Herath, Dinuka, Secchi, Davide and Homberg, Fabian

Organization vs Disorganization: A Computational Model of Goals, Motivation and Problem Solving

Original Citation

Herath, Dinuka, Secchi, Davide and Homberg, Fabian (2015) Organization vs Disorganization: A Computational Model of Goals, Motivation and Problem Solving. In: European Academy of Management (EURAM) 2015, 17-20 June 2015, Warsaw, Poland. (Unpublished)

Organization vs Disorganization: A Computational Model of Goals, Motivation and Problem Solving

Abstract

This paper presents an agent-based simulation of "disorganization" and its effect on problem solving. The Prime objective of the simulation is to determine the variance in problem solving under two settings. The first has inflexible structural limitations enacted on the agents (organization) while the other has very little structural limitations (disorganization). The simulation also employs goals as a foundation for the motivation with which agents solve problems. Findings of the simulation show that the "organization" setting guarantees a minimal number of problems are solved independent of how much simulated employees interact with each other. Instead, the "disorganization" setting seems to be more efficient when agents extend the range of social interaction, in or outside their working group, department, or division.

Keywords: agent-based modeling, disorganization, expectancy theory, goals, problem solving, effectiveness

Every organization sets a number of goals (Brown et al 2005) and each goal is observed as having an inherent level of complexity. Some are relatively simple; others appear to be very complex (Locke and Latham, 2013). As Locke and Latham (1990) state "[g]oals ought to be measurable and well defined" and this, historically, directed to the idea that a well-organized structure associated with clear goals renders them manageable (Shenhav, 2002). This belief goes deep down to the roots of management (e.g., Taylor, 1911; Fayol, 1919) since it echoes the belief that goals should be clearly associated with managers and employees. According to the aforementioned belief, it is the clearness of instructions and effective organizational structures that enables goal attainment (Chandler, 1932; Simon, 1947). This aligns with the school of rational or traditional management (Scott, 2001). Nevertheless, recent debates have cropped up questioning the effectiveness of rigid organizational structure and highlighted the apparently positive effects of disorganized work environments on work outcomes and productivity (Deci and Ryan, 1991; Amabile, 1996; Frost et al, 2010).

This paper is an attempt to study the effects of disorganization on goal realization (framed as problem solving; see below). Even though, some researchers claim that disorganization might bring some benefits (Abrahamson and Freedman, 2006), the effect of disorganization on particular organizational procedures and processes have received limited attention. There is discussion about the notion of "disorganization" in the literature (Abrahamson, 2002). Therefore we have decided to use disorganization as an umbrella term to incorporate multiple concepts (Abrahamson and Freedman, 2006). One of the most prominent of these concepts is that of messiness, which describes the unwanted aggregation of things both physical and non-physical as disorganization (Abrahamson and Freedman, 2006). Another prominent characterization of disorganization is the reduction of organizational structure (Cohen, 1974). Furthermore, some researchers also define disorganization as low levels of organizational control (Warglien and Masuch, 1996). This paper focuses on goal attainment under conditions of less or more structure and of formal or informal rules of interaction for employees. Therefore, it is clear that the idea of "disorganization" tackled in this paper is constructed around research on the effects of increasing and decreasing control in organizations (Merton, 1968; Crozier, 1969; Cohen, 1974; Abrahamson and Freedman, 2006).

The study presented in this paper has two primary purposes. First, the paper investigates the effects of disorganization on goals. In doing so, we utilize an agent-based computational simulation model (ABM) to unveil the effects of disorganization and organization on employee's access to problems and solutions, in light of available problem solving opportunities. The primary interest of the research is to compare and contrast the efficiency of both organization and disorganization in terms of achieving goals, namely problem solving. This is done through simulating fluctuations in motivation among employees when problems are solved. The second objective of the paper is to contribute to building of a theory of disorganization (Abrahamson, 2002; Warglien and Masuch, 1996). Consequently the study aims to expand the understanding of how disorganization affects organizations.

Theoretical Framework

Disorganization

Disorganization is an idea first presented and discussed in the seventies (Cohen et al., 1972) and it may also be labeled as *organized anarchy*. This is the manner in which Cohen and March (1974) discuss it relative to leadership, under circumstances of ambiguous power and its responsibilities, a condition that offers beneficial results for leaders. In the 60s, disorganization was characterized as any deviation from the organizational protocols and procedures (Merton, 1968; Crozier, 1969). This definition quickly revealed to be insufficient since there is no explanation as to "what" disorganization is, nor does it define its features, origins and consequences (Shenhav, 2002; Warglien and Masuch, 1996; Abrahamson and

Freedman 2006). For the purpose of clarification, note that in the context of this study, the word "disorganization" does not imply the opposite of "organization" by default. Therefore for disorganization to occur, it is not necessary that the organized apportionment of a given environment, resources or thoughts are identified. To make a rudimentary example, when we observe what looks to be a dis-organized desk, we do not need to have a clear idea of how the same desk would look if it were organized. In this case, there is no specific benchmark but probably a mental model that allows us to distinguish a generic disorder. Additionally, disorganization can be also understood as an epiphenomenon which takes place within a more organized or structured context (Abrahamson and Freedman 2006).

In the context of the study we might refer to disorganization and organization as ways of distributing, assembling and linking resources, thoughts, and elements (let this be meaning 1). In contrast the term "organization" can also refer to social structure as a way of drawing resources together within a restricted and formal social setting (e.g., a company, the European Union) (meaning 2).

In the case the latter (meaning 2) is used, it is apparent that dis-organization cannot be considered as an antonym. The model presented in this paper focuses on organization as ways of distributing, assembling and linking resources, thoughts, and elements (meaning 1). The way disorganization occurs in this model is within a defined formal social structure (meaning 2). Thus, the two levels are nested (meaning 1 is nested within meaning 2).

Disorganization has constantly been considered as an unfavorable factor for organizational performance (Shenhav, 1995; Shenhav, 2002). Contrarily, Abrahamson (2002) argues that there are drawbacks to order such as inattention towards emergence, reduced worker enthusiasm and deviance from primary goals and objectives of the organization. In light of fresh evidence (Warglien and Masuch, 1996; Abrahamson and Freedman 2006), some academics (Freeland, 2002; Warglien and Masuch, 1996) now reach agreement that there are benefits of minimally structured organizational settings (disorganized environments). The primary advantages of disorganization can be found in decision making, problem resolving (Cohen et al., 1972), innovation (Freeland, 2002) and motivation (Warglien and Masuch, 1996). Some key advantages of disorganization emphasized by Abrahamson (2002) and Abrahamson and Freedman (2006) are efficiency advantages, increasing creativity, political advantages – indispensability, less utilization of resources, allowance for atypical agents/ processes.

Given the theorized advantages of disorganization, some researchers consider of disorganization as something that can be managed (Warglien and Masuch, 1996; Abrahamson and Freedman 2006; Freeland, 2002). Under this milieu, management does not entail "structuring." Instead, it implies optimization and direction of disorganization (Abrahamson and Freedman, 2006). The application of an amount of disorganized mechanisms, associations and procedures when desired (in decision making, in innovating, etc.) can be perceived as disorganization management. Given the hypothesized aptitude of disorganization to be managed to achieve improved outcomes for an organization, understanding the stages of disorganization at which operational goals can be set is an essential task.

