Spontaneous Organizations:

Collaborative Computing Model of a Networked Organization

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***Abstract*—In most real life organizations, actions usually occur irrationally among their members which modify the behaviors of the organizations. As in Occupy Wall Street (OWS), for instance, that starts in 2011, and it was ongoing over more than 600 communities since then. Social movement, as in the OWS, frequently detected to increase the network rapidly. Therefore, our attention in this paper is on social networks among agents and their effects on the organization and the others. We show a study of such a movement that we label as Spontaneous Organization (SO). We illustrate a life cycle of the SO from the formation of it until the dissolution while covering some important concepts that case such a huge viral spreading. We present a method that can be used to assign tasks to the agents inside the organization depending on their level of fitness. A simulation for a small example of the real life that mimics a spontaneous organization will be implemented using NetLogo for further validation.**

Social networks; nontraditional collaboration; multiagent Strategies.

I. INTRODUCTION

Online multiplayer gaming environments, such as EVE, exhibit non-traditional style of formation and working organization [1]. EVE is a game played by a spontaneously formed group of individuals. Each player team has a specific number of players who work together to achieve certain goals by winning the game. The players of the game are monitored and controlled through actual people in varied locations who are connected with each other through the Internet. Since team players might know each other or not, their actions typically absorbed from their own ideas constrained by the game rule and commitment. Recent movements such as the Arab Spring [2], and the Occupy movement has similar phenomenon [3]. They are simply distinct group of individuals, who share affinities and possess similar objectives or ideologies that are socially connected via social mediums for extemporaneous decision and action. The organizational behavior can be affected by its agents' actions which link them with each other to achieve certain goal fast. These links differentiate between strong to weak depending on type of ties connecting them. The organization can adjust and develop its behavior by being aware of its agents' actions and modify them in order to help itself to easily clarify goal, maintain sociality, and organize itself. Agents' beliefs have effects on the links inside the organization, yet the absence of them may lead to segregation, anarchy, or dissolution.

Social connections provide opportunities for the agents to adapt their environments in order to be liked. Strategic network formation is a related topic that is an active research problem in network science [32]. Since these connections will modify their norms from time to time, their actions will be artificial from their environment. The dominant group, inside the organization, is responsible for creating plans and ideas in order to keep their organization's behavior stabilized. Other clusters that have different behaviors may also exist inside the organization, and they may try to modify its current situation. They may succeed in modifying their behavior when the dominant agents do not have strong ties with other agents in their organization that build their synergies. The coherence of the organization's behavior become consistent and stronger when there is no conflict between the current activities of the agents inside it and the older ones. However, the agents may found a difficulty when adopting the new environment when its new action is slightly different from the preexisting one since its adaptation mainly is a copy of others' activities. When the inconsistent hierarchy of identities uses to understand agents' actions, asocial behavior may occur inside the organization itself or with other organizations. This promotes a mutual social behavior in the organization structure.

We present an analysis that accounts for common processes in a prototypical organization of the type we describe as spontaneous organization (SO). This model will have predictive power that can be used to describe artificial crowds. As well, it can also be used to explore and simulate existing SOs that are on the rise. Furthermore, we develop a new methodology that allows the agents to negotiate among themselves to achieve tasks that are distributed to them by the specific agents in order to develop and maintain their organization.

We structure this paper as follows. We will present an analysis for some of the related works in section two. In section three, we will show a SO life cycle from the formation until dissolution. We will cover some of the important concepts that effects its interaction and viral spreading. A methodology for assigning tasks among the agents inside the organization will be addressed in section four. Finally in section 5, we will conclude our paper after presenting the implementation of our work on a real life example of a SO.

II. RELATED WORK

In the field of Computer Science, researches scarcely consider spontaneous behaviors and their effect on a wide range of organizational phenomena. Therefore, our focus is on the confluence of social networks inside the organizations. In

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order to build an organization, agents need to participate in it as showing in the international cooperation presented by Tuomela [4]. He uses three steps: collect goals and plans, high ties among agents' preferences, and helping attitude. *Collaborative network organizations* (CNO), therefore, focus on the kind of organizational model that applies information and communication technologies (ICT) to assist the progress of finding chances in collaborative organizations [5].

