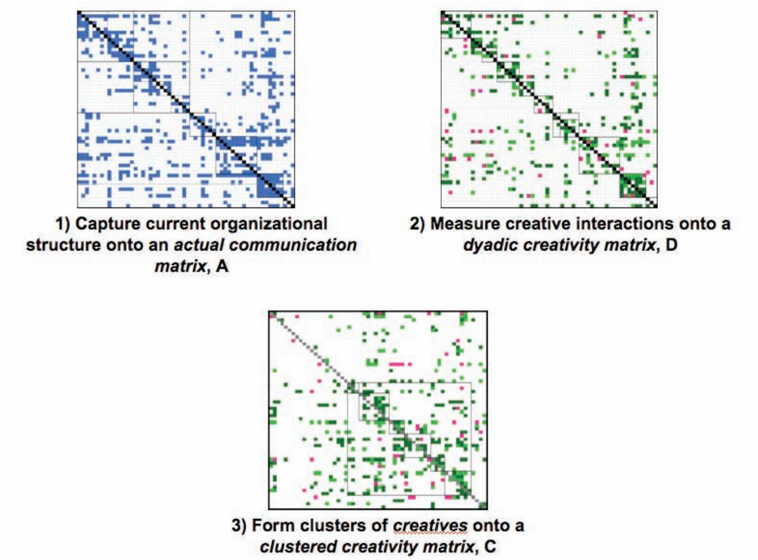

Figure 1. Three-step Research Approach

AN EXAMPLE FROM SOFTWARE DEVELOPMENT

We implemented our research approach in a software development firm. The firm, founded in the 1980s, is a public company and is traded on the German stock exchange. It is one of the world leaders for a particular type of application in the software industry, and its principal market consists of business customers. The firm’s development organization is distributed across three different locations in two neighboring European countries. During the time of data collection, the development department worked on the development of seven distinct software products. The empirical study focused on the firm’s development department, which was organized into eleven organizational groups.

We used two methods to collect the data: semi-structured interviews and a Web survey. First, we conducted semi-structured interviews with the executive team of the firm, including the CEO and VP of development, to understand their portfolio of products and general organizational structure. We also conducted semi-structured interviews at all three sites with group leaders and developers about their development process and the nature of the workload associated with the products under development. Then, we created and distributed a survey throughout the development organization to capture individual data on product development activities and organizational interactions with other members of the development department. The survey took an average of 49 minutes to complete and was filled out by 58 out of the 66 people in the development department (88% response rate). Although 50% of the nonrespondents were from the support group responsible for documentation and information systems support, these individuals did not significantly differ from members of the respondent groups in terms of gender or location. Hence, there is no reason to suspect that nonrespondent bias significantly influenced the results presented here [17][18].

Step 1: Capture current organizational structure

The development department studied was formally organized into eleven groups: eight development groups (i.e., programmers); one quality control group for testing all the products; one architecting and managerial group (which made important software architecture decisions and managed the department's resources); and one support group responsible for documentation and information systems support. The quality/testing group was evenly distributed among the firm's three locations, while the other organizational groups were almost evenly distributed between its two biggest sites. We capture the technical communication patterns both within and across organizational groups associated with the development of the seven products in the firm's portfolio. We documented these data into an actual communication matrix (**A**) whose off-diagonal marks (*i*,*j*) indicate whether the person in row *i* went to person in column *j* to request product-related information during the last year. Note that we sequence this matrix to capture the structure of the organization into its 11 functional groups; hence, the matrix cluster together people who belong to the same organizational group. Figure 2 shows the actual technical communication patterns of the organization studied in a 58x58 actual communication matrix. Respondents reported 632 product-related interactions in which actor *i* "went to" actor *j* for product-related information. This results in a communication network density of 19%.