Current research (e.g., Stacey, 1993; Muller, 2000; Abrahamson, 2002) aims to deliver a theoretical clarification of the notion of disorganization. Disorganization itself has not received much attention from mainstream management researchers given that the field has been concerned with the ordered, the rational, and the structured for quite a long time (e.g., the so-called rational systems theories; Scott, 2001). The modern lack of consensus on as to what disorganization actually is can also be seen as one such cause. Nonetheless, some authors (Stacey, 1993; Muller, 2000; Nonaka, 1988) directly or indirectly discuss the idea of disorganization from numerous vantage points (individual, group, and organizational level).

In this paper, we begin from the basic working definition of disorganization as presented by

Abrahamson (2002). This definition was chosen because it provides substantial detail and makes the concept easier to operationalize in a simulation. He posits that "[d]isorganization is the disorderly accumulation of varied entities in hierarchically ordered complex human structures" (p. 4).

According to the abovementioned definition, disorderly accumulation refers to involuntary aggregation of both nonphysical and physical components within an organization (varied entities in the definition). These entities are also hierarchically ordered, pointing at how an organization is usually structured. Although this definition coarsely covers the notion of disorganization it still does not offer much of a description of what "disorganization" is. Abrahamson (2002) further postulates that disorganization as described above is an inescapable condition inside an organization and should be incorporated. The rate at which a disorderly accumulation of varied entities happens is reliant on the structure of an organization. The structure can be inflexible (organized, hierarchy) or flexible (disorganized, anarchy). These types can be re-worded to designate a decrease of structural controls (hierarchy) and rules of interaction that workers are exposed to (anarchy).

Goal setting

One of the methods to enhance the understanding and study disorganization is that of associating it with a concrete and inescapable constituent of organizing (Warglien and Masuch, 1996). In this study, we claim that one such component is "goal setting" (Locke and Latham 1990; Locke and Latham 2013). In order for a goal to be accomplished, employees must make decisions and solve problems. In this paper, we are not interested in what way goals are actually "set" or in the individual or collective decision making process leading to a shared understanding of prioritizing goals and identifying what they should look like. It is worth noting that some of these goals are ambiguous (Cohen and March, 1974), thus making it challenging to deal with them. Not all goals are direct and easily quantifiable, as the theory seems to endorse (Locke and Latham, 1990). If we consider elements of goal ambiguity, we may realize the more individuals dealing with the same goal may help defining the shared meaning it has for the organization, employees, and administration (Cannon-Bowers and Salas, 2001). Furthermore, the dynamic of advice giving and taking between members of a team and/or hierarchical levels (Bonaccio and Dalal, 2006) affects how people think and act on particular goals and tasks. These wider procedures can also be defined cognitively, providing an externally and socially dispersed type of the goal setting process (Hutchins, 1995; Cowley and Vallee-Tourangeau, 2013). This is why it is valuable to approach solving problems related to goals using a less-organized (or disorganized) viewpoint.

Moreover, disorganization and goal setting share some commonalities. Both disorganization and goal setting take place at every hierarchical level of an organization (be it the mailroom or the boardroom). Also, both disorganization and goal setting can be witnessed regardless of the vantage point from which the observation is made (individual perspective, group perspective or organizational perspective). Furthermore, setting up goals simulates motivation as one achieves the goal (i.e. solves the problem) and is ready to move to the next one. Lastly, the impacts of disorganization on goal setting have not been explored before and this provides an added reason to investigate how the two variables cooperate together (Abrahamson and Freedman 2006).

Goal setting theory (Locke and Latham, 1990) was formulated over a 25 year time period based on 400 plus laboratory and field studies (Locke and Latham, 2013). Recent studies have observed features of goal setting theory as learning goals and individual efficacy (Donovan and Williams, 2003; Seijts and Latham, 2001; Drach-Zahavy and Erez, 2002; Wiese and Freund, 2005). The theory posits that hard and clearly defined goals lead to better task performance than vague (less defined) or easy goals if the individual has the efficacy, commitment and does not have other contradictory goals (Locke and Latham, 1990).

The association between goal difficulty and task performance has been established both theoretically (Locke and Latham, 1990; Locke and Latham, 2013) and experimentally (Donovan and Williams, 2003; Seijts and Latham, 2001). In addition, Bandura (1997) and Brown et al. (2005) observed that self-efficacy, past performance and various external factors affect the way goals are put in place. Although the relationship between goal difficulty and performance is well studied, the external environmental or social influences of disorganized work environments on goal setting have not received the same interest (Locke and Latham, 2013). In the simulation model presented in this paper a goal is considered a precondition for a problem to be resolved. This means that when a problem is resolved a goal has been accomplished.

Nonetheless, as previously mentioned above, one of the effects of disorganization on goals is that they can turn out to be vague (Cohen and March, 1974). Of course, there are several means goals can be perceived in such a way. For instance, a goal can be perceived and understood differently from worker to worker, be defined free of the hierarchical level(s) in which it is first demarcated, and its realization may be adjudged differently due to the goal being unclear (i.e., ambiguous) in the first place.

The Model

We explore the effects of disorganization on goals and task performance utilizing agent based modeling (ABM; Fioretti, 2012). ABMs can be seen as a direct answer for the problem of understanding intricacies involved in an organizational setting (Miller and Lin, 2010). ABM can be used to simulate numerous organizational dynamics in a simple yet comprehensive way (Lomi and Harrison, 2012; Secchi 2015). The key advantage ABM has over its alternatives is the ability to be more malleable and adaptable (Gilbert and Terna, 2000), characteristics that have increased its use among scholars (Gilbert, 2008). Moreover, this class of models is particularly well suited to represent complex adaptive systems, such as organizational problem solving dynamics.

Accompanying the case of ABM for this particular issue this paper is concerned with is the fact that this tool has previously been used to model and simulate effects of disorganization in decision making. Fioretti and Lomi (2008) used an ABM to simulate the garbage can model (Cohen et al., 1972) of decision making. In formulating the model for investigating effects of disorganization on goal setting and task performance, we follow ideas presented in Lomi and Harrison (2012). In fact, a set of rules are a direct derivative from the underlying theory which can then be modeled into parameters. Thus the work of Fioretti and Lomi (2008) and Lomi and Harrison (2012) were used as groundwork for the research discussed in this paper. These procedures were modeled using conditional statements.

The two central states of the simulation are modeled as "organization" and "disorganization." Hierarchy (organization) characterizes the structured working environment with rigid rules, regulations and operational procedures where agents can only move based on sufficient conditions. Anarchy (disorganization) equates to a loosely structured work environment where agents are fully independent and free to move.

Space and agents

The domain in which the agents reside is three dimensional. The dimensionality of the simulation space allows each agent to move along the *x*, *y*, and *z* axes. A three-dimensional simulation space is used as an alternative to a two dimensional simulation space in order to give more variability to agent movements.