There are three important concepts of collaboration which are networking, communication, and coordination. Networking includes communication and information trade for shared benefit whereas coordinated networking includes beside information exchange and communication, altering activities to achieve more results. The difference between cooperation and collaboration is that cooperation includes communication, information exchange, activity adjustments, and resources sharing to accomplish compatible goals [4]. However, collaboration is a tedious procedure where agents share information, resources and responsibilities to mutually plan, implement, and develop a sequence of events in order to accomplish certain actions and then generate behavior together [6], [7].

Collaborative networks (CN) contain a diversity of agents who are mostly independent, physically dispersed, and mixed in term of their culture, environment, activities, and social capital in order to develop common interests [8]. The geographic dispersion of agents can make the local organization impede the efficiency of the larger one [9]. Collaboration requires common community, common goals, and committed relationships within its compound set of variables and cognitive, social, and emotional situation [10], which should be defined by the leader because the communication differences [11].

Social network (SN) is a group of agents that share commonalities. Common bond of social network may be the community in which members share their belief, their subdivision, career and social interests. From nearly any commonality or even a desire to make connections among their member, social networks can arise. Organizational networks changes from day to day depending on different criteria. Some of these changes are adding more connections, changing of interaction behavior, evolving new members … etc. Any kind of change in the network happens over time. Such networks that change over time are called *dynamic social networks* (DSNs).

Social networks are fundamentally different from other types of networks. It has been observed that the degrees of adjacent vertices in networks are positively correlated in social networks but negatively correlated in most other networks. Besides, network transitivity or clustering which is the propensity for vertex pairs to be connected if they share mutual neighbors. Social networks are often divided into groups to account for the observable clustering. *Detection of Social network change* combines the area of statistical process control and social network analysis. Those two approaches together produce significant insight into organizational behaviors and social dynamics. A statistical process control is a statistical approach for detecting anomalies in the behavior of a stochastic process over time. Common interests of structural analysis are in the network substructures, such as Dyads or Triads. Networks usually evolved depending on the combination of dyads and triads into larger ones, but still closely connected to their structures.

Any organization should goes through processes of formation, socialization, and dissolution [12]. Larsen and McInerney [13] created *virtual organizations* (VOs) to develop information products in order to understand the communication in VOs and to allow their members to learn trust. They found that when members have worked together, the organization is going to be able to function optimally because their knowledge of working together will affect their goal to training, coordination, and control. Besides, distance, time and trust are also important properties for the agents' connections inside the organization. There are several tools that can be used for collaborative and cooperative networked environments. Network, in general, is a set of interrelations among agents to certain process. These processes can change the interrelationships into activities, which will help them to cooperate in order to achieve a specific purpose.

Most of existing organizations are frequently temporary in order to gather its perspective from the possibility of rapidly evolving constellation of well-matched research and experimentation to each organizational opportunity. However, if the organization is launched in a short period of time and has a short life cycle and dissolution when the goal completed, it is called *a dynamic organization*. Clustering may also exist inside the organization created by a temporary group of professionals who works together towards a common goal [8]. Any network has a life cycle in order to be built and maintained, especially if it is dynamic. The life cycle stages we envisage are creation, operation, evaluation, dissolution, and metamorphoses [14].

In any organization, the agents assign problems to solve by dividing them into tasks that might be dependent or independent. These tasks may have several subtasks that have to be executed in sequence to find a solution. Any organization might have a hierarchical structure, a method of collaboration, a security scheme, a process control, and outside interaction. In interaction, the distance among agents can affect cooperation and persuasion negatively, and fraudulence positively among agents (i.e. the possibility of fraudulence occurs will be higher if the agents go farther from each other). In Dziurla-Rucinska, et. al., the authors use synchronized communication after a while for executing tasks because the communication flow is not stable while the execution progress in order to develop a model that provide the process control for the organization. These problems can be overcome by successive connections among the agents [15]. The organizational structure, therefore, should include some activities that help to overcome cultural gaps, solve conflicts, and increase the payback of the role re-division [16].

There is a positive relationship between the performance of an organization and the relationships of its members with each other. The relationships can be affected by the design process, internal group dynamic, and external support methods [17]. The effect on the agents' sociality is the combination of the ties among them as well as both physical and sequential distance [18]. The interaction style can affect the outcome performance and process in the organization [19]. Therefore, four important concepts should be considered when designing an organization: structure, situational constraint, work characteristic and

strategic objective [20].The agents usually need to adapt the new environment in order to build and maintain the organizations. The adaptation can be direct where the behavior of the agents is assigned, or indirect which required a fitness function because it is depends on the feedback.

Through these sources Camarinha-Matos, Afsarmanesh, Tuomela, Zhang and the others addressing this research are attempting to present different type of organization we call spontaneous organization (SO). The SO environment can be described as a combination of agents, teams, and organizations that interconnected with each other nontraditionally. These unprompted connections allow its members to collaborate and work together on achieving certain goals fast. The SO accounts for rapid rates of dissemination in ad-hoc networks so that previous organizational models that explain behavioral dynamics in organizations do not have the potential to model it. Therefore, we will describe the formulation of the SO from the formation of it until the dissolution. We will illustrate a method for the SO that describe the tasks assignment for the agents in any nontraditional organization. We will simulate an example from a real life environment using NetLogo for building the SO which in part validates our method.

III. A SO LIFE CYCLE

The spontaneous organization (SO) has properties that similar to many traditional organizations. Usually, it goes through processes from formation to dissolution. Some other operations may also exist inside it. Any organization goes through certain processes that formulate its existence. Virtual networks, for instance, have a life cycle stages of creation, operation, evaluation, dissolution, and metamorphoses [16]. These basic stages are very noticeable in the life cycle of many existing organization, such as the SO. In here, we will describe the formation, dissolution, interaction, viral spreading, and some of other operations of a SO in detail.

A. Formation

In the formation of the organization, the agents need motivations that persuade them to participate in the organization activities [21]. Motivational quantities (MQ) framework provides the agents with applicable utilities in a wide range of MAS in order to make them capable of reasoning about which tasks should be accomplished and when to accomplish them so that they will satisfy their organizational goals. Their amounts of utility will increase with the increase of motivational quantities. This will give them the opportunity to perform tasks fast, as showing in Figure 1.

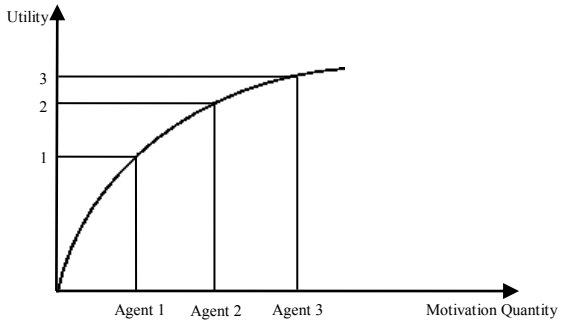

Figure 1. Motivational quantity for the agents (adapted from [21])

Figure 1 shows that the motivation quantities have profound effects on the utilities for agents over their motivation quantities. This effect, in result, change the social capital of the organization, it may start or remove the organization since it is an important aspect of its formation [21].

Social capital involves certain aspects of social structures, which is social network and it facilitates' actions of their agents. It deliberates resources flowing in a network, but in many cases it represents an amount that is more than the simple aggregation of the resources possessed by its components. For example, some resources controlled by X may be useless to X, but certainly important to Y, and social network linking X and Y makes it possible that Y can capitalize on X's resources, and so on and so forth. This is the social capital phenomenon that it cannot be reduced to its individual unit's resource amount.

Organizations evaluate each group depending on their performance and the quality of their results, and they also need to evaluate teams on the quality of their interactions and the relationships among their agents. Every organization has relationships based on the previous experiences, present interactions, and expectations for the future. Each agent has an impact on its organizations, which can change depending on its connections inside or outside its organization. This impact can be effective when it reaches certain level which allows it to spread ideas to other agents who will repeat the same process. When this idea goes through many agents at the same time, it can be considered a movement. The optimality of these connections occurs when their activities are synchronized so that the organization may experience a weakness when it holds a lot if conflicting ideas at the same time. Therefore, all organizations whether small or large have some social capital that is continually flourishing and diminishing.