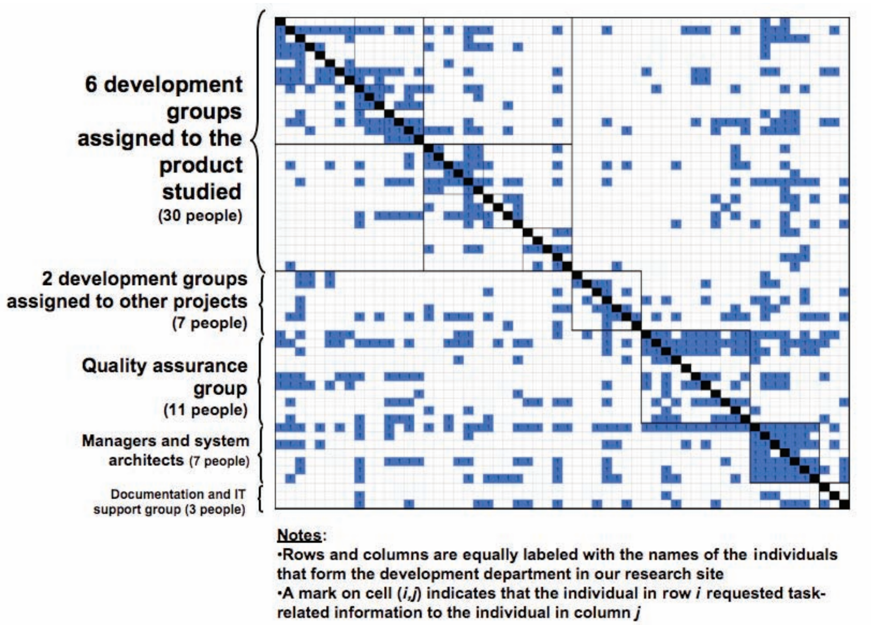

Figure 2. Actual Communication Matrix

Step 2: Measure creative dyadic interactions

We measure creativity (at the dyadic level) for each task-related interaction identified in step 1 [18]. Because the focus was on the outcome of the relationship and because the source and recipient are the *only* actors equipped to accurately assess the outcome of a dyadic relationship, we relied on the recipient to evaluate the creativity level of the outcome of her relationship with the source based on her interactions with the source during the past year. We capture the level of creativity associated with each relationship by asking each respondent to rate, on a seven-point Likert scale ("strongly disagree", "disagree", "marginally disagree", "neither agree or disagree", "marginally agree", "agree", and "strongly agree"), their level of agreement with the following statement [18][20]: "When I interact with [name of source contact], it is easy for me to generate NOVEL creative solutions and/or ideas. These NOVEL ideas can be either related to our products or the way we do things.” Consistent with [3], the survey does not offer the respondent an explicit definition of creativity. However, the survey question captures both the novelty and usefulness dimensions of creativity so that the respondent can make an accurate assessment of the level of creativity resulting from interactions with the source in the past year. Relying on the recipient to assess the novelty and usefulness of her ideas is consistent with Simonton [21][22], who suggests that the creator evaluates her creations before presenting them to the community for further scrutiny. This is also in line with Csikszentmihalyi [23], who acknowledges that “a person who wants to make a creative contribution not only must work within a creative system but must also reproduce that system within his or her mind. In other words, the person must learn the rules and the content of the domain [area of contribution], as well as the criteria of selection [and] the preferences of the field” (p. 47), which ultimately decide how novel and useful the contribution is. This is especially pertinent to product development organizations, where individuals have a common understanding of the knowledge domain in which ideas would be valuable and understand well the criteria that would categorize an idea as novel and useful.

Because we are interested in maximizing the likelihood of generating creative outcomes when people interact with each other, we recode the original scale used to measure creative interactions in order to distinguish *negative* creative interactions (that hinder the generation of creative ideas on the recipient measured by the three disagreements assessment in our original Likert-scale), *neutral* creative interactions (that do not significantly impact the generation of creative ideas on the recipient as measured by the neutral statement in our original Likert-scale), and *positive* creative interactions (that trigger the generation of creative ideas on the recipient as measured by the three agreement statements on our original Likert-scale). Making this distinction is fundamental to be able to run the clustering analysis in the next step. Figure 3 shows the dyadic creativity matrix (**D**) with green cells denoting interactions with positive creative interactions (positive dyadic creativity) and purple cells highlighting negative creative interactions (negative dyadic creativity). More specifically, the distribution of creative is as follows:

- 44 (or 7% of) task-related interactions with negative levels of creativity
- 221 (or 35% of) task-related interactions with neutral level of creativity
- 126 (or 20% of) task-related interactions with positive level of creativity (low level)
- 241 (or 38% of) task-related interactions with positive levels of creativity (medium and high level)

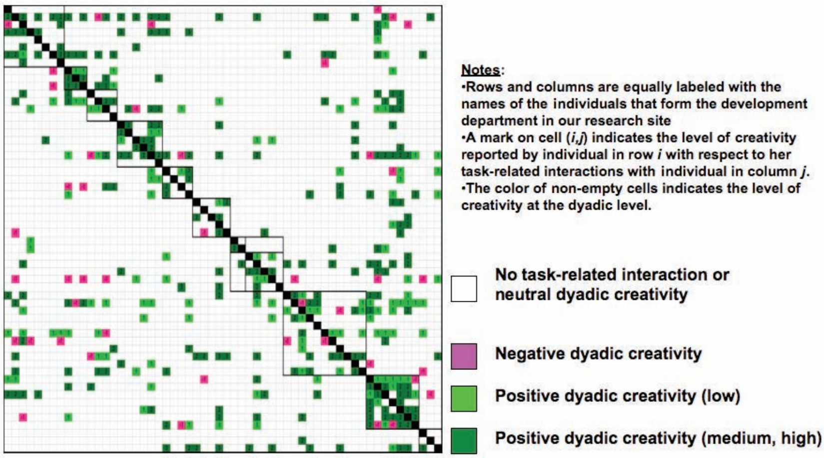

Figure 3. Dyadic creativity matrix

Step 3: Form clusters of *creatives*

We use the dyadic creativity matrix (**D**) as the key input in our clustering analysis. The objective of the analysis is to identify groups of individuals whose task-related interactions (among themselves) have been characterized by positive dyadic creativity and a minimum of negative dyadic creativity. Because neutral dyadic creativity neither triggers nor hinders the generation of creative ideas we treat them as non-existent interactions in our clustering procedure. We have used various heuristics swapping algorithm facilitated by Excel macros to identify the groups of individuals who are more likely to generate creative ideas when interacting with each other. The output of the clustering analysis is summarized in the clustered creativity matrix (**C**) shown in Figure 4. Such a matrix highlights six clusters of 33 people in total (57% of the 58 people entered in the analysis) who have reported positive levels of dyadic creativity with other colleagues in the clusters they have been assigned to. (The size of these groups range from 3 to 8 people.) The average density of these six creativity clusters is 46%, which is significantly higher than the average density of 30% of the 11 organizational groups of the current organizational structure. Hence, our solution indeed identifies an alternative organizational arrangement that pulls together people with a history of generating creative ideas when interacting with each other during their task-related interactions. More importantly, our heuristics keep dyads with negative dyadic creativity out of the clusters. In other words, our clustering analysis keeps creativity "blockers" (i.e. those people who are likely to hinder the generation of creative ideas of others inside the cluster) outside the creative clusters. Our analysis yielded only one interaction within cluster in which one side of the dyad reported a negative dyadic creativity while the other one reported a positive dyadic creativity. Our clustered creativity matrix (**C**) is sequenced in such a way that the six clusters are arranged together so that one can also visualize the task-related interactions that have occurred among individuals across clusters. Most of these cross-cluster interactions report positive dyadic creativity while few of them report negative dyadic creativity. Considering the dyadic creativity of these cross-cluster interactions is important if managers decide to combine some of these clusters together to form a temporary large group to search creative solutions for a given task.

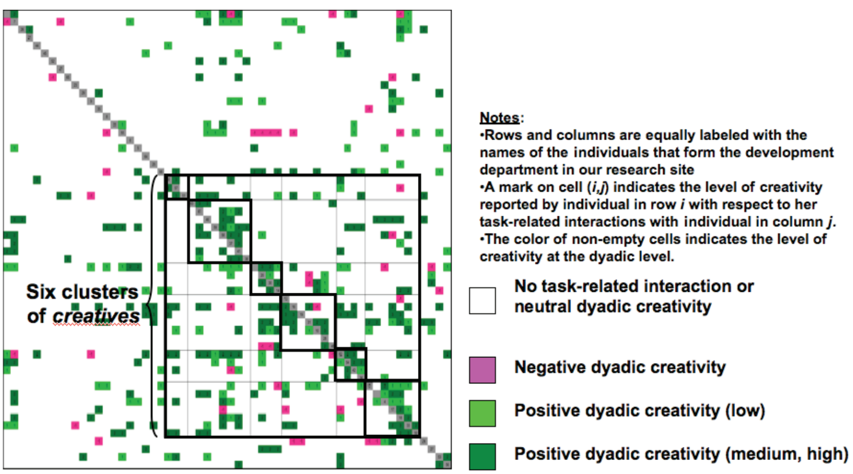

Figure 4. Clustered creativity matrix

Analysis

After obtaining an alternative organizational scheme of six groups of individuals with a history of generating creative ideas when they interact with each other, we focus our analysis on assessing the effort that would take to go from the current organizational structure illustrated in Figure 2 to the alternative (temporary) organizational form suggested in Figure 4. *How difficult would putting these six clusters in place be?* To address this question we analyze the set of task-related interactions with positive dyadic creativity that these six clusters enclose. More specifically, we examine whether putting these six creativity clusters together requires bringing people from different organizational groups or from different sites. (Recall that the organization studied was structured into 11 organizational groups and located in three different sites.) To do so, we first calculate the fraction of interactions within the creativity clusters highlighted in the clustered creativity matrix (**C**) that occur across organizational boundaries in the actual communication matrix (**A**). Similarly, because we know the location of each individual in the organization, we can also calculate the fraction of interactions within the creativity clusters that occur across locations.

There are 66 dyadic task-related interactions occurring within the six creativity clusters, 71% of which occur across organizational groups (in the current organizational structure) while only 18% of them are collocated within the same site. Interestingly, the results of our clustering analysis suggest to form creative clusters involving people from 10 out of the 11 organizational groups. (The only group that does not contribute to the six clusters of creatives is the two-people group assigned to special projects.) Hence, the organizational effort to form the clusters of creatives is moderated. Although most of the creative clusters comprise people from the same location, these new clusters involve people from various organizational groups. This is consistent with previous research that suggests that collocation and diversity are key determinants to achieve novel and useful outcomes [6][11][18].

DISCUSSION

This paper introduces a three-step approach to design alternative organizational forms that maximize the generation of creative ideas. These alternative forms of organizing for creativity can provide guidance to managers when deciding whom to assign to a team (or task force) from which creative solutions would be demanded. Our approach does not pretend to permanently change the existing organizational structure. Instead, we aim to capture the current state of the organization as a key input to generate temporary organizational alternatives to form creative teams. We not only capture the formal and informal structure of the organization but also measure the creative outcome of each task-related dyadic interaction. We exploit the notion of creative interactions to capture the extent to which interacting with someone for task-related matters triggers (or hinders) the generation of creative ideas. Because we are able to document how good (or bad) actual task-related dyadic interactions are, we are able to cluster individuals who stimulate the generation of creative ideas when interacting with others. We found that putting in place an alternative organizational form that clusters individuals with positive levels of dyadic creativity (keeping creativity blockers out of the clusters) requires the necessary effort of bringing people together from various organizational groups. As a result, the impact on the organizational groups that lend some of their members to the cluster(s) of creatives need to be carefully assessed to avoid irreversible disruptions on the existing organizational structure. Moreover, because the possibility that dyadic creative outcomes change over time is significant, it is important to consider our approach with a dynamic perspective in which the first two steps are repeated whenever there is evidence of a significant change in the communication patterns of the organization.

Although we illustrate our approach in an in-depth case study in a software development organization, additional validation in other types of technical organizations would be required before generalizing the results presented here, which offers interesting opportunities for future research in this area. From a theoretical viewpoint, the implications of this approach rest on the usage of task-related interaction outcomes (such as dyadic creativity) to explore alternatives ways to cluster organizational groups to maximize specific organizational outcomes of interest. We have illustrated our approach to re-organize for creativity, however this approach could be used to reorganize for other important outcomes such as rework management or knowledge transfer. From a methodology viewpoint, our approach will benefit from development of new clustering algorithms that not only cluster people with positive dyadic outcomes but also isolate these clusters from individuals who hinder dyadic outcomes. From an empirical perspective, it is important to show that clustering people based on our approach leads to the production of highly creative outcomes. Our current research efforts focus on addressing these opportunities to push this research forward.

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