Exploring Impacts of Project Overload on Creativity: An Agent-Based Modeling Approach

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2012

Thesis submitted for completion of
Master of Sustainable Product-Service System Innovation (MSPI)
Blekinge Institute of Technology, Karlskrona, Sweden

Abstract: Project overload is an unpleasant phenomenon which is happening for employees inside those organizations trying to make the most efficient use of their resources. AE project inside VolvoCE (VCE) is an Advanced Engineering project eager to be innovative suffering from project overload. This research aims to help VCE to move towards creative organizational climate. To do this, the author used the Agent-based modeling (ABM) approach to examine the current reality of VCE and AE projects, where the opportunities and challenges for reducing the risk of project overload and moving towards innovation were identified. The results of this research allowed the researcher to define the gaps inside AE project and create a list of some recommendations. From these results: project overload can damage the employees’ focus and bring psychological stress reactions; Creative actions are less likely to be the result of a team with high level of project. On the other hand, motivation on proper challenging goal is more likely to help individual to alleviate the negative aspects of low level of project overload.

Keywords: Innovation, Creativity, project overload, Agent-based modeling
Acknowledgements

This report is the result of my master thesis project in “Sustainable Product-Service System Innovation” program carried out at Blekinge Institute of Technology in Karlskrona, Sweden with cooperation with VolvoCE (VCE) innovation department in Eskilstuna.

I would like to thanks the following people: Jenny Elfsberg from VCE because of all support she generously offered during my thesis work, Anthony Thompson for being my advisor and for all his support, Massimo Panarotto for being my advisor and Tobias Larsson my supervisor at Blekinge Institute of Technology.

And special thanks to all of those AE projects experts that I have been in contact with during my research and interviewed them. I would like to also express my gratitude to my close friends (Cassandra, Teresa and Pezhman) who helped me revising my report.
Romer in 2007 predicts that the country that will lead in the 21st century will be one that implements innovations—meta ideas—supporting the production of new ideas in the private sector[1]. In this thesis we are trying to explore the impacts of project overload on creativity. Multiple project strategy is applied inside organization in order to make use of resources in an efficient manner. However multiple project involvement brings advantages which seem to be positive for creativity. Research shows that many creative advances have resulted through combinations of already existed ideas [24]. That is one reason that successful creativity is more likely when you work on multiple projects at the same time. On the other hand, when in multiple projects setting lack of opportunities for recuperation, inadequate routines, scarce time resources, and a large number of simultaneous projects happens then project overload would happen [6]. Project overload also means when there is high-level of psychological stress reactions, less activity for improvement, low development of skills and no adherence to time schedule [6].

Managers can match people with jobs that play to their expertise and their skills in creative thinking, and ignite their intrinsic motivation [2]. Challenge means matching people with the right assignments. Challenge is one of the key elements for organizational creativity [3]. Perfect matches stretch employees’ abilities. The amount of stretch is crucial: not so little that they feel bored and lose their motivation but not so much that they feel overwhelmed and lack of focus.

This thesis claims that, one of the weaknesses of organizations is to not pay careful attention to right challenges for employees or design an appropriate team. Organizations do not consider employees category in terms of capability to handle multiple projects and also their true passion while assigning them to several projects simultaneously. Individuals are different and have different capabilities. As we discussed above in the challenge definition Perfect matches stretch employees’ abilities. Appropriate number of projects in our thesis called multiple projects and more than that is project overload. In the current thesis results out of simulation with agent-based modeling helps to argue that project overload is more likely to limit creativity actions.
We argue that one of the current weaknesses of our case study _VCE and AE project team_ is that people randomly getting assigned to the projects without considering the fact of their ability, interests and passion. We argue that innovation and creativity inside organization should not be a function of chance, in return, culture of creativity should exist and the climate should foster creativity not kill it.
Glossary

ABM: Agent-based modeling

Challenge: matching people with right assignment

Creativity: ability of thinking of novel ideas and solutions

Deductive reasoning: using the knowledge and information you have in order to understand or form an opinion about something

FSSD: Framework for Strategic Sustainable Development

Idleness: time which people are idle waiting for the rest of team to finish their part

Inductive reasoning: using known facts to produce general principles

Innovation: implementation of creative ideas

Macro-level: Consists of (social) structures, rules and roles

Max-Neef needs: Basic human needs vital for a high quality life for all people

Micro-level: Actions and processes of individuals inside desired society

Multiple projects setting: several different projects being run simultaneously

Netlogo: Software tool for ABM

Project overload: when number of projects goes up and lack of time for recuperation happen for people

RBPM: Result Based Project Model defined by VCE

VCE (VolvoCE): Volvo Construction Equipment
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1 Introduction

Today the main concern of worldwide companies and organizations is economic growth [4]. Since the technological innovation is a major force in economic growth [4], many researches and experts have been trying to answer questions on how to be innovative and how to move towards innovation. Additionally, we all are trying to make our world a better one for ourselves and for the next generation which mean moving towards sustainability. Sustainability is playing a new role in competitive landscape, which brings the pressure to companies to think differently about products, technology and their process [29]. For bringing sustainability as new frontier inside organizations, innovation is needed in order to move ahead of the competitors [29]. Considering knowledge and creativity as two important ingredients for innovation [1], in this thesis we try to maneuver on influential factors have an impact on creativity and innovativeness of teams and individuals inside organizations according to the fact that creativity is seen as a cornerstone of innovation [5].

It is supposed that if a company could get use of knowledgeable experts and highly creative environment to motivate experts and spark their creativity this company is more likely to be innovative [1]. Looking scientifically at organizations and teams has required having a clear understanding of the question we are trying to answer. In this thesis our question is” How does project overload influence creativity?” For pursuing the answer we need to justify relevant elements directly or indirectly influence our question. In this research, we try to investigate on the relationship of multi-project involvement and project overload in team members and the creativity. How team members’ creativity is affected by working simultaneously on several projects and therefore, how the team’s innovation is affected by that.

There is a tendency in organizations to grow with a multi-project strategy from a single-project and share the certain expertise [31] [6]. There are advantages and disadvantages in multiple project commitment, which have strong impact on individual level in teams. Lack of opportunity for recuperation, psychological stress reaction and time pressure are namely negative factors in individual performance [6].

During the research one case study is under examination. Advanced Engineering (AE) project is knowledge based project executing with VolvoCE and is supposed to work on concepts such as energy efficiency
for new machines. In this case 70 experts are interacting together in one knowledge based project. 45 experts are involved in the project around 10% of their time and five people 100% of their time .etc. According to the project managers’ opinion, experts with few percentage involvements are not motivated to work on this project. Based on my interviews with one of the project managers, when individuals are dedicating just around couple of percentage of their time to the project, they actually do not find the real time in their priority list of work to put a real focus on the project. Although research shows some benefit of sharing experts in different projects rather than just sitting at one project, the risk of limiting creativity because of being in too many projects seems also high. We would mention that creativity is less likely to be sparked inside this team because of lack of focus, lack of balance in team contribution, lack of appropriate communication, lack of enough time resource, lack of cohesion in team and some other factors discussed in chapter 6. We would argue that creativity is less likely to happen if the risk of project overload is high in people. At the same time this thesis assumes that there is an optimum level as the middle ground amount of projects for each person that creativity is more likely to happen not too much to be out of control not too less to be boring. We argue that individuals should be treated as human-beings with feelings and the fact of differences should be appreciated rather than considering people as machines with similar characteristics. Method what we are making use of is Agent-based modeling(ABM) in which bottom-up perspective is helping to look at micro-macro level of organizations to better understand the problem. From the bottom level of organization agents are the elements working together in cooperation, by coordinating and negotiating to make decisions [8]. In different cases based on the question, we can define different agents with related attributes and states. This is the advantage of Agent-based system for social behavior that we can get help from it to have better understanding of current specific situation. More complete explanation is coming following chapters.