There are two elements of social capital that plays a major role in formation of the organization which include shared values and trust. In order to make the organization more efficient, we will give an over view for each one of them in detail here.

1 Shared Value. It can be describe as strategies and plans that strengthen the competitiveness of the organization and at the same time developing the social actions inside the organizaiton in which it functions on classifying and increasing the connections between these actions [22]. Cultural values tend to increase the coordination between agents and increase understanding among them. Overall performance of organization will consequently increase.

Organizations can create successful development by creating sharable values. Dominant agents should know the proper coordination for them in order to permit shared values. This is a part of virtuous circles of sharable values, and by increasing values in one area, it will rise opportunities in the others. Sharing values involve presenting an increase of common needs, considerate the organizational productivity and collaborate across boundaries in order to develop new knowledge. Every organization should consider decisions and opportunities as shared value in order to grow.

2 Trust. Trust is in the degree of belief in validity and veracity of messages. Trust is a mechanism for overcoming uncertainty and introducing stability into agent transaction. Trust can be defined as a function of (a) a basic trust attitude toward another agent, and (b) the value of the object trust. The

notion of trust changes as the relationship between agents moves from impersonal to personal [23]. Interpersonal trust is the trust between two or more agents. Strengthening ties between agents in social ties increases their interpersonal trusts. Trusted agent is likely to experience autonomy. Trust is the replacement of control [24]. It might be damaged by layoffs and resolved by rich media [25]. Therefore, sharing common interests may result in building trust among the agents. It usually takes a lot of time, space and social interaction to be spread from one agent to another, but sharing experiences and knowledge increase it.

Many scholars have distinguished the difference between trust that arises as an ending of a balanced decision based on facts and experience and trust that is a product of affect-based stimulus. McAllister argues that the judgment underlying the development of cognition-based trust "differs considerably" from the logic underlying affect-based trust [26]. Cognition-based trust is rooted in the logic of switch over, whereas affect-based trust is shared in nature. Cognition-based trust is connected to a person's reputation for "dependability, reliability, and professionalism" and is, therefore, circumscribed by one's certified role. Affect-based trust presupposes an emotional bond and a quality of the relationship. Numerous authors in [26], [27], [28], [29], and [30] propose that trust is motivated by a combination of cognitive and affective components. Wicks and the others write that although a rational prediction is an important part of trust, it "provides a grossly incomplete understanding of trust". They identify two additional, closely related characteristics as essential to the development of trust. The first characteristic is affect or emotion and the second one is an affective element with a strong moral component [31].

B. *Viral Spreading*

Usually inside the organization, ties among agents inside it differentiate from strong to weak. The organization might consist of two or more individual ties with each other through a local bridge or transitivity like a triadic closure (i.e., clustering coefficient), which is "if X knows Y very well (strong tie)" and "Y has also a strong tie with Z", then the possibility of X knowing Z through Y is high. If we implement such a theory in a large environment with a multitude of individuals, we provide the incentive and the opportunity for the individuals to grow trust with each other through these strong and weak ties [32]. These social ties can be also performed depending on the geographical proximities, shared similarities, or through some kind of strength [33]. This will allow more new member to merge inside the organization and be active. The speed of the viral spreading can be measured through equation 1.

$$viral\ speed = \sqrt{level\ of\ interest * size\ of\ cluster} \quad (1)$$

In general, there are two models used to describe this viral spreading among the agents. The first model is the Granovetter's model of homophily [34]. It represents the collective movement of actions that are more likely to occur if there are low thresholds and more variations (i.e. density) in it. This happens when the minority inside the organization starts to move to another organization with similar properties.

The second model is standing ovations model or peer effect [35]. This model can be recognized as a peer effect or as information. It can be achieved when there is high quality, low threshold, large peer effects, or more variations. As well in the advance model of it, it can be increased if there are either large groups or influential agents entering, besides the standard possibilities. This happens when the minority leaves (i.e. changes) their properties and adopts the existing organizational behaviors.