The model contains of 4 agents which have a set of variables defined under them. Table 1 shows agent types and their attributes (parameters in the simulation) while Table 2 shows parameters, values, and a short description of what they represent.

Table 1 about here

Independent of its type, each agent is assigned a *level* that is used to specify where each agent is situated within the organizational hierarchy. These levels are defined by numbers from 0 to 4. The number '0' represents the lowest tier of the hierarchy (e.g., mailroom) while the number '4' represents the highest level (i.e. boardroom).

The agent 'employee' characterizes the typical worker within a given organization. *Efficacy, ability*, and *motivation* are characteristics of each employee and are attributed through a random normal distribution with a mean of 0 and standard deviation of 1.

The 'problem' agent represents both physical and non-physical problems which arise within an organization (e.g., unruly employees, broken computers, delayed projects, low sales, and angry customers). This agent in the context of the model is used as a placeholder to represent all the multitude of problems an organization faces. Each problem has a *difficulty* assigned to it through a random normal distribution with a mean of 0 and standard deviation of 1. The difficulty of a problem represents the inherent complexity (or simplicity) of any given problem and is used in the decision making process. A problem is perceived more or less difficult depending on how this inherent complexity matches with an employee's abilities, efficacy, motivation, solutions, and opportunities. Such matching reflects problem difficulty relative to each agent-employee.

The 'solution' agent represents both physical and non-physical options available (e.g., repairman, various tools, will power, collective action, political capital) which can be used to solve problems. The solution agent acts as a placeholder to represent all the various solutions available within a given organization. Each solution has an *efficiency* assigned to it through a random normal distribution with a mean of 0 and standard deviation of 1.

The ‘opportunity’ agent is used to represent the occasion when a problem can be solved and when solutions are available. This variable takes into account the fact that in any given organization the opportunity to solve problems arise and cease to exists, thus the opportunities need to be grabbed once presented. A given opportunity does not have any attribute which is unique to it but shares the level attribute with all the other agent types.

Table 2 about here

Movement

Movement in the model represents the real-world movement of agents within an organization. The orientation of a given agent (the direction which they are moving towards) depends on its type. Once an agent turns to a random direction it scans its surroundings and moves toward other agents within its range or randomly, depending on the following rules:

1. Problems move freely (i.e., randomly) within the solution space. Upon every step a given problem turns to a random angle and moves a patch before repeating the procedure ad infinitum until the simulation is stopped or the problem is solved in which case it exits the solution space.
2. Solutions tend to move around problems. In this context a solution represents resources available for solving a problem. The solution agent parallels the resources available in the real world, both physical and non-physical. A given solution scans its surroundings and moves towards the maximum valued problem in range.
3. Opportunities represent the window of time and circumstance where a given problem can be solved. In the real world some problems can only be solved at an opportune

time or place thus this agent represents the reality of the window of opportunity. A given opportunity scans its surroundings and moves towards the maximum valued problem in range.

4. Employees within the model are fully mobile and move randomly in the simulation space. This represents an organization where employees tend to move around and are not stationary. Even if an employee is stationed to a physical location they have the opportunity to handle multiple problems and move around their designated physical location. Employees move towards problems at any given time. A given employee scans its surroundings and moves towards the maximum valued problem in range.

In order to impose the conditions of both "organization" and "disorganization" within the solution space, various movements based on a set of rules have been developed. First, once "disorganization" is switched-on all the agents within the solution space move with complete autonomy and each agent turns to a random direction and moves forward freely. Under this condition agents are free to interact with one another without any restrictions. This form of movement represents a "disorganized organization" where employees, solutions, opportunities and problems move freely within the organization and interact without any restrictions. All the single agent movement conditions are applied under this setting. The distance a given agent travels under the disorganization setting is determined by the "range" parameter which is an initial condition.

In contrast, when the "organization" is switched on the agents are only allowed to move to a certain set of other agents within the solution space. The condition of "organization" is designed to represent the hierarchical nature of a real world organization where for example a problem in the mail room tends to be handled by an employee from the mailroom rather than an executive from the boardroom. This hierarchical restriction is implemented through the use of the "level" variable of each agent. The algorithm for hierarchical movement is as follows:

$E_l \neq P_l$ OR $E_l \neq S_l$ OR $E_l \neq O_l$

In the above algorithm let "E" be employee, "P" be problem, "S" be solution and "O" be opportunity that are available at a given "level," "l." The employee's hierarchical level is checked against the hierarchical level of the solution, problem, and the opportunity so that the agents are dispersed without any interaction if the levels are not equal. In order to implement the aforementioned algorithm fitting a real world scenario some inter-level interactions were allowed. The extent to which the inter-level employees interact is dependent on the randomly defined position they find themselves in. In a real world scenario employees on a higher level might solve problems appearing in lower levels, eventually.

Therefore, in order to implement a more practical hierarchical rule, the so-called "segregation" algorithm is used (Wilensky, 1997), based on Schelling's racial segregation model (Shelling, 1969, 1971). The purpose of the segregation algorithm is to separate agents in a way that agents with similar levels cluster together. This clustering allows agents with different hierarchical levels to interact to a small extent. For example, if the segregation is set to 70%, this implies that 70% of the times agents will only interact with other agents who have the same level and they tend to interact with agents from other levels 30% of the times.

Decision Rules

The same decision making logic is used both when movement is disorganized and organized. A problem is solved when a participant has sufficient ability (a), efficacy (e), motivation (m) and a sufficiently efficient (Sme) solution such that their product is greater or equal to the difficulty of the problem. This is called a "completed solution" in the model. Completed solutions take place when at least one participant, one opportunity, one solution, one problem are on the same simulated place (the so-called "patch"). The sum of the abilities (including motivation) of the participants on the patch, multiplied by the efficiency of the most efficient solution on the patch, is greater or equal to the sum of the difficulties of the problems on the patch (Equation 1).

$$E(a*m*e) + S\mathbf{me}\,(ef) \geq P(d) \quad (1)$$

Most often, completed solutions occur when just one participant, one goal opportunity, one solution and one problem happen to be on the same patch and the ability of the participant, multiplied by the efficiency of the solution, is greater or equal to the difficulty of the problem as shown succinctly in Equation 1.

When the difficulty of a given problem is greater than the product of the employee efficacy, ability, motivation and the efficiency of the solution in range no decision is made (Equation 2). If that is the case then, all agents immediately disperse.

$$E(a*m*e) + S\mathbf{me}\,(ef) < P(d) \quad (2)$$

Motivation

For the purpose of the simulation it is assumed that in order for a problem to be solved a goal has to be set by an employee. It is assumed that setting a goal is only possible if an employee is sufficiently motivated. It is assumed as a precondition that the external rewards and incentives are present within the model which provides the necessary extrinsic motivation. It is also assumed that employees are intrinsically motivated by the interest and the enjoyment of the tasks at hand to some extent. The levels of motivation among employees are randomly assigned among the employee population within the simulation.