The first chapter will discuss about organizational creativity and project overload separately. Chapter 2 would be dedicated to method aspect of our research. In chapter 3,4 and 5 different methods would be introduced with details. The discussion would be continued with describing the impacts of project overload on AE project creativity based on the results of this research.
1.1 Innovation

The concept of innovation itself is broad though the purpose of innovation is to create new business and to help economic growth [4]. Technological innovation is known as a major force of economic growth [19]. A precondition for technological innovation is organizational innovation [32] and additionally for organizational innovation the capacity of learning and ability of problem solving and generating new ideas are named as important factors [33]. Creativity is the thinking of novel and appropriated ideas while innovation is the successful implementation of those ideas within an organization [34].

There are also other interesting topics researchers have discussed before, such as a concept called innovation DNA [33][19]. One principle is that innovation actually can be put in the context of a learnable and improvable human practice similar to engineering or medicine; therefore it becomes possible to gain new insights about the reasons that some companies are more successful at innovation. Many studies tried to explain how companies differ from each other at the human level during the innovation process [33]. Here the idea of bottom-up [7] view and micro-macro [18] perspective is used in our research. What specific factors in a project team are more likely to spark creativity in the micro-layer of a team and what factors are more likely to act as an obstacle for creativity. A more complete explanation is argued in following chapters.

Although essential basic materials for innovation are knowledge and its functionality that is supplied, the creativity and creative application of knowledge is the base of innovation [1]. In this research we discussed around innovativeness and creativity of teams and team members while they are involved in multiple projects.

1.2 Organizational Innovation

Organizational innovation could be defined as multi-level relationship between innovation and organization which comes with three interdependent perspectives: first organizational structure and its relationship with innovativeness, second the process of learning and knowledge gained inside organization and perspective of innovation in the process and third innovation in organizational capacity in tolerating adaptation and change. Usually organizational innovation is seen as a
necessary pre-condition for technological innovation therefore, it is worth it to pay more attention to some micro level capabilities such as organizational culture, capacity for learning, individual values and shaping the organizational structure [32].

1.3 Creativity

1.3.1 Definition of creativity

Creativity is defined as the ability of thinking and generating novel valuable ideas or solutions [5]. Organizational creativity can be interpreted as work of individuals together in order to create a useful new product, service, idea or process in a system [5].

Capability for creative action is based on several different elements inside organizations and individuals. For example happy and healthy people are more likely to use their knowledge and skill more eagerly and put it into more creative uses [1]. Culture and tradition, talent and personality [1] and many other factors related to creativity have been discussed in some recent researches [1][5]. Amabile[2] offers a well-known model for creativity in which three main component is discussing as main components of creativity; skills in the task domain, skills in creativity thinking and intrinsic motivation. Figure1 illustrates these three components. When it comes to motivation, it is important to emphasize the differences between what motivate employee and what demotivate them which are two independent elements [44]. Herzberg [44] explained that motivators such as challenging work, recognition and responsibility [44] would increase satisfaction and commitment to the organization, in return, factors such as salary and benefits do not actually motivate employees, but have the power to demotivate them if missing [44].
Challenge, freedom, resources like money and time resources, environmental support and some other factors are in the model suggested by Teresa Amabile [2]. In the following chapter this model would be argued comprehensively. Ruef [11] explains that while individuals having access to non-redundant information from their social networks as well as avoiding the pressure for conformity and feeling available trust for supporting new ideas, creativity is more likely to happen [11]. On the other hand, intelligence, environmental support and motivation are discussed as main factors for creativity on Kaufman and Sternberg view [35]. What it is eager to be investigated in this research, and what will be explained more in this chapter, is the effects of workload on creativity. Hoegl and Gemuenden [28] conceptualized a model of six facets as a theory for high quality in teamwork for innovation; they also empirically validated this model. These six facets are: communication, coordination, balance of member contributions, mutual support, effort, and cohesion [28]. In the following chapters we would talk more about Hoegl and Gemuenden’s model. Unlike traditional school of thought, contemporary researches in creativity discuss the fact that all human beings, each single individual with normal capabilities is able to produce creative work in some domain and some of the time and if the social environment can influence both the level and frequency of creative actions [2].

Figure 1: Amabile’s three component of creativity
1.3.2 Organizational climate for creativity

Teresa Amabile[2] emphasized that creativity is more often killed rather than getting support inside the organizations she observed during her research [2]. In her opinion the main reason for this reality is because creativity is undermined in work day, and work environment, but unintentionally by managers for some good reasons such as maximizing productivity or having more business control. In Amabile, the theory of creativity is that it is possible that both creativity and business imperatives can be developed together. Three components in Amabile’s theory are relevant in creative processes; first, the domain relevant skills such as knowledge, technical skills and talent of individuals inside the organization which could be improved during the work experiences and by learning. Second, the creativity relevant skills, namely, thinking or working styles, personal cognitive or characteristics. Third component is intrinsic job motivation which represents the perception of individual motivation and also the attitude regarding to the task. The external social environment that people work in is also important in intrinsic motivation. Ford [5] proposed that individual creative action is an interrelation link between the knowledge and skills mentioned also by Amabile’s model and motivation in addition to sense making [5]. These factors interact with individuals strong self-leadership determine whether they engage with innovative actions versus habitual actions [26] Ford [5] suggests that knowledge multiplied by motivation and sense making factors predict the creative action of person [5].

Therefore, in Amabile’s theory individual creative action is a function of personality, knowledge, intrinsic motivation, cognitive style and social influence. Team’s creative action is aggregation of team composition, team characteristic and team process [5] and it can be interpreted that an organizational culture leads the team output towards creative result.

Challenge, freedom, resource, group work feature, supervisory encouragement and organizational support are the factors discussed in Amabile’s theory as important influential factors on creativity inside organizations. Goran Ekvall [3] also debated about organizational psychology and similar factors for creativity in his research; challenge, freedom, idea support, trust/openness, dynamism/liveliness, playfulness/humor, debates, conflicts, risk taking and idea time [3].
Figure 2: Influential factors on creativity

Challenge means that people are matched to the task they are involved with and they emotionally feel engaged with the goal of the project. Individuals experience high positive challenge climate when they enjoy their work, their task is meaningful for them and they do not suffer from lack of interest [3]. It is important that person be assigned to the perfect matches that stretch employee’s ability not so little and not so much [2].

Freedom means the ability of employees to discuss openly about problems, ideas and situations with their social networks. It is also important that organization or manager makes the goal clear and remains integrated with that goal to the end [2]. In a climate with freedom individuals could take initiative and solve the problems or take the decisions in their own way. On the other hand a climate which is missing freedom would include people who are passive and will never cross the established routines [3].

Resources such time is one main resource can influence the creativity. This is important to assign people with the right task with right amount of resources [2]. Amabile explains that in some situations time pressure in
which high motivation and meaningful challenge can exist enhance the creativity. One of the elements occurs in organizations and routinely hinders the creativity is tight time schedules. Constant tight time schedules can lead to burnout for individuals. In extremely tight time schedules and severe workloads while people cannot find time for recuperation and rest, individuals would suffer from some symptoms such as fatigue and depression; this stage is known as burnout [40]. Having talked about creativity and time, it is vital to mention that creativity often takes time, happening after incubation and sleeping on ideas [2]. Idea time is one concept Ekvall brings to discussion in order to defend the importance of time allocation to the elaboration of new ideas. On the other hand, in tight time schedules every minute is booked and there are no possibilities to think outside the box [3].