C. *Interactions*

Social interactions are simultaneously connected with the degree of trust, involvement, ties, commitment, and performance of the SO. The mass of social interactions will be correlated with the degree of *tacit to tacit* knowledge sharing, which is mostly achieved through *tacit to tacit* communication [36]. Tacit knowledge can be described as the knowledge that is personal, experiential, and context specific. Social interaction is an important factor that helps social capital to grow. Social capital provides the ability for the collaborative agents to make decisions. By the time the social capital grows inside the SO, the SO will gain structural, relational and cognitive profits. Social capital in an SO gives major changes such as the launch of new strategic plans for providing trust among actors in virtual teams, ties, norms, deep cultural change, and acquisitions [37]. Therefore, the lack of it will lead to dissolution of the SO.

Service level Agreements (SLAs) usually applied among the interacting organizations. It describes the service source vs. service purchaser relation in a proper manner. The requirements mentioned in the SLAs present the limitations and metrics that define excellence of service. The organization has to include an SLA template which describes the agreement type that goes with the resource usage when it starts a new connection with the others in the network in order to tie all the agents interested to it [38].

D. *Dissolution*

By the time the members inside the organization reach their goal (depending on the kind of organization), most of them will lose their interest in being active members in the organizations. Consequently, the social capital will decline until the ties among the agents inside the organization are weak and disappear in the worst case. The same thing will occur when agents spend excessive efforts to achieve their goal yet they fail. This problem may occur because of weak ties among the agents or a bad leadership for their organization. This leads to many problems like providing wrong ideas, assigning unsolvable tasks, or lacking skills to manage the organization. In addition to these an underachieved organization is a good reason for dissolution.

In a social system as SO when we lose the motivation to form the organization, it will erode coherence and incline to anarchy, which is the highest state in the social entropy. Social entropy can be used to measure the state of atrophy in an organization; i.e., decomposition. It exacerbates the tendencies of social networks for breaking down over time going from cooperation to conflict. Social entropy can measure the organizational impulses through equation 3.

$$SE(R) = \sum_{i=1}^{c} \frac{|c_i|}{\sum_{i=1}^{c}|c_i|} \log_2\left(\frac{|c_i|}{\sum_{i=1}^{c}|c_i|_i}\right) \quad (3)$$

Here, R is a set of agents, and c is the possible overlapping subsets.

E. Other operations

Organizations normally go through other basic operations that allow their members to function effectively as well as to help improve and develop the organization. A few of these operations are growth, shrinkage, merge, steady state, and bifurcation and we describe them next.

1) Growth: Any networked organization will grow if there are more agents joining it. Moreover, structure elements usually play an important role in the SNO because they can decide the size of the network.

2) Merge: Two or more organizations can be merged together in order to build a large one. Occasionally, they merge when they have similar attributes in order to form a larger one, which helps the organization to grow.

3) Shrink: This is the opposite of the organization growth. The organization shrinks after it loses agents. It is one of the organizational attribute that may cause to dissolution of the organization.

4) Steady State: This is the behavior of the organization when nothing changes for a long time.

5) Bifurcation: This occurs commonly within organizations. Agents may have different points of view from each other and attempt to strive for their own cluster inside the organization.

IV. Task Assignment Strategy

In multiagent systems, agents negotiate over tasks. Sometimes they negotiate in order to maximize their own utility while ignoring the utilities of others. This is known as agents who are self-directed [39], [40], [41], [42], [43], [44]. On other hand, externally-directed or cooperative agents maximize the utility of their organization considering the achievement of others as their own [21], [45], [46], and [47]. Dominant agents are a combination of these two types of agents inside the organization. They are responsible for building a coherent belief system from the agents in order to keep a sense of continuity toward their organizational behavior. Those agents act as organizers for the other agents to assign tasks and examine their level of completion for further assignments.

By the time the agents receive the tasks from their organizer, they start to negotiate amongst themselves in order to find the next best fit to achieve each task. Then, they will send their payoffs to the organizer in order to assign the tasks to them depending on their level of fitness. The plan usually consists of multiple tasks, and every agent has their own set of strategies to achieve them. The organizer group will start to examine the agents' level of fitness and assign the tasks to the proper one of them who has the best fit capabilities (i.e. a set of payoffs). This leads us to extend the traditional type of analysis that has been used in game theory to represent a game between two players. In the SO, we have to deal with an unbounded (i.e. unknown number of agents), which makes it somewhat challenging to construct a closed form payoffs matrix. This kind of game can be used to solve many of NP-complete problems up to date, such as the argumentative n-player game represented in [48], [49], [50], [51], and [52].

Von-Newman and Morgentern showed that utility capture an agent's outcomes (i.e. preferences).they presented a formula to calculate the expected utility in equation 2 [53].

$$optional\ decision = D^* = \sum_{s_j \in S}^{n} P\left(\frac{S_J}{D_i}\right) \times U(S_J) \qquad (2)$$

Here, after selecting D_i, which is a set of decisions the $agent_i$ made, the summation will be for the conditional probability and relative utilities of $outcome_j$ multiplication.

Decision theory is a game against nature which is used by self-interested agents to make optional decisions in uncertain environments. Nature commonly behaves randomly. When the opponents are also independent and self-interested agents, a *multi-person decision theory* (MDT) is appropriate to consider. Self-interested agents are not "selfish", but they have an ego-centric perspective. Emotions are not considered. However, game theory developers assume that rationality implies self-regard. This is the premise for game theory (GT).

Currently, the consideration should be upon the aspects of communication among agents. They should interact among themselves to arrive into a goal and to get the best results of payoff according to different strategies. One of these strategies is to understand dialogue protocols, and to integrate interaction with independent reasoning. The game matrix can be presented in a shape of cylinder in order to allow the agents to spin from different strategies and to pick the one that maximize the payoff. This is shown in Figure 2, where K is the number of strategies, and n is the number of agents.

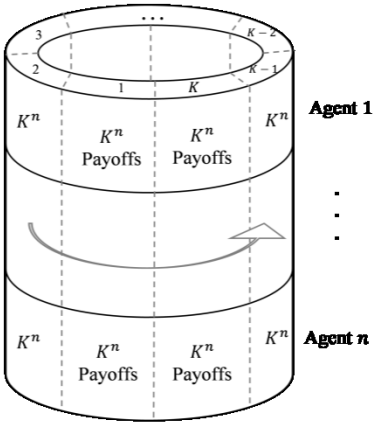

Figure 2. The cylindrical shape that represents the agents' payoffs

Each circular strip of the cylinder represents one agent's strategies to achieve a certain task. These strategies can be changed depending on the aimed strategy that has been chosen by the agent itself. Further demonstration can be seen in the table 1.

Table 1: Spinning strategies for a better payoffs game among n agents

		Task 1			
	Agent 1	Str.1 = K^n	Str. 2 = K^n	…	Str. K = K^n
		Agent 2	Str. 1 = K^n	…	Str. K = K^n
Agent 3	Str.1 = K^n	Str. 2 = K^n	Str. 3 = K^n	…	Str. K = K^n
…	…	…	…	…	…
	Agent n	Str. 1 = K^n	Str. 2 = K^n	…	Str. K = K^n

Here, the agent payoff for certain strategy and the others' payoffs, if this strategy has been chosen to represent K^n, where K is the number of strategies that can be used to achieve tasks, and n is the number of participant agents inside the organization.

The organizer has the opportunity to pick which agent has the best payoff (i.e. capability) to achieve the task assigned. This type of game is optimal because it allows the agents to view other agents' payoffs, and then choose one of its strategies that maximize its expected payoff. Further properties that can be seen in the traditional games can be applied here, such as Pareto-domination, Pareto-optimality, Nash equilibrium, and stable Nash equilibrium.