In line with motivation theories (e.g. self-determination theory) we assume that the experience of successfully solving a problem has a positive effect on motivation (Deci and Ryan, 1991; Steel and Konig, 2006). An employee can set themselves either a “hard” or an “easy” goal. A hard goal is set if the following condition is satisfied:

$$2*(E\,(a*m*e)) \leq P\,(d) \quad (3)$$

Where "E" is employee, "a" ability, "m" motivation, and "e" efficacy. "P" denotes problem while "d" denotes the difficulty of the problem. As Equation 3 depicts, if a problem's difficulty is greater than or equal to two times the product of an employee's ability, motivation and efficacy then the problem can be seen as a difficult problem to be solved. Thus an employee in such a predicament has to complete a hard goal. The term "hard" here implies that the problem a given employee is trying to solve is a very difficult one (i.e., 2 times one's own capabilities). Even though the problem might be hard it can still be solved using a highly efficient solution, where the combined value of both the employee's attributes and the solution's efficiency will be adequate to solve the problem at hand. In such a case where a "hard" problem is solved, the employee's motivation increases by a predefined value (i.e., 2).

On the other hand, if the product of the employee's attributes is greater than the problem's difficulty then the problem can be easily solved once a solution is utilized.

$$2(E\ (a*m*e)) > P\ (d) \qquad (4)$$

Therefore in a situation where the above condition (Equation 4) is satisfied, where two times the product of an employee's attributes are greater than a given problems difficulty a problem is classified as an "easy" problem. This implies that the employee does not have to set a "hard" goal. In this case the employee's motivation does not increase as much compared to a "hard problem" but does increase slightly (i.e., 1).

Computational Experiments

Upon construction, the simulation model was subjected to comprehensive experiments in order to determine if the simulation was working as expected, if the proper results were being produced and if the results produced were consistent over multiple runs. The tests were divided into two categories namely the "organized movement" experiments and the “disorganized movement” experiments. Given the large number of simulation parameters and the variations of values available it was imperative to select a specific set of parameters for this particular study.

Upon considering the options available we decided to focus the testing for this particular paper on opportunities for solving problems under organized conditions as well as the effect of the range of interaction under both the environmental conditions.

Table 3 about here

Utilizing the parameter variations depicted in Table 3 both the organized and disorganized movement settings were experimented upon through the simulation. At any given instance the employees are divided into five employee types (levels) with a default distribution which is: low level workers (50%), supervisors (25%), managers (10%), middle management (10%) and top management (5%). The default percentages tend to reflect a paradigmatic example of the composition of employees within a standard organization.

The range parameter determines the number of patches a given agent will scan during a single step. The scanning allows an agent to acquire some knowledge about its surroundings, namely if any other agent is present in the vicinity. Using this knowledge the agent can either move towards an agent or move away from an agent accordingly. Therefore, range represents the way workers socialize with those close to them more often than to those far away. The vicinity is to be intended as working closeness, as it is within people in the same department.

A time limit of 1620 steps for each run of the simulation was imposed on each experiment and 20 repetitions of the experiments were carried out to check the consistency of the results obtained. The 1638 steps were decided upon after taking into consideration an employee’s normal year of work within the organization. Therefore, 1 step is equivalent to 1 hour. On average the actual work time of a worker working for 8 hours will be around 6.5 hours. The remaining 1.5 hours will be utilized for lunch and other mundane tasks. In a usual month the total working days is around 21 days after deducting weekends and 1 public holiday. Furthermore, on average an organization works throughout the years (12 months). Therefore, 6.5 hours a day for 22 days a month within 12 months approximates to 1638 hours.

Findings

Table 4 below shows the findings of the simulation experiments in the tabulated manner. The table shows if the results were of any interest or not.

Table 4 about here

As shown in table 4 the results indicate a clear difference in the problem solving efficiency of the different configuration of parameters. These differences were observed using conditional plots which allowed us to visualize the number of problems solved in a given period of time under the varying parameters reported in Table 4. “Some difference detected” means that when analyzing the results a clear increase or decrease in the number of problems solved was observed under one setting or both settings (organization and disorganization). In contrast “no deference detected” means there was no observable difference in the number of problems solved.

When analyzing the results of the simulation our primary focus was on investigating the efficiency of problem solving under both the organized and disorganized settings. In doing so, we compared the number of problems solved under both conditions within a given period of time. Furthermore, upon analyzing the plots we discovered that the results were consistent under most conditions. Figure 1 depicts the number of problems solved given time (i.e., “steps” in the simulation) under “organization”. Figure 1 depicts results obtained when range was 7, the initial number of employees, problems, solutions and opportunities were 100. The red line in Figure 1 is the best fitting regression line for the represented data (IV: range, DV: problems solved). We use this to estimate the average effect of a given set of conditions in the simulation. The two horizontal lines (gray) indicate the values of *y* (i.e., problem solved) corresponding to 1000 and 1500 time steps.

Figure 1 about here

Figure 1 shows that under the “organization” setting, 40 problems were solved in the first 1000 steps (lower horizontal gray line intersecting the regression red line) while 62 problems were solved (upper horizontal gray line intersecting the regression line) in 1500 steps. We also found the mean motivation in this configuration of parameters was 76.65. Next, we plotted the number of problems solved under the same parameter conditions for the “disorganization” setting (Figure 2).

Figure 2 about here

Figure 2 shows that 51 problems out of 100 were solved in the first 1000 steps while 74 were solved after 1500 step. The mean motivation in this particular set of conditions was 183.27. From these results, it is apparent that the “disorganization” setting is generally more efficient than the “organization” setting, also reflected in the higher motivation. However, through further analysis of the data we found out that this was not always the case. Through analyzing both data of the organized and the disorganized setting it was observed that the range parameter had a noteworthy effect on the problem solving efficiency while the other parameters did not. These results are further dissected and discussed in the sections below.

In studying the results produced under the organization setting we discovered that the “range” parameter produced some noteworthy effects. Figure 3 graphically represents these observations.

Figure 3 about here

The number of problems solved in 1638 steps (opportunities for interaction) and its variations given the different range, i.e. the extent to which each agent reaches out to less (range = 3) or more (range = 11) of the other agents, and the number of initial opportunities available. The range parameter is translated to the number of collaborations/interactions in a real world context. From the angle of the curve we can observe that the number of problems solved within a given amount of time increases with the higher values of the range parameter. Further analysis on these results also showed that the lower the number of opportunities compared to the number of problems, the lowers the number of problems solved. However, when the initial number of opportunities is higher than or equal to the initial number of problems there was no effect on the efficiency of problem solving. In summary the above figure shows that range plays a significant role in the efficiency of problem solving under the organization setting. These results were consistent when range was plotted against the initial number of problems and solutions.

As with the organized state, the range parameter played a vital role in the disorganization setting. Figure 4 shows the number of problems solved within 1638 steps under varying ranges and varying initial opportunities. As with the organization setting the disorganization setting seems to be highly affected by the range parameter. However, what is surprising is the fact that under a low range of 3 almost no problem gets solved. This is in stark contrast to the results of the organization setting where, at a range of 3, around 25 problems were solved. However, as soon as the range increases under the disorganization setting the problem solving efficiency leapfrogs that of the organization setting as can be observed when comparing Figure 1and Figure 2.

Figure 4 about here

Discussion and Conclusions

Results obtained from the simulation exemplify that, compared to the “organization” setting the “disorganization” setting offers a better structural setup for problem resolution only under certain conditions. Disorganization may provide swifter access to problems, opportunities and solutions when employees socialize (parameter range) more with each other. However, a more organized setting guarantees that certain problems get solved even when socialization is at its minimum (range = 3 in Figure 3).

These results demonstrate that disorganization may not be entirely disadvantageous to an organization, in contrast to views advocated by rational management theorists (Scott, 2001). However, results also show that disorganization does require wider range for the employees to work in especially when the solutions and opportunities available within the organization are very limited. This seems to suggest that disorganization without proper opportunities or solutions available does not render any benefits to the organization. The result signifies the importance of the socialization process or the “range” an employee can scan around him or herself, for the efficiency of problem solving. Findings also show that disorganization (access to problems, opportunities and solutions without any structural restrictions) is not always beneficial, if employees are not able to socialize on a wider range in the organization. Although our results don't provide direct evidence it seems to indicate that it is particularly important that disorganization be matched with a more socially-related (or shared) distribution of responsibilities. It is the organization as a social environment for cooperation that favors disorganized (or unstructured) solutions.

Primarily, results produced from the data analysis of the model indicate that disorganization does indeed create an environment conducive for efficient problem solving given proper freedom individuals have for searching for opportunities and solutions. This is consistent with the results obtained by Cohen et al. (1972) and Fioretti and Lomi (2008) who, under other conditions, affirmed that disorganization is generally a more efficient condition than organization in decision making at all levels of the organization. These findings further lend support to the assertions made by Abrahamson and Freedman (2006) that disorganization may be beneficial to problem solving.

Secondly, results exemplify that a rigid organizational structure and rules of interaction may be disadvantageous to problem solving due to restrictions on how agents engage with each other and solve problems. On the one hand, the model also points out that sometimes opportunities and solutions are accessible to workers that are not directly associated to a particular problem, thus disorganizing the rigid organizational structures and rules of engagement allows such indirect associations and makes problems solved more efficiently for organizations. This may be the case of an IT company where software engineers are free to look for solutions to their problems in places where, in a hierarchical structure, they would not be allowed to look for them (e.g, in the legal, HR departments, or operations). On the other hand, the organization setting allows some problems to be solved even when people do not seem to be actively looking for opportunities and solutions available. This may be the case of a company that needs to guarantee that the minimum amount of problems get solved on a daily basis. The national post, for example, cannot possibly allow that a minimal amount of problems do not get solved on a daily basis. These businesses are usually organized very rigidly.

Thirdly, making agents liberally move in the workplace with relaxed constraints means that the employee's abilities are more probable to be matched with the "correct" opportunity, problem, or solution. The worker that is "trapped" to one hierarchical level may see his/her particular abilities go unused because they do not match any problem to be resolved. There is scope in workers allotting themselves to problems and picking and choosing the correct opportunities to act and the correct solutions to usethrough the reduction of structural constraints and rules of engagement, the disorganization condition increases the personal discretion available to employees. Personal discretion is coined as the degree to which a task affords substantial freedom, independence, and choice to persons, in determining the processes to be used in carrying out a given task (Hackman & Oldham, 1980). The findings further show that under the disorganization setting the workers have increased individual discretion in the problem resolution process. This also means that different agents/workers 'see' and apply diverse solutions to problems, increasing the probability that it gets solved. This also adds to the level of motivation among employees. Furthermore, given that employees have increased autonomy they are able to self-determine which opportunities they engage with. This fulfillment of their self-determined aim generates positive feedback and increases their intrinsic motivation.

Fourthly, contemporary organizations are predominantly made up with teams; some teams often compete with each other to accomplish heterogeneous or near heterogeneous tasks. An out-group looking at another team might undervalue or overvalue the competencies of its rival team which leads to false judgments, perceptions and expectations (Cohen and March, 1974). In order to circumvent unnecessary and unfair judgment based on biased reasoning, a disorganized decision making process and problem resolution process which involves actors from several groups can be utilized. The results further indicate that decreasing rigid rules of interaction does contribute to a larger number of problems being solved. This decreasing of the rules of interaction ensures that the worker who previously was unable to interact with others due to rigid structures can now do so with comparative ease. Agents in the model can be interpreted as teams of individuals, if one gives that interpretation to it. From our findings, we are not able to define whether individual and team problem solving is affected by organization or disorganization. However, this is clearly an interesting area to move this research further.

Fifth, the results indicate that, when the opportunities for solving problems are less than the problems available within the workplace employees are not able to solve as many problem as when enough opportunities are present. This finding directly shows the importance of creating problem solving opportunities within an organization. Which means that in order to have effective problem solving, managers must provide employees opportunities to engage with problems and find relevant solutions. There opportunities can manifest into aspects such as stakeholder participation.

Finally, findings show that the average motivation among employees is greater under disorganization in comparison to motivation levels under organization. This difference in motivation levels can be credited to the higher number of problems solved under disorganization compared to organization. Under a rigid organizational structure with multiple constrains employees are limited and lack suppleness to solve problems that suit their abilities. This limitation was observed while running the simulation and the results confirm that lack of "elbow room" decreases an employee's efficiency as exposited by Crozier (1969). However, under disorganization employees are more autonomous and have more freedom of choice both in the problems and the solutions available to solve those problems.

Limitations and Prospects for Further Research

One limitation of the model as it currently stands is its resemblance to the real world. The model does mimic the basic problem solving process within a work environment however the dynamics it encapsulates is currently limited. In future iterations increasing the number of model parameters and introducing group problem solving, goal prioritization and multiple problem engagement will alleviate the current limitation to greater degree. Plus, introducing concepts such as promotions and demotions for employees along with training are some further research which can be carried out on the model. Introducing multiple types of problems, solutions and opportunities and goals (i.e. stationary and mobile) are also future enhancements which will increase the simulations link to the real world. Furthermore, in order for the model to function as it is we currently use some underlying assumptions. One such assumption is that when a problem is solved a goal gets achieved. The assumption then implies that a goal was set at the point of engaging the problem (i.e. the goal of solving the problem). This assumption currently is not directly operationalized within the simulation, thus can be viewed as a limitation. This limitation can also be tackled in future iterations of the model where the process of goal setting can be made more explicit within the simulation with a number of malleable parameters which will enable the experimentation of multiple settings. In addition, currently we employ a unified value of a given agent in the decision making process. For example, when an employee meets and problem the model multiplies the employee’s efficacy, ability and motivation and comes up with a single value. This process does not create any issues when considering the problem solving efficiency. However, it does make it difficult to analyze one particular aspect of an employee’s attributes (i.e. efficacy) which is a limitation of the current set up. Finally, when experimenting on the simulation we are currently employing a subset of all the parameter ranges. Thus, there are parameter variations which have not been tested yet. In future iterations the remaining variants can be experimented. When the aforementioned limitations are addressed using the future research enhancements also discussed above the model will be more accurate that it is now, it will also generate valuable new data which could hold some interesting results about disorganization and problem solving as a whole.

Conclusions

The objective of the simulation model was to utilize the unique functional and technical capabilities offered by agent-based modeling to simulate an organizational work environment and its dynamics with regard to problem solving, goals and motivation. The model was constructed to simulate two distinct movement and interaction patters one reflecting organization (rigid structural constraints and tightly controlled rules of interaction) and the other reflecting disorganization (reduction of structural constraints and rules of interaction). Through the execution and subsequent data analysis it was discovered that neither full disorganization nor full organization are the ideal for solving problems in an work setting. Instead we observed that disorganization seems to be a more efficient condition for problem solving, especially when the range parameter was high. In this case employees are given unrestricted access to problems, opportunities and solutions (i.e. disorganization). It was further discovered that in a state where 70% of organization and 30% disorganization were maintained provided the most efficient problem solving in the experiments conducted. Thus, overall results highlight the importance of structuring work but simultaneously leaving room for employees to thrive.

.

References

Abrahamson, E. (2002). Disorganization theory and disorganizational behavior: Towards an etiology of messes. *Research in Organizational Behavior* 24: 139-180.

Abrahamson, E. (2004). Change Without Pain: How Managers Can Overcome Initiative Overload, Organizational Chaos, and Employ. Boston, MA: Harvard Business School Press Books.

Abrahamson, E., & Freedman, D. H. (2006). *A perfect mess: The hidden benefits of disorder.* London: Weidenfeld & Nicolson.

Amabile, T. M. (1983). *The social psychology of creativity*. New York: Springer-Verlag.

Amabile, T. M. (1996). *Creativity and innovation in organizations.* Boston, MA: Harvard Business School.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: Freeman.

Bazghandi, A. (2012). Techniques, advantages and problems of agent based modeling for traffic simulation. *International Journal of Computer Science Issues* 9(1): 224-245.

Black, J., & Edwards, S. (2000). Emergence of virtual or network organizations: fad or feature. *Journal of Organizational Change Management*. 13(6): 267-276.

Blumenthal, M. S., Inouye, A.S., & William, J., (2003). *Beyond Productivity: Information, Technology, Innovation, and Creativity*. Washington, DC: National Academies Press.

Bonaccio, S., and R. S. Dalal. 2006. Advice taking and decision-making: An integrative literature review, and implications far the organizational sciences. *Organizational Behavior & Human Decision Processes* 101 (2): 127-151.

Brown, S. P., Jones, E., & Leigh, T. W. (2005). The attenuating effect of role overload on relationships linking self-efficacy and goal level to work performance. *Journal of Applied Psychology* 90(3): 972-986.

Cannon-Bowers, J. A. & Salas, E. (2001). Reactions on shared cognition. *Journal of Organizational Behavior* 22: 195-202.

Champion, A., Mandiau, R., Kolski, C., Heidet, A., & Kemeny, A. (1999). Traffic generation with the SCANeR II simulator: towards a multi-agent architecture. *Proceedings of the first Driving Simulation Conference* 311-324.

Chandler, A. D. (1932). *Strategy and Structure.* Cambridge, MA: Harvard University Press.

Cohen, M. D. (1972). A garbage can model of organizational choice. *Administrative science quarterly* 12(2): 1-25.

Cohen, M. D., & March, J. G. (1974). *Leadership and Ambiguity, The American College President*. New York: McGraw-Hill.

Cowley, S. J. & F. Vallee-Tourangeau, F. (Eds.), *Cognition beyond the brain. Computation,* *interactivity and human artifice*. London: Springer.

Crozier, M. (1969). *The bureaucratic phenomenon.* Piscataway, NJ: Transaction Publishers.

De Vulpain, A. (2005). Listening to Ordinary People: The Process of Civilization on the Way to a New Society. *Society for Organizational Learning.* 6(7): 6-7.

Deci, E., & Ryan, R. (1991). A motivational approach to self: Integration in personality. In R. Dienstbier (Ed.), *Nebraska symposium on motivation: Perspectives on motivation*, Lincoln: University of Nebraska Press 38: 237-288.

Donovan, J. J., & Williams, K. J. (2003). Missing the mark: effects of time and causal attributions on goal revision in response to goal-performance discrepancies. *Journal of Applied Psychology* 88: 379-402.

Drach-zahavy, A., & Erez, M. (2002). Challenge versus threat effects on the goal–performance relationship. *Organizational Behavior and Human Decision Processes* 88: 667-682.

Eisenberg, E. M. (1984). Ambiguity as strategy in organizational communication. *Communication monographs* 51(3), 227–242.

Fayol, H. (1916). *Administration industrielle et generelle.* Comptes Rendus Mensuels des Reunions de la, Societe de 1'Industrie Minerale, [Translated by: Garzon del Camino, 1985].

Featherstone, M. (1990). *Global culture: Nationalism, globalization and modernity*. Thousand Oaks, CA: Sage.

Fioretti, G., & Lomi, A. (2008). An agent-based representation of the garbage can model of organizational choice. *Journal of Artificial Societies and Social Simulation* 11(1): 1.

Freeland, R. F. (2002). *When Organizational Messiness Works.* Harvard Business Review 80: 24-25.

Frost, J., Osterloh, M., & Antoinette, W. (2010). Governing Knowledge Work: Transactional and Transformational Solutions. *Organizational Dynamics* 39(2): 126-136.

Gilbert, N. (2008). *Agent-based models.* Thousand Oaks, CA: Sage.

Gilbert, N., & Terna, P. (2000). How to build and use agent-based models in social science. *Mind & Society* 1: 57-72.

Hackman, J. R., & Oldham, G. R. (1980). *Work Redesign. Boston*. MA: Addison-Wesley.

Hutchins, E. (1995). *Cognition in the wild*. Cambridge, MA: MIT Press.

Jarvenpaa, S. L., & Leidner, D. E. (1998). Communication and trust in global virtual teams. *Journal of Computer-Mediated Communication* 3(4): 0-30.

Locke, E. A., & Latham G. P. (1990). *A theory of goal setting & task performance.* Englewood Cliffs, NJ: Prentice Hall.

Locke, E. A., & Latham G. P. (2013). *New developments in goal setting and task* *performance.* London, U.K: Routledge

Lomi, A., & Harrison, J. R. (2012). *The garbage can model of organizational choice: looking forward at forty*. Bingley, U.K: Emerald.

Miller, K. D., & Lin, S. J. (2010). Different truths in different worlds. *Organization Science* 21: 97-114.

Mobley, W. H., & Fisk, M. J. (1982). *Employee turnover, causes, consequences, and control*. MA: Addison-Wesley Reading.

Muller, F. (2000). Handbook of ecosystem theories and management. New York: CRC Press.

Nohria, N. (1994). *Networks and organizations: structure, form and action*. Boston, MA: Harvard Business School Press Books.

Nonaka, I. (1988). Creating organizational order out of chaos: self-renewal in Japanese firms. *California Management Review* 30(3): 57–73.

Schelling, T. (1969). Models of segregation. *American Economic Review* 59: 488-493.

Schelling, T. (1971). Dynamic models of segregation. *Journal of Mathematical Sociology* 1: 143-186.

Scott, W.R. (2001). *Institutions and Organizations.* Thousand Oaks, CA: Sage.

Secchi, D. (2015). A case for agent-based models in organizational behavior and team research. *Team Performance Management*, 21(1): forthcoming.

Seijts, G. H., & Latham, G. P. (2001). The effect of distal learning, outcome, and proximal goals on a moderately complex task. *Journal of Organizational Behavior* 22: 291-307.

Shalley, C. E. (1995). Effects of coaction, expected evaluation, and goal setting on creativity and productivity. *Academy of Management Journal* 38(2): 483-503.

Shenhav, Y. (1995). From chaos to systems: The engineering foundations of organization theory, 1879-1932. *Administrative science quarterly* 21: 557-585.

Shenhav, Y. (2002). Manufacturing rationality: The engineering foundations of the managerial revolution. Oxford: Oxford University Press.

Simon, H.A. (1947). *Administrative Behaviour.* New York: Free Press.

Stacey, R. (1993). Strategy as order emerging from chaos. *Long range planning* 26(1): 10–17.

Stacey, R. D. (1995). The science of complexity: An alternative perspective for strategic change processes. *Strategic management journal* 16(6): 477–495.

Steel, P., & Konig, C. J. (2006). Integrating Theories of Motivation. *Academy of Management Review* 31(4): 889–913.

Taylor, F.W. (1911). *Principles of Scientific Management.* New York: Harper and Row

Terhurne, H., (2010). *Innovation by Creativity*. Herts, UK: Ecademy Press Limited.

Thompson, J. (1967). *Organizations in Action: Social Science Bases of Administrative Theory*. Classics in Organization and Management Series. London, U.K: Transworld Publishers.

Warglien, M., & Masuch, M., (1996). *The logic of organizational disorder.* Berlin: Walter de Gruyter.

Wiese, B., & Freund, A. (2005). Goal progress makes one happy, or does it? Longitudinal findings from the work domain. *Journal of Occupational and Organizational Psychology* 78: 287-304.

Wilensky, U. (1997). *NetLogo Segregation model.* Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL, URL: http://ccl.northwestern.edu/netlogo/models/Segregation.

Wilensky, U. (1999). *NetLogo, Segregation model.* Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL, URL: http://ccl.northwestern.edu/netlogo/.

Table 1: Agents and Attributes

Agent	Attributes
Employee (E)	Efficacy (e), Ability (a), Motivation (m), level (l)
Problem (P)	Difficulty (d), level (l)
Solution (S)	Efficiency, level (l)
Opportunity (O)	Level (l)

Table 2: Model Parameters

Parameters	Values	Description
Levels	0,1,2,3,4	Each agent is assigned a hierarchical level randomly. This parameter allows the creation of a hierarchy with the model.
Efficacy	N ≈ (0, 1)	Unique to an employee. Represents an employee's capability in solving problems
Ability	N ≈ (0, 1)	Unique to an employee. Represents an employee's level of skill and competency in solving problems
Motivation	N ≈ (0, 1)	Represent an employee's intrinsic and extrinsic motivation.
Problem difficulty	N ≈ (0, 1)	Represents the inherent level of complexity or simplicity of the problem.
Solution Efficiency	N ≈ (0, 1)	Represents the suitability of available resources to be used for problem solving.
Range	1 – 10	The range determines the amount of patches an agent will scan. i.e., if the range is set at 5 an agent will scan 5 patches around itself at every step.
Similar Wanted	0.00 – 1.00	Under the organization condition, the similar wanted parameter determines the percentage of agents of the same hierarchical level that a given agent is satisfied with. I.e., when similar wanted is set to 70% an agent will be satisfied if agents in range were of similar level 70% of the time.

Table 3: Subset of parameters variations selection for the study

Varying Parameters	**Organization**	**Disorganization**
Range	[3; 5; 7; 9; 11]	[3; 5; 7; 9; 11]
Initial Number of Opportunities	[50; 100; 200]	[50; 100; 200]
Initial Number of Solutions	[50; 100; 200]	[50; 100; 200]
Initial Number of Problems	[100; 200; 500]	[100; 200; 500]
Initial Number of Employees	[100]	[100]
Similar Wanted	[0.8]	[Doesn't apply]
Hierarchical Division of Labor		
Hierarchical Levels	100 Workers	100 Workers
Level 0	[50]	[50]
Level 1	[25]	[25]
Level 2	[10]	[10]
Level 3	[10]	[10]
Level 4	[5]	[5]

Table 4: Results breakdown

y x	Range	Opportunities	Problems	Solutions
Range	-			
Opportunities	Some difference detected	-		
Problems	Some difference detected	No difference detected	-	
Solutions	Some difference detected	No difference detected	No difference detected	-

Figure 1: Number of problems solved at range 7, given time under the organization setting

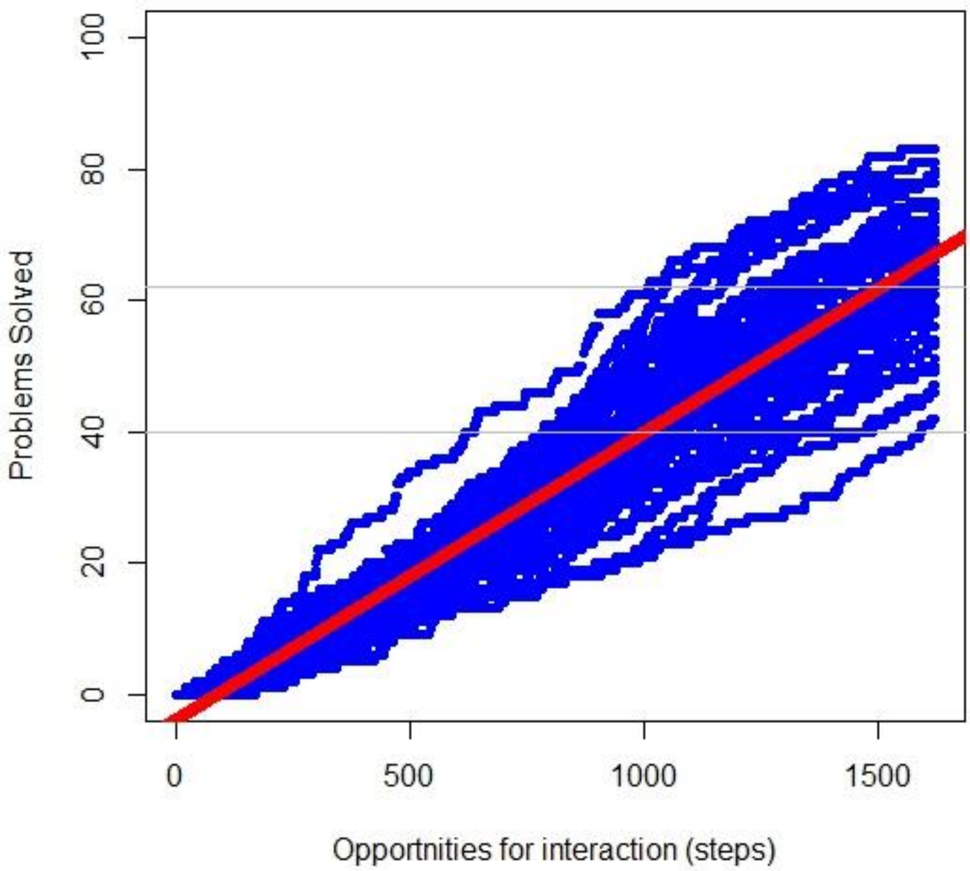

Figure 2: Number of problems solved at range 7, given time under the disorganization setting

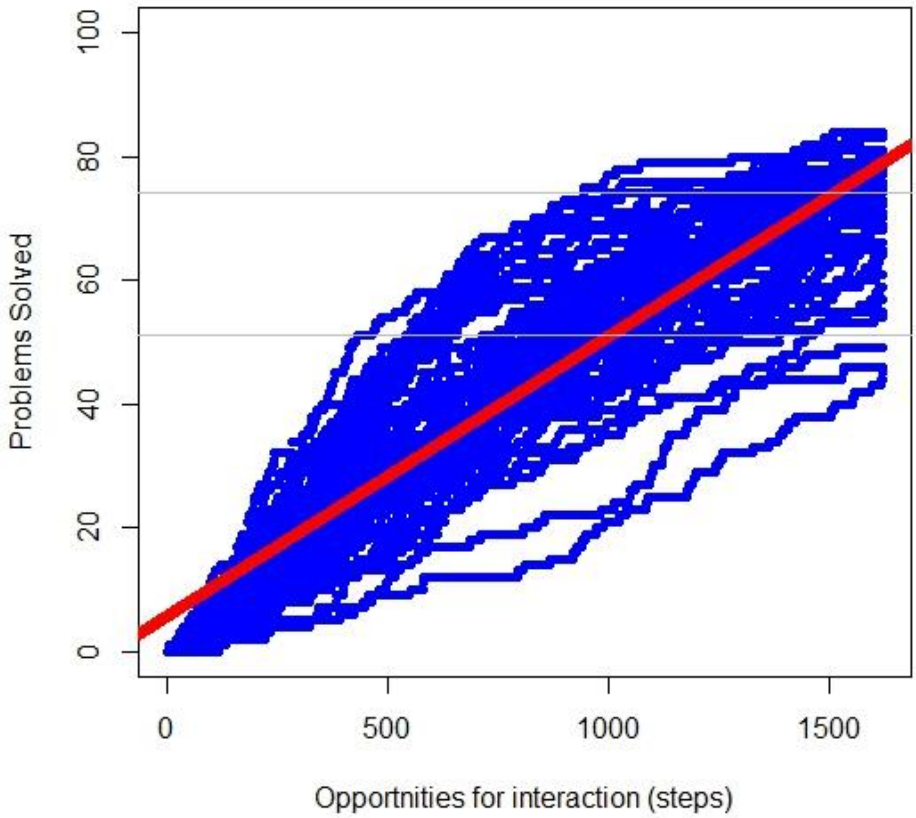

Figure 3: Conditional plot of the effects of range and opportunities on problem solved, given time under organization

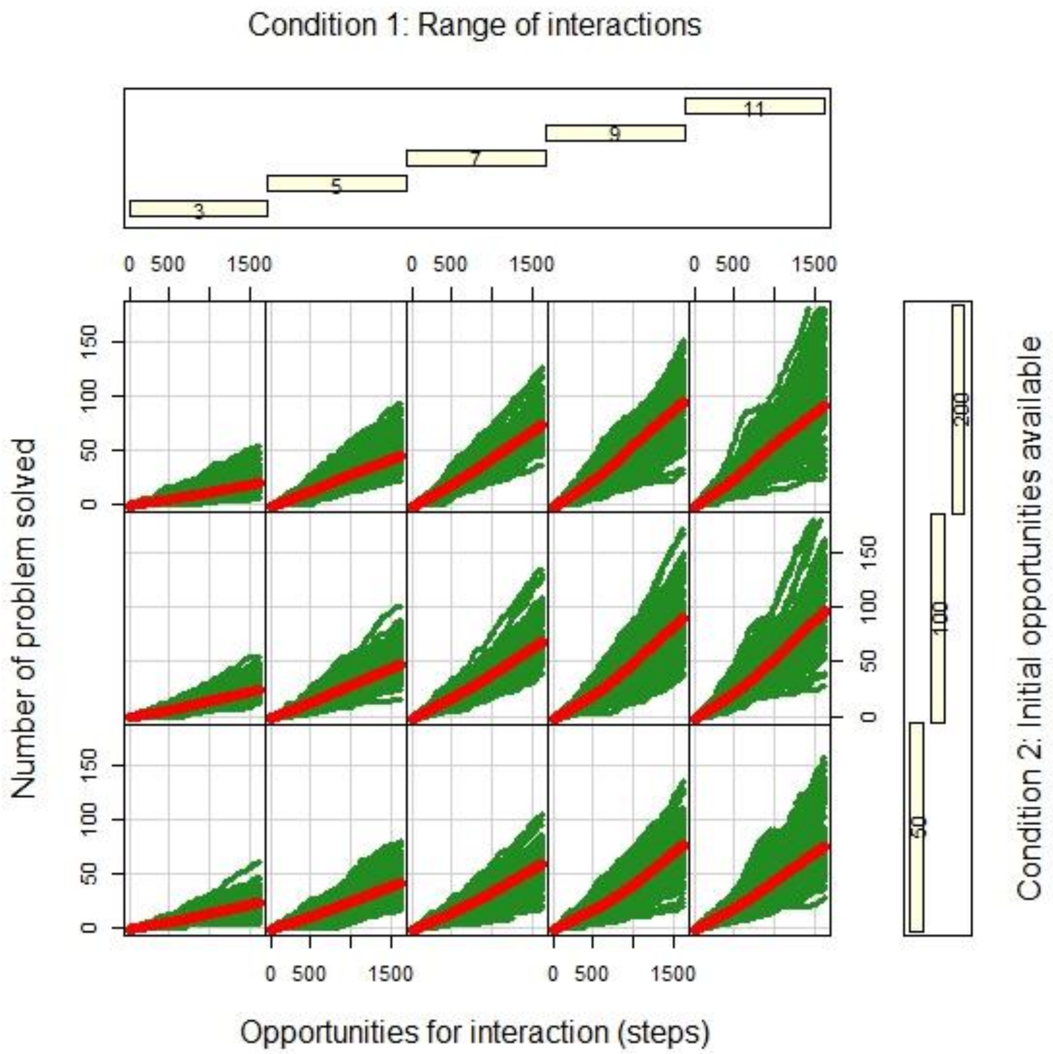

Figure 4: Conditional plot of the effects of range and opportunities on problem solved, given time under disorganization