On work-group features Amabile explains that if an organization tends to create a creative team, should pay careful attention to the design of that team. A mutually supportive group is more likely to be creative, and with the privilege of respecting a diversity of perspectives and backgrounds, there is positive atmosphere inside the team. Diversity inside teams is positively important, but with three conditions; team members should share their excitement over the team goal, members should supportively help each other’s in hard situations and setbacks and each single member should recognizes his unique talent and ability and also understand and respect others opinions[2]. Ekvall talks about conflict in emotional relationships between team members which can act negatively and hinder creativity. In other words, if team members dislike each other and a positive mutual psychological chemistry does not exist between them this act as a negative point [3].

On supervisory encouragement, people can find their work interesting and have personal motivation to work, but to sustain such passionate feeling most individuals need to feel that their work is appreciated by their organization or the managers [2]. It is also important how new ideas are treated. Idea support is one term from Ekvall which argues the importance of embracing new ideas and openly listening to new suggestions. Usually climates that kill creativity are greeting new ideas with skeptical view, or even with harsh criticism [2]. The supportive behavior, in return, is when managers serve as role model and encourage the collaboration and communication within the team. Trust and openness is another factor Ekvall adds to the model for creative climate. A high level of trust and safe
emotional feeling is needed that people walk forward and talk about their new ideas without fear of reprisal and ridicule in case of failure [3].

Organizational support has a meaning wider than supervisory encouragement and means that creativity would be enhanced and ignited when whole organization support it. Amabile again emphasizes that encouraging information sharing and collaboration enhance the creativity climate and support all three components. When people can easily collaborate and exchange their ideas by working together more knowledge they can gain. When employees enjoy working together and the common goal makes more sense for them creativity is more likely to happen [1]. Risk taking is also inside the Ekvall’s model which seconds the importance of tolerance of uncertainty in organizations. It limits creativity if employees always prefer to move in the safe side because of organization’s hesitation for taking a risk in embracing new ideas [2]. Playfulness and debate are two more factors discussed by Ekvall. In playfulness the easy-going climate of laughter and joy helps to reduce a serious climate that bored people. Also, time for debate and having discussion on opinions, problems and difficult situations can enhance intrinsic motivation and also help individuals improved their knowledge [2].

Hoegl and Gemuenden[28] offered a concept of team-work quality. They conceptualize and empirically validate a pattern in order to capture the complex nature of creativity inside team work. This higher-order pattern has six facets which are determined as process variables related to team-work quality indicates that good work quality and team member satisfaction leads to success for innovative projects [28]. These six facets are; 1) communication, 2) coordination, 3) balances of member contributions, 4) mutual support, 5) effort and 6) cohesion [28]. When team members openly communicate and contribute together and exchange their information [28], coordinate their activities [28], has balance in contribution and individuals contribute their knowledge to their fullest potential [28], reciprocally support each other’s idea or in problem solving situations [28], establish high effort in team work and enhance the fact of team cohesion where team members maintain in group [28] this team has high teamwork quality [28]. Information processing and communication between the team members in an organization with high degree of autonomy over project decision will more likely increase the sharing of ideas and information as well as the coordination of task actively [28].
1.4 Multi-project setting vs. Project overload

1.4.1 Multiple-project strategy

“All decisive advances in the history of scientific thought can be described in terms of mental cross-fertilization between different disciplines.” Arthur Koestler

There are many innovations (product innovation, service innovation or organizational innovation) which are the result of new combination of old ideas [24]. Individuals have the ability of incubating several ideas from other projects while they are hard at work on one project. This incubation is one reason that creativity is more likely when people are involved in multiple projects simultaneously [24].

A multi-project strategy, which involves experts in multiple projects at the same time, is in favor of many organizations in order to share certain expertise and reduce project idle time as well as to improve the ability to transfer knowledge between different projects [36]. Multiple project management also is used by organizations who seek to improve their efficiency and cut the cycle time inside the interrelated projects, in addition to transfer technology between projects [31]. Despite the high rate of utilization of this strategy in the industries, multiple project management research is still limited [37]. Some research has released the preference of managers to share their engineers between two or three projects at same time where an effective maximization of productivity may happen [36]. Figure 3 illustrates the advantages of multiple project strategy.

There are somehow differences between multi-project work and other kinds of multi-tasking. Being a multi-project worker means to be formally assigned to a temporary organization that there is a demand to coordinate your own work with other co-workers in the same project or projects. Person in multiple projects may have autonomy to make technical solutions, but is still administered by the project environment and what happens in it [6].

Capacity inside organization means the ability of running multiple projects to provide sufficient resources, commonly human resource [15]. It has been argued that organization which defines multiple projects simultaneously for
their experts cannot afford to have professional resources stay idle waiting for next action while still in payroll [31]. Thus, there is a tendency to reduce the number of employees and have resource that is fairly and predictably occupied all the time. Spfhler and Biagini[15] confirm that there is hardly a company to be found which does not launch more projects than it can master with the available resources [15].

![Diagram of multiple project setting and its advantages]

Figure 3: Multiple project setting and its advantages

1.4.2 Project overload

Although it seems that using the experts in multiple projects has many advantages as some of them are named above, however most managers have agreed that the more projects carried out simultaneously, the longer the average project duration [36] and the more fragmentation at work [6]. Project overload is the concept discussed in this thesis and refers to involvement in multiple projects in which number of projects that matter can make the individual lose the control over his work. Number of projects, insufficient time resource, insufficient routines and lack of opportunity for recuperation are four factors that explain the variance in project overload [6]. Considerable amount of time wasted with set-up time is also another significant negative factor in project overload [58]. In other words, switching between projects requires a setup time when people have to
adjust their brain to the next project they want to focus on [6]. Insufficient time resource by itself causes psychological stress which leads the project to fragmentation and disruption [6]. Lack of opportunity for recuperation and reflection has a very important influence on performance on individual level [6]. Time for personal feedback after peak periods of work also has a positive effect on personal happiness and satisfaction on individuals [43], and joy and happiness has a positive impact on creativity as well [3]. Because of additional complexity working on multiple projects simultaneously is likely to limit the chance of personal feedback and reflection [6]. Lack of time also can influence being able to obtaining useful and necessary information from an individual’s social network involved in the projects [6]. The pressure of project overload can lead to a lack of opportunity to express and defend ideas, which is an important element having an impact on people’s sense of work and freedom [6]. There are many researches discussing the relationship between project overload and certain outcome variables such as high level of psychological stress reactions (figure 4). Being involved in several projects can inherently lead a person to make a prioritization list to finish the task before deadlines [6], and therefore some of the projects would be neglected.

Briefly, high level of project overload would cause; 1) low adherence to time schedule 2) low development of skill 3) less activity for improvement 4) high level of psychological stress reaction (figure 4) [6].
1.4.3 Project overload and creativity

High level of stress can bring a negative personal feeling, and limit creativity. On the other hand, positive personal feelings and motivation play a key role in sparking creativity in people [3]. A challenging project goal and high motivation on a project can make the project overload easier to handle [6].

In other words, emotional engagement with project and experiencing joy and meaningfulness of job has impact on creativity [3]. While people are working simultaneously on several projects, feeling of indifference and sentiment of apathy and lack of interest is more likely to limit the motivation during the work [3].