After the organizer group receives the set of capabilities from the agents, they match the tasks to them depending on their level of fitness. Since the plan for the organizational behavior may consist of different type of plans, the organizer usually goes through the processes for assigning these tasks shown in the algorithm illustrated in Figure 4.

```
Task-Assignment
 assign first task
 if plan is independent
     assign the rest of tasks
 else
     for i = 2 to number of tasks
         wait for = size of task / (capability * performance)
         if gate is OR
             assign next task
         else
             wait until all the tasks are completed
             assign next task
```

Figure 3. Algorithm for Assigning Tasks

Before the different behaviors the organization makes, it builds plans for them and divides them into different tasks that produce different actions from its agents. Tasks usually are a part of a bigger plan. They can be dependent or independent and leaner or complex, which force it to be composed with different types of the logical gates (i.e., OR, AND). Figure 3 illustrates a simple algorithm that can be used to assign tasks to the agents considering the different types of plans. This algorithm has been implemented in the next section in order to simulate a small pasture environment.

V. Implementation Result and Discussion

In order to illustrate our SO model, we introduce a small example from real life that simulates grazing over a green pasture environment. A set of grazing cows have been implemented as agents. We conceived of constructing a simulation that mimics spontaneous gathering of grazers in order to perform an organization. Since the organizer unit in our model is an important factor, we should include it in this organization as well. A herder is used as the organizer in order to make it easy to control the agents; several shepherds may also exist for further, collaborated control.

We used Netlogo for our simulation environment. Netlogo is simulation program that has been developed in Java. We captured a two dimensional area where cows exist with a maximum number of 30. At least one shepherd and three cows are needed to form the simplest organization. The connection edges among agents are explicitly specified. Shepherds, who will be used as the organizer, will move toward the cows and control their activities and assign other tasks to them, as shown in Figure 4. Since our simulation represents a square of infinite activity in the land, we founded our assumption on the idea that cows are able to connect with each other inside their immediate organization, yet not outside the fence.

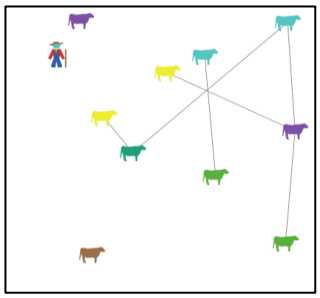

Figure 4. Some Cows are linked with each other to copy each other's behavior

In Figure 4, the cow shape represents the agents and the shepherd icon shape represents the organizer. The tasks that the cows have to achieve are assigned by the organizer. In this simulation, the cows are charged by moving around in the pen and associate themselves with others in their environment.

In this simulation, two types of organization have been implemented, which are the traditional and the SO in order to present a clear contrast between the properties of each one of them. As well, it is used to demonstrate the differences in links and efficiencies. These properties can be specifies as shown in Figure 5.

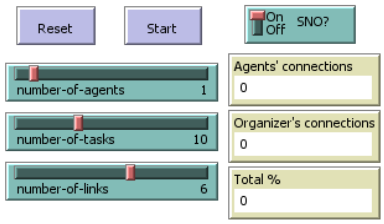

Figure 5. Panels for specifying the properties of the simulation

The two monitoring boxes depict the number of interactions whether the cows among themselves in order to achieve tasks or with the shepherds.

After the cows are settled in the pasture, they will start to link with each other and with other members in their organization in order to mimic their behavior. Similar to the *triadic closure* that exhibits the possibility of "x" knowing "z" is high if they have a mutual friend "y" [47]. Their performance is directly proportional to their ability to organize for coherent coordination. Shepherd will play the role of organizer in order to collect information about remaining cows and to instruct them with additional tasks to perform.

In a traditional organization, the action that the organization makes is a copy of one single individual inside the organization and their linkages traverse its action to the others who mimic its behavior. The shepherd is controlling this cow knowing that other members will do similar properties as this one, while ignoring their own action. Since the organizer collects the information, he might be able to make his own decision or call for help from the closest supportive group. For instance, if there is a lethal disease spreading among the cows, the organizer will in turn use the current information to solve the problem or call for help. After the tasks have been assigned to the agents through the organizer, they will start processing this task. Here the cows have to follow the shepherds. When the cow is in the range of any other cow that is linked with the group, it will link itself to it. This is depicted with lines in Figure 4. The rate of tasks achievement will increase which present the rate of interactions among themselves. This increased rate will facilitate clear opportunity to copy others.

The organizer activities will plateau since it is responsible for just a few cows. Their connection will reach a steady rate at a point where they are able to be assigned for the next task as is shown in Figure 6.

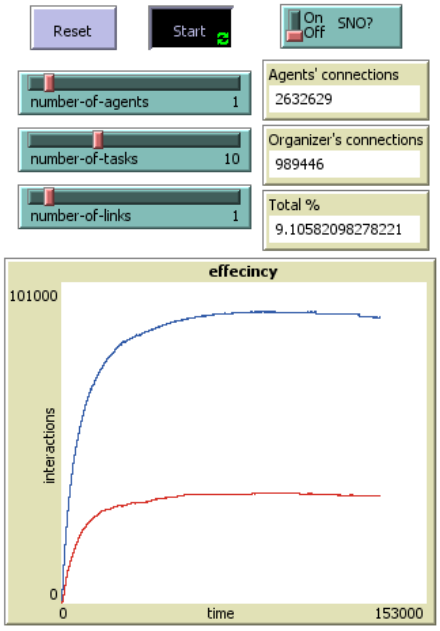

Figure 6. Traditional organization connections' plot

Here, the lowest line presents the organizer's connection to the agents (i.e., the higher, blue line). The organizer (i.e. the lower, red line), plateaus at a rate that allows it to control the agents and to assign tasks to them. In an SO, such a process usually takes a shorter time to process in a more efficient way, as in Figure 7. The agents will have fewer connections since they do not frequently link with the organizer. This leads their connection to stabilize to a lower rate than traditional organization, as showing in the monitor boxes.

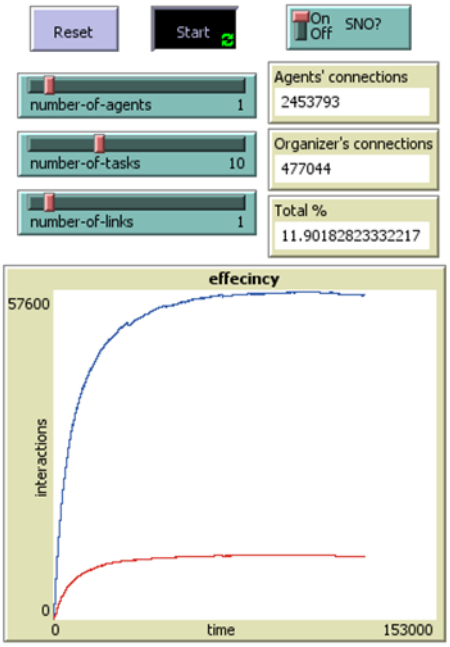

Figure 7. SO connections' plot

From this simulation, we observed that the traditional organization has more connections and interactions with their leaders as well as with each other inside the organization while the spontaneous organization has a lot fewer connections whether with the leaders or among its members. However, the total percentage for these connections shows that the spontaneous organization is more collaborative networked organization depending on the agents connections among themselves while ignoring most of the organizer command and control, yet the member in a traditional organization participate more through the tasks that their leaders assign to them. This has a profound impact on the agents behavior inside the organization which in result affect their collaboration toward one another.

VI. CONCLUSION

Our attention for this research is on the confluence of social networks and collaborative models in organizations. The agents need a collaborative networked organization that links them with each other in order to provide continuity toward their goals and to develop and maintain their organizational existence. There is a deficiency of existing organizational models that explain behavioral dynamics inside the organization. This prevents the models from adequate representational power to model a spontaneously formed organization that account for rapid rates of dissemination in Ad-hoc networks. To remedy this, we described the formulation of SO from formation to dissolution considering attributes synthesized from various disciplines. We illustrated a method for an nontraditional organization that has the potential to assign tasks to the agents depending on their level of fitness in order to help the organization to accomplish goals through its agents in order to produce different behaviors. We validated this collaborative model by simulating a real life example of SO. We wish to use this foundational work as a basis for future development of online networked collaborative models.

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