Time pressure and shortage in time resource limits the ability of taking initiative and looking outside the existing routines and therefore limits creativity [3]. Sufficient time is needed to discuss fresh suggestions, elaborate them and test them. In multiple projects environment the shortage of time resource is one of the key factors impact on individual performance [6]. Earlier in this chapter we mentioned that reducing the idleness of experts is one of the key purposes of sharing experts in multiple projects. There are many discussions that opine idleness by itself can help us solve
complex problems better and reflect on our work deeper [42]. But the question would remain here that how much of being idle is necessary, and at the same time sufficient for an innovative person? Ricardo Semler writer of *seven days weekend* explains:” *Idleness is really the time when you solve problems. People say idleness comes close to sloth, which is not true at all. It is from idleness that the best things I've ever done have come*” [41]. Dr.Dan Siegel the writer of *Mind sight* [43] suggests seven daily essential activities to optimize brain matter. For example, “Time In”, as time for quiet, internal reflection after focusing on work can help brain to integrate information better [43]. He explains that for developing our inner resourcing we need essential pauses in our mental space, which multi-tasking denies us from. Dr.Gary Small author of the book *iBrain* claims that switching between multiple tasks limit our unique human attributes, such as self-awareness and creativity [43].

![Figure 5: Variables resulted by project overload](image)

There are various positive and negative aspects, advantages and disadvantages of working on multiple projects simultaneously. Some of the advantages and disadvantages were discussed in the above paragraphs. It was also tried to address the relationship between these negative and positive aspects and important factors that have an impact on creativity. For
In organizations with a long queue of projects waiting for experts, it is quite common to find resources (e.g. engineers in the engineering design department) who share their time between projects due to internal pressure and in order to satisfy the constant demands of project managers to see progress in their own projects. This has negative effects on productivity of these resources. These situations have negative effects on the mind concentrations of these experts and also each time they switch from one project to another, some “setup” time is lost [36].

In this research there is the understanding of importance of teamwork in innovation projects [36] however we also try to examine the impacts of project-overload on individual level. In current research we will use agent-based perspective to find the connection and relationships of some of these elements and make an order to them. More descriptions will be provided in the following chapters.

1.5 Sustainability

In the introduction part, it is mentioned that for organizations moving towards sustainability is an integral part of development [29]. Not only Innovation and creativity can help companies to accelerate their sustainability achievements but also sustainability would help companies to think differently and act creatively about their products, process and business models [29]. What does sustainability means? Sustainability means the ability to live the desirable life in earth without limiting the ability of next generations to live their desirable life. A sustainable society is the one that without disturbing and eroding its fundamental natural life system is able to continue to develop and create a nice human well-being [9] Four basic principles are formulated in order to define a sustainable society in which “nature is not subject to systematically increasing 1) concentration of substances extracted from the earth crust 2) concentrations of substances produced by society 3) degradation by
The fourth principle of sustainability is talking about people and their ability to meet their needs. These need for all people are essential. The most basic needs that have priority to be met are encompassed in the Max-Neef classification of basic needs. These needs usually defined as needs which are beyond the needs to be physically survived and are vital for a high quality life for all people. Max-Neef classification is as follow: 1) subsistence, which could be interpreted as physical and mental health, having food or shelter 2) Idleness, could be defined as imagination, tranquility and space of mind 3) protection, 4) Creativity, curiosity and imagination while having work and skill could be its interpretation 3) Identity 4) Participation 5) Affection 6) Freedom.

Max-Neef believes that if one of these basic needs is systematically neglected and is in short supply, this could cause “poverty” and it is independent from how much money or food the individual has. If no attention goes to cure and remedy the shortfall, there is the risk of emerging deprivation disease for individual. Examples include psychological stress reactions caused by lack of idleness [9] any organization which wants to be sustainable and applies the strategy towards sustainability should be able to address this question:” does our behavior or our work policy limit people’s well-being? Or does it have consequence that limits people’s fulfilling life now or in future?” Part of the organizational sustainability is achieved by not systematically degrading the ecological system and social system (social sustainability) [9].

1.6 Social sustainability and Project overload

Considering the fact that many organizations are eager to move towards sustainability, one of the methods for building a desirable sustainable future is Backcasting. Backcasting from future means to look ahead and build a vision of success in the future then ask,” what do we need to do today to reach this vision?” [9]. An effective shared vision and definition of sustainability for planning sustainable development inside the organization is helpful. For creating such a clear vision inside organization and following a complex decision making path in daily work the Framework for Strategic Sustainable Development (FFSD) could be applied. FSSD is a
five level framework for planning in complex systems; 1) system level 2) success level 3) strategic level 4) action level and 5) tool level are the levels of this framework.

In the current thesis social aspect of sustainability is in focus of the research. The question is; if and how project overload would hinder sustainability inside VCE system? The system level includes the information about the system that we -as planners- aim to make it sustainable. System could be a city or an organization or any system with subsystems [9]. Usually planners gather whole information which may matter during the process about the system. Here in this thesis the system under study would be VCE - the organization in which our case study lives-. Subsystem of this organization is the team with individuals which either working on a sustainable or unsustainable situation. The AE project team in VCE is our system.

The success level is the desirable shared vision of future. In this level the overall goals would be defined that should be achieved by whole organization during the process. In our case we define the success as moving towards social sustainability in which individuals are able to meet all their basic human needs that none of the needs described in Max-Neef list is systematically neglected. Based on VCE rules and policies individuals are supported carefully and the basic rights are secured for employees. The organizational Success level in our system is defined based on this thesis research question. Project overload has the ability to put individuals in the risk of psychological stress reaction, and also to limit people from satisfying their needs to enjoy idleness, space of mind and imagination. In sustainable system people are not subject to conditions that systematically undermined their capacity to meet their need, therefore in case that high project overload makes work out of control and cause mental stress reaction it is unsustainable [6][9]. At the same time freedom to make autonomous decisions in difficult situations and also freedom to build social network within organization in order to exchange ideas and improve knowledge is another aim in the success level. We suggest that Success inside the VCE would be assured when project overload is not happening for people, and employee do not suffer from negative aspects of workload. It is suggested that each employee has a comprehensive psychological profile and historical document in which managers can find the interest and capabilities of employee in terms of handling multiple projects simultaneously.
In the Strategy level Backcasting could be one strategy we choose to describe desirable future and then start to think what is necessary to do in order to achieve it. Our backcasting from desirable situation is to have a calm and creative environment which is recognized as playful, dynamic and supportive climate [3]. Allocating individuals with too many projects, although may bring profit for organization [14], can cause fragmentation on individuals work and make them under strong pressure [6]. Satisfaction inside work and feeling happy would be decreased with high level of project overload [6] and therefore makes people feel unfulfilled [1]. Having the culture of innovation inside organization mean to cherish creativity in all moments of daily work and respect people social life. One of the factors Amabile[2] focuses on, was that individuals need to be assign to the task that match their skill and interest. People the need to be recognized for their abilities and unique skills, therefore it is important to match employees with projects that fit them [2].

The action level in the FSSD includes concrete steps that are planned in the success level to move towards sustainability. In the conclusion chapter we would discuss some suggested actions and tools.

1.7 Research Question

The question this thesis is trying to answer is: “How does project overload influence creativity inside organizations?”. Being involved in multiple projects is more likely to help creativity to be fostered [24], however when the number of projects goes up and lack of opportunity for recuperation as well as insufficient routines and low adherence to time schedule happen project overload is happened [6]. This research peruses the relationship between project overload and creativity for teams and organizations.
2 Methods

This thesis project uses a case study –AE project inside VCE-, workshop and ABM as its research methodologies, all are explained in details in the next chapters. In this section a brief explanation of each items is provided, however if necessary, more details is given in the following sections together with the results.

2.1 VCE as case study

Volvo Construction Equipment (VCE) is a subsidiary of Volvo AB. VCE develops, manufactures and markets equipment for the construction and related industries. Inside VCE, AE project is Advanced Engineering project, the phase where knowledge is built not products, as for instance new transmission concept project. In the section three the more complete explanation in AE project is provided.

2.2 Workshop

Workshop as the method described here takes that into account by involving users not only debating, but also acting and participating in prototypes. In this research the structure of the workshop has been designed to enable the participants to express themselves by talking, doing and making as well as bringing their creative actions to the projects. People express their thoughts through different channels and by enabling people to express themselves not only by conversations but also by acting and constructing artefacts we create a richer understanding of their needs and desires as well as their context and situation. Workshops help us to have deeper realization about the question we are trying to answer. This discussion is expended upon in the section four.

2.3 Agent-based modelling (ABM)

Agent-based modeling (ABM) basically differs from other simulation methods since its fundamental key units are the agents or individuals. Agents are in fact a collective of heterogeneous entities that are interacting together or with their environment. Agents influence each other’s micro-decisions and from the interaction between agents macro-scale group
behavior emerges. In the simulation environment a virtual society could be interpreted in which each agent’s decision has impact on other agent’s behavior [7].

Simulation beside deduction and induction is known as a third way of doing science [7]. Inductive means to use the known facts to produce general principles while deductive means to use the knowledge and information you have in order to understand or form an opinion about something. Simulation starts with a set of precise assumptions more like deduction, but unlike deduction, it does not prove theorems. In fact a simulation would generate data that can be analyzed inductively. Unlike typical induction, however, the simulated data do not come from direct measurement of the real world, but it comes from a rigorously specified set of rules defined by programmer [7]. Simulation modeling can be used to aid cognition while deduction can be used to find consequences of assumptions and induction can be used to find patterns in data [7]. The role of simulation usually is not to create a facsimile of any particular social system or organization that could be used for prediction, but to use simulation to assist better understanding and help in the exploration of the consequences of several assumptions and initial conditions [19]. Express in simple words, simulation could be used as a tool for the refinement of theory.

2.3.1 Building blocks

This is a fact that most innovations are coming from combining well-known building blocks in new ways; for example, big innovative revolution of internal combustion engines back in twenty century is actually combining existing parts in new ways [30]. What is a building block? In fact building blocks are the fundamental components which would form a system; as for instance, human face could be seen as a system in which eyes, nose and mouth are its building blocks. As a matter of fact, if we want to recognize the specific face we should have the right building blocks, same wise; if we want to recognize a successful innovation team we should have the right related building blocks. As for instance, comparing healthy and unhealthy organizations BoozAllenHamilton institute calls the four building blocks of organizational DNA (1) Decision Rights (2) Motivation (3) Information (4) Structure [39].

John Holland explains Complex Adaptive Systems (CAS) as a dynamic network of many agents ( which may represent species, individuals, firms,
nations) making decisions and acting in parallel, constantly acting and reacting to what other agents are doing therefore, each agent behavior has impact on others’ decision [39]. Innovation teams could be considered as Complex adaptive systems in which agents are the members of the team and their behavior builds up their innovation system. Going on to understand innovation in the process we have to find right building blocks for our research question on the organization we are investigating [30].

For building a model in ABM environment defining our building blocks are significant. Our research is trying to answer the question of relationship between creativity and project overload. In this model the system is the AE project team, agents are VCE employees working on AE project and the building blocks are number of projects that each individual is involving in, in addition to each agent’s motivation. In chapter 5 a complete description of computational model and its components will be provided.

### 2.4 Agent-based modeling for social science

“Models can surprise us, make us curious, and lead to new questions. This is what I hate about exams. They only show that you can answer somebody else's question, when the most important thing is: Can you ask a new question? It's the new questions (e.g., Hilbert's Problems) that produce huge advances, and models can help us discover them.” Joshua M. Epstein

Building simplified representations of social phenomena is almost all social science research progress [23]. These representations can be purely verbal. For instance, a book-length representation of past events and some inter-relationships of traditional work of historical organizational management is a verbal presentation which is hard for the researcher and the reader to determine precisely the implications of the ideas being put forward [23]. In other fields, for example, some areas of economics, more formal and statistical or mathematical equations offer as representation for the related phenomena. These make understanding and assessing consistency and other desirable properties much easier than with verbal representations [23]. In these areas, model-building as a method involved with understanding the social world is generally accepted [7]. However, statistical and mathematical models also would be too complicated to be analytically tractable. Making and simplifying assumptions until the equations do become solvable is a common solution for this complexity [23].
Agent-based computational modeling is a relatively new tool for empirical research [7]. Epstein[7] explained that agent-based computational modeling is well suitable for answering the upcoming question:” How could the decentralized local interactions of heterogeneous autonomous agents generate the given regularity?”[7]. The interaction of heterogeneous agents in bottom-up or micro-macro layers would create an artificial society in which researcher can observe the macro-structure as the result of those interaction [7]. The complexity of social systems is a problem of modeling sociological phenomena: social actors, actions and processes called micro-level do have implications on the macro-level which consists of (social) structures, rules and roles [18]. On the other hand the macro-level is structuring all embedded actors and actions (cf. [10]). The linkage between micro and macro level has to be taken into account to help the better understanding of social behavior. Each agent design has to include mechanisms for receiving input from the environment, for analyzing the inputs and making decisions. Three components build the production system: a set of rules, a working memory and a rule interpreter [23]. Intelligent agents simply are the agents that in a timely fashion are able to perceive their environment and respond to its changes, they are also able to exhibit goal-directed behavior as well as have social ability which means capability of interacting with other agents [8].

The target of developing models using computer simulation is to understand better the phenomena of social system that researchers want to investigate on [23]. We build a model of the target through a theoretical process of abstraction (this model is a set of mathematical statistical equations or a computer program) [23]. The value of computer programs as models, for social studies, has been better appreciated for understanding and formalization of social system [23].

There is no unique best way of building a multi-agent system. However, based on the target and purpose of the simulation various architectures could have merits [23]. However, for receiving data from the environment, remembering the previous data and actions, and for carrying out actions, a mechanism should be included in each agent design [23] which in common with all ABM.
3 Case study with VCE

Although within the traditional business lines of technology there is a mix of project models, Result Based Project Model (RBPM) is a model introduced by VolvoCE (VCE) in order to support the strategic direction of VCE Technology that will provide benefits over time. RBPM development objectives are; a) enable global work and support cross-site knowledge sharing, i.e. results can be delivered by any site b) better use of the right competence at the right time c) better control of competences and resources within the line organization serving as a cornerstone for continuous improvement d) a common infrastructure support the use of common technical solution and common parts to speed up development without compromising quality.

Advanced Engineering (AE) project is part of VCE which is defined as a RBPM. Detailed description, Proof of Concept, Technology development, Verification and Transfer to customer are steps of AE projects delivered by project team and line organization (figure 6).

![Detailed description Proof of Concept Technology development Verification Transfer to customer](image)

AE

Figure 6: Advanced Engineering project based on RBPM

Two different projects are running inside the AE, both about building new machines: 1) excavator and 2) wheel-loader. AE is the phase where actually knowledge is built not products (example is new transmission concept project).

During the relevant documents reading and interviews with AE project – some of the supervisors, leaders, managers and employees- and documents reviewing from this case study, the vital data is gathered for this research. AE project has 83 experts on its board, from several different Cost centers and departments such as a large loader platform, engine performance, and power train control, software testing global and other centers. Talking about AE team size and team members, it is important to mention the percentage of members’ involvement; at the first stage 13 people put 0% of time in to this project which practically reduced the team members to 70. People who
have been fully committed to the project and spend 100% or more of their time are five individuals. And 45 people have been committed to the project around 10% of their time. In the histogram below, there is an illustration of the distribution of resources in the project and their involvement. Each employee has 128 hours monthly work time.

![Histogram of individuals and their commitments](image)

**Figure 7: Histogram of individuals and their commitments**

In the Figure 7, the X axis shows commitment in percentage – for example 120% commitment - in the project based on the 128 hour work monthly, Y-axis is Number of people working in the project at a certain commitment-level, for example 45 people working in the project around 10% and 5 people works more than 100% in the project. Managers usually do not consider project overlap or similarity in projects when they want to allocate individuals to projects. In AE some leaders, for example two or three, from different departments are fully committed and work 100% of their time on AE project. Usually three months is needed for establishing the resources including experts and team members for each AE project.

Inside VCE system, there is a prioritization list for projects in which for instance the technology department would dedicate the highest priority to broken machines if needed and AE project is in the last priority in the technology department list. In the experts priority list also AE projects is in the bottom of the list, based on this fact usually AE project could easily be
neglected by system and people. It is obvious that in this system resources are available according to prioritization; Product support projects are coming first in terms of the priority then industrialization projects and last AE project. According to my interviews with one of the project managers, individuals would start with an AE project and after few months they would be prioritized into other projects like product support. In this situation it is possible that individuals be eliminated from AE project and be allocated to other projects and this is usually unpredictable. On the other hand, even if experts still stay in AE project they would be divided into several other projects simultaneously which AE is in the last priority for them. In this interview, it was also mentioned that, as a consequence, consultants get to work with AE for approximately 10% of their time and employees would work with product support or other projects.
4 Workshop

For better understanding of the research question and case study one workshop has been run with students in order to observe them working on different projects. The result of this workshop and its out-coming data helped the building process of the simulation. The results came out of this workshop is described as follows.

Workshop design:

One three-hour workshop with following orders was held in one sunny day of April 2012; we started with 30minuts ice-breaking exercise and creativity practice in order to make the atmosphere ready for a creative participation. Two hours was the whole time duration from starting working on projects to finishing them, and the last 30minuts was dedicated to reflection and receiving feedbacks.

The number of participants was 12 individuals, in addition to 3 more people helping to record the session. Five different creativity projects were defined in this workshop. According to the fact that the main aim of this experiment was observing creativity of teams and individuals while working on multiple projects simultaneously, Participants have had the freedom to choose either they want to be involved just in one project, or in two ,three, four or five different projects simultaneously.

The five different projects were as follows;

Project1: what is your desirable journey after graduation, what to think through? Brainstorm for coming with a story and illustrate your story. (Some equipment is provided but go crazy and tell us your story with any tools or any style you wish (storytelling, theater, drawing or collage but be creative)

Project2: if today is the last day of earth, what it is going to look like?

Project3: how a practical sustainable city could look like?

Project4: you are moving to a new country, what is your journey from decision making to settle down.
**Project 5:** Karlskrona municipality defines a project and asks you to run it. There is a large landscape in one neighborhood; they want to use it in a profitable way. What do you think you can build there, or use that landscape for?

**Target of the workshop:**

The main targets of running this workshop were to better understanding the case study I am working on, as well as gathering data for the agent-based simulation I am building. If I want to name the targets behind this workshop they can be namely:

1. Observing individuals behavior while involving in different projects simultaneously.
2. How idleness (waiting time, time for sleeping on their ideas, time for recuperation after expressing and participation in each project…) effects individuals creativity (idea generation., looking out of the box….etc.).
3. Observing the Motivation of participants base on their project overload (to be actively involved in process, have passion to solve the problem), If and How number of projects affect their motivation.
4. Does switching between multiple projects positively or negatively impact transferring knowledge between projects and new idea generation?

Five different projects are defined with creativity subjects. Individuals are divided to teams to work on their projects. In the figure B, the structure of project teams is illustrated. Individuals are shown as alphabets; alphabets in white color are individuals who worked just on one project, alphabets D,E,F,M are individuals working on two projects and so on.
Category of Individuals based on number of projects they worked on

<table>
<thead>
<tr>
<th>one project</th>
<th>Two projects</th>
<th>Three projects</th>
<th>Four projects</th>
<th>Five projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B, C, P, H, D, E, F, M</td>
<td>G</td>
<td>Q</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 8: Workshop design*

Project 1 has three full-time people working on the project while two other members are in multiple projects involvement. Project 2 and project 3 do not have any person as full-time member; two of their members are in two-project involvement, one in three-project, one in four and one in five-projects simultaneously. Project 4 has one full-time member, one person working on five projects simultaneously; one working on four projects and two are working on two projects. Project 5 has one member from each category.

We start our workshop with fifteen minutes of introduction speech about innovation, creativity, my research question and the purpose of the
workshop. During the speech the important influential factors on creativity briefly was explained. I encouraged the participants to be free and crazy to bring their imagination to the real world. I tried to make a trustful and supportive environment for them and asked them to feel free to have discussion and debate on their ideas even out of their teams. After first part of introduction, two ice-breaking games worked very well and all people felt more close together.

**Ice-breaking games:**

We played a fruit game in which all people are sitting on their seats in circle and one person without seat is standing in the middle of the big circle. Each person would be in one fruit-name category, for example apple, orange, banana. Then the person in the middle will shout load one of the fruits name and people with that fruit category have to change their seats with others while other people remaining on their seats. This game was one of the games I had played in one of the workshops during “innovation in mind” conference in Lund Sweden 2011. Second game was actually a simple warm greeting and hugging game in which individuals spreads their love and smile to each other. After introduction part, the projects get started with explaining the problems each team was supposed to solve.

During the work, project1 faced some sort of conflict between those three members who were full-time committed in the project. In fact, the person who was at five-project category did not have any contribution with this project, since he was not motivated to share his ideas where there was already a comprehensive discussion between other members and he had missed that. Same wise, the other member who was involved in two different projects prefers to spend most of her time in the other project since she felt her ideas are more appreciated. However, she explained that being in the project1’s discussion and debates helped her to come with more creative ideas and used them in her second project). At the end, when everybody voted for the best creative project, project1 presentation did not receive more than 7 votes out of 15 from audience.

Project2 without any full-time member surprisingly was not that much empty and lonely. Most of the time there was either all members or couple of them who were all together working on this project. They explained that the interesting topic of the projects and good relationship between team members helped them to be more motivated to work on it. The person with five-project involvement explained that he put most of his time in this
project because felt more enthusiastic while working on it. Most of the members of project2 and project3 were shared and it helped them to manage time between both projects. Project2 final presentation was the fourth most creative one in audience votes.

Project3 faced many minutes of loneliness without any members working on it. But since four of its members were same with project2 self-management helped the team to manage to finish the project on time. Surprisingly this project got the highest vote of creativity with 15 votes. The reason of this high vote was basically the great idea of one of the members who confess that the idea came to his mind at the moment of presentation and it was not in the project plan at all. The person who came with this idea was the one who was involved in three projects simultaneously. They explain that the project was 10% developed until the last fifteen minutes and the team members complete it on the last ten minutes as they call it 90-minute goal!

Project4 had one person as full-time member who told us she felt bored sometimes that was sitting all alone while waiting for other people to join her and put their ideas on the project. In general it was a busy project and its members had motivation to work on it. They explained that because three members of them had a good relationship together and also been involved in other projects again together, already they had a good sense of motivation to work together. This project got the third place of creativity according to audience votes.

Project5 with one full-time member and one two-project member was one of the less active project teams. But at the end one of the most creative ideas came out of it, although because of its presentation audience did not vote for it still majority accepted that project5 could have been number one because of its novel crazy idea. Person who was in two projects simultaneously explained that she put most of her time in this project but got many ideas from the other project as well. She continued because of enough time and self-confidence she had, she was freer to express her ideas and because of mutual trust with other members, she was best of herself during the project. The person who was in four-project category was quite passionate to put her ideas in this project too. They explained the best ideas came out from person with two projects and person with four projects in this team. The other member with five projects simultaneously told us he
did not participate in this project that much because he could not manage his time.

**Workshop conclusion:**

When a team with different team members is created, one of the important issues in their quality of team-work is the balance in contribution. In other words, when there are members with 100% time dedicated to the project and they get fully involved with the project it resulted disturbing to have members with 20% of their time who cannot be that much active in the team. It also makes the same difficulty for the person with 20% of commitment in the project since he feels apart from the core team and feels less important in the decision making process. 83% of people involved in the workshop (10 out of 12 people) believed that they felt uncomfortable with huge gaps on member’s contribution in project. Another result from this workshop was the fact that individuals with more than one project were eager to spend most of their time in the project which was more fun for them. Even though I asked them to divide their time equally between projects (but also I gave them autonomy to act freely), 87% expressed that they did not divide their time equally and they dedicated more time and attention to one of their projects. They also told that they have been more motivated to work on the project which the team structure was closer to their personality, the project was more interesting and the team members were more creative, therefore they did not put energy or attention to the rest of their projects. In the team performance and the output of projects, percentage of team members did not affect the creativity of teams, but individuals involved in more than one projects acted more creative rather than individuals involved in one project.

People, who had the chance to choose their projects by themselves, expressed more satisfaction and were more motivated to work on their projects, on the other hand, people who got assigned to the projects showed less motivation during the work. Person who I asked her to be in four projects simultaneously told me that she knew she could not manage all projects and at the end she felt overwhelmed and unfulfilled. She believed that her energy was wasted just because of too much project, she said she found two of projects really interesting and match with her abilities, but since she felt responsible for other two projects as well, it limited her freedom to put her best ideas on the projects. In reverse, six out of nine
individuals who choose the projects to work on expressed happiness and satisfaction on their work.
5 ABM on the case study

Agents are the individuals populating the simulated environment. These agents, either in aggregate or as individuals are the units of analysis. Each agent has some states that would be described here as well. This model tries to understand and analyze the relationship between involvement in multiple projects and likeliness of creativity. The definition of multi-project and creativity has been offered in previous chapters. There are several positive and negative facts affecting teams and individuals related to multi-project involvement. Two important factors of creativity are relevant knowledge and intrinsic motivation. Multi-project involvement brings along gathering knowledge from social network and can affect the intrinsic motivation as well. In this model rules for agent-agent interaction and agent-environment interactions would be defined. It is assumed that Agents are divided to three categories which define their capabilities to handle multiple projects.

1: Full-time agent, whose perfect challenge is working just on one project

2: Tow-project agent, whose perfect challenge is working on two projects simultaneously.

3: Three-project agent, whose perfect challenge is working on three projects simultaneously

This simulation is trying to bring the project overload situation into the computational modeling world, therefore in order to separate the fact of multiple project setting and overload those three categories above are assumed. It represents that a) based on individual characteristics, capabilities, and interests in addition to the b) based on the nature of the project, project overload may happen. Sometimes three projects simultaneously is perfectly fine for some individuals, according to the assumptions that a) people have different characteristics and capabilities b) those projects can stimulate individual motivation and passion. If the project has an appropriate challenging goal as well as good group-feature and proper team structure, people would find it as a perfect challenge; the three categories above is the simple form of these criteria.

Agent’s attributes:
1) **Personal-category: IP.** Agents can have one IP based on three category mentioned above.

2) All agents’ relevant knowledge and skill would be set as random-normal at the beginning of the model because in reality also individual’s knowledge about the new project they interring in differ and also is not infinite. Here this relevant knowledge does not represent the whole level of knowledge of individuals, but the knowledge and skill they may have about the project domain they are committed to. During the project and after interacting with other team members and the managers and after the final-shared goal has set, agents start to gather data and improve their relevant knowledge. Since the length of project is not forever, the knowledge gaining about the project domain is also not infinite.

Normal distribution: \[ y = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}} \]

Relevant Knowledge: \( K(T) = \{ Y/ \ 0 < Y < 30 \} \)

3) **Level-of-pressure:** if agents suffer from project overload their pressure is high.
   Here pressure means the difference between agent capacity and the number of projects he is involved with. We assume that agents have different preference and capability in handling several projects.

\[ P(t) = \{ z \mid -5 \leq z \leq 5 \} \]

4) **Level-of-motivation:** “0” when agent has completely lost his motivation, “2” when he is highly motivated and “1” neutral.

\[ M_i(t) = \{ y \mid 0 \leq y \leq 2 \} \]

Level of motivation of all agents’ at the beginning would be a random distribution between 0 and 2. “0” or “1” or “2”. But during the project this motivation could increase or decrease.

\( p(t) \) would have impact on motivation of agents.
5) Number-of-projects : NP

**Environmental attributes:**

Communication-level: the level of freedom to have communication with social network inside organization. Higher communication-level means that agents have more autonomy to hold debates and exchange ideas, to take time for discussion and contributes in skill improvement.

**Rules:**

1) Level-of-pressure: \( P(\text{Agent}) = IP_i - NP_i \)
   Level-of-pressure of agent (i) would increase if the number of his project is higher than his capacity (IP).
   Here we assume that agents are in three categories based on capacities on handling project-overload. If the number of projects is lower than their level-of-pressure means that they are not met their challenge and still their work is not match enough with their capabilities, therefore their motivation may be lower than the time that they have the perfect challenge. But still environmental and other agents attributes can increase or decrease their motivation toward their projects. On the other hand if the level-of-pressure is higher than their capacities there is the risk of project-overload means that if this pressure is one unit across their capacities there is the likeliness to stretch their capabilities and moderate the pressure if the challenging project is close to their interest and if there is a supportive group-feature; group-work feature is about mutual supportive environment in which people are working and when there is high level of communication and supervisory encouragement.

2) number of other agents each time agents can meet :
   \( B_i(t) = (NP) \ast \text{random (communication-level)} \)
   Number of other agents that they can meet and have interaction with is based on their communication-level which is an environmental attitude.

   \( B_i \) would define the number of links between agents each unit of time.
3) Relevant Knowledge: relevant-knowledge of agents could be a function of natural logarithm. For sake of simplicity, here in this model knowledge would increase statically base on time.

The differences between highest knowledge and lowest knowledge inside the individual social network while working on the projects is shown by PM(t). The difference between knowledge will exponentially decay from the beginning point of its execution, as follows:

\[
PM(t) = \lambda(1 - (e^{-\kappa(t-t_1)}))
\]

Relevant-knowledge: \( k(t) = k(t_1) + K(t_1)PM(t) \)

Where \( t_1 \) is representing one unit time before time \( t \).

Each time that agents meet another agent with higher relevant-knowledge they would improve their relevant-knowledge, therefore number of their projects indicate their social network and the times they can meet other agents and gain knowledge.

Note 1: The more often people exchange ideas and data by working together, the more relevant-knowledge they will have [2].

Note 2: one of the characteristic of project overload is the limitation for improvement.

4) Level-of-Motivation :
   If ( \( P_i < 0 \) ) then \( M_i(t) = 1 \)
   If ( \( P_i > 0 \) ) then \( M_i(t) = 0 \)
   If ( \( P_i = 0 \) ) then \( M_i(t) = 2 \)

   if ([M(t)] of partner >= 2) and ( K(t) of partner > K(t) of myself)[
   \( M(t) = M(t-1) + 1 \)

   If (\( M(t) > 2 \) )
\[ M(t) = 2 \]

For agents with pressure either positive or negative there is the risk of losing motivation:
If \( P_I(t) \neq 0 \),
if \( (M(t)_{\text{of partner}} \leq 0) \) and \( (K(t)_{\text{of partner}} < K(t)_{\text{of myself}}) \),
\[ M(t) = M(t-1) - 1 \]
if \( M(t) < -1 \) \[ M = -1 \]
Note: information sharing and collaboration heighten peoples’ enjoyment of work and thus their intrinsic motivation [2].

5) Likelihood-of-creativity:
\[ C_i(t) = M_i(t) \times K_i(t) \]

Creativity in each individual is a function of knowledge and motivation; means that as motivation goes up the likelihood of creativity as up and as their knowledge around the related domain there are working goes up the likelihood of creativity enhance. [Ford, 1996] proposed that creativity is a function of motivation multiply knowledge and ability [26].

5.1 Translation to the software program

5.1.1 Netlogo

NetLogo is an agent-based programming language and integrated modeling environment. In this thesis I used Netlogo as software for modeling [38]. Working with Netlogo is relatively easy. NetLogo comes with a large library of sample models which help to work more comfortable while modeling; this is an advantage of Netlogo in compare with “Ascape” or “SWARM” [19]. Netlogo also comes with a way of easily running “what-if” scenarios with Behavior Space—a tool that allows one to perform experiments with the programmed model. In this thesis I used Netlogo as my modeling software and I should admit working with it was applicable.
5.1.2 Results

In this chapter the results coming out of the final simulation would be discussed. Figure 9, illustrates the interface of the final developed computation model.

![Diagram of simulation interface]

**Figure 9: The interface of the model**

Results in detail:

In this simulation some teams of agents are created in order to interact together and create the teams’ likeliness of creativity. Teams are made up of agents with different percentage in commitments and some are involved in multiple projects simultaneously. In the table below, both teams (team1 and team2) are built randomly which means that the most eligible agent has got assigned to the open project without taking care of designing the team based on perfect matches and group-feature. In addition, there are agents who are involved in three, four or five projects simultaneously; therefore the risk of project overload is relatively high. The model can be run several times and different results can be captured, the results are not satisfactory yet in terms of creativity.
Here Teams are made of agents who got assigned to the project randomly not based on their category. The risk of project overload is also so high. The result of likeliness of creativity is disappointing.

In the next table below, the five agents with 5 different projects are eliminated from team and instead one full-time agent is replaced. Similar to the previous table, both teams are built randomly. As it is illustrated in the likeliness of creativity, the results are improved in compare with previous table with the high risk of project overload. Even in the first curve a satisfactory result is observed. The significant problem still remains here which is the fact that creativity is a function of chance, it may happen but may also not happen. More we reduce the number of agents with risk of project overload better results would happen but still based on chance.
The more you reduce the risk of project overload with cutting off the projects you are assigning to individuals, the more the likeliness of creativity! But, still the creativity is a function of chance. Here Teams are created of agents who got assigned to the projects randomly not based on their category; creativity may happen or may not happen.

The last table below demonstrates the comparison of two different teams. The first team is created randomly as we were talking in the last two tables. The second team, in return, is built based on the accepted criteria for a creative team which are matching agents with perfect challenge and designing a good group-work feature. We observed the likeliness of creativity when the risk of project overload is high and it was not satisfactory. Here in this table we will see the difference of likeliness of creativity when the risk of project overload is relatively low. In the team1 with black curve still the creativity is a function of chance. On the other hand, the team2 with red curve when the culture of creativity exists shows that the likeliness of creativity is always satisfactory.
## Ideal likeliness of creativity

Ideal likeliness of creativity is when all agents all fit with their category based on project overload. Team2 is made of agents who do not suffer from project overload and they are more likely to be creative. Team1 is created of agents who got assigned to the project stochastically not based on their category. They are less likely to be creative; and this is also observable that more the number of agents with high projects involvement, lower the probability of creativity would be.
6 Project overload and creativity inside case study

As we discussed in the chapter “organizational climate for creativity”, in Amabile’s model [2] and in Ekvall’s model [3] some of the influential factors on creativity are as follow; challenge, freedom, resources (e.g. time resource), group-work feature, encouragement, trust, dynamism, diversity, debate and idea time. In addition, there are some variables related to multiple project involvement and project overload namely; reducing idle time and limiting the personal improvement. Now the question is about the relationship between those variables of project overload and creativity.

From the significant advantages of multiple projects we can name a) shared expertise b) transfer knowledge between projects. Knowledge and relevant skills are important factors for creativity. Being involved in multiple projects simultaneously could be lead to knowledge gaining and skill improvement [36][6], therefore multiple projects can act as catalyst for creative actions [24]. In AE project in which more than 70 people are involved there is a good opportunity for transferring knowledge and information between different departments and various projects. In addition diversity of expertise is important for boosting creativity and also could help a high-level of a) shared expertise and b) transferring knowledge. Diversity in project team is one positive element has impact on creative actions only if members appreciate it and use it appropriately [2]. R.Keith Sawyer[27] argues that creative advances combination is one reason that innovative success is more likely to happen when we are involved in multiple projects simultaneously while focusing and working hard on one project; ideas from the other projects are incubating on your head. This is the incubation that usually gathers ideas from more than one project, causing combination and leading to creativity that the creator is not consciously aware of it [27].

Reducing idle time of experts is another positive factor in multiple project strategy which is aimed to use the expensive professional employees to an efficient manner [6]. On the other hand, tight time schedule and time pressure is one outcomes of project overload [6]. Considerable amount of set-up time is named as negative aspects of project overload which is a consequence of switching between projects while working on several projects. In Amabile’s model time as a resource is under investigation, she
mentioned that sometimes and under some circumstances can spark creativity; as for instance ”say that a competitor is about to launch a great product at a lower price than your offering or that society faces a serious problem and desperately needs a solution – such as an AIDS vaccine. In such situations, both the time crunch and the importance of the work legitimately make people feel that they must rush. Indeed, cases like these would be apt to increase intrinsic motivation by increasing the sense of challenge. Organizations routinely kill creativity with fake deadlines or impossibly tight ones.” (Amabile) [2]. If individuals feel overwhelmed with projects work and feel unfulfilled because of tight time schedule it can damage their motivation and consequently creativity [2]. Idea time for each individual and time dedicated to debate and exchange ideas are vital for a creative organization and it is all about importance of specific amount of time people use to elaborating new ideas [3]. In AE project one of the significant elements that are likely to hinder creativity is lack of idea time. During one of my interviews, I realized that due to tight time schedule of employees and mainly for those who are involved in several projects there is no time for actually reflecting on their knowledge and information. One of the experts expressed himself as follow: “it is too much work for me, not because I cannot do that because I think I can. But I love to spend my time to develop myself inside the work and to be affective on one of the projects that I feel passionate about and unfortunately I cannot find any time in my schedule to focus on it”.

Challenge means to match individuals with a right assignment. Perfect matching means not too less that employee get bored and also not so many that they get overwhelmed [2]. If supervisors have the deep understanding of their team members, it is more likely that they match them with right projects and as a consequence increase the likeliness of creativity [2]. In both Amabile and Ekvall’s model it talks about challenge in organizations in which they stressed that people should experience joy and meaningfulness in their work. Based on the interviews, in AE project employees are suffering from lack of interest in their projects; it does not mean that AE project is not joyful for them; in contrast, some of them really prefer to work on AE instead of their other projects. It was mentioned before that AE projects have the lowest priority for organization and that is why employees cannot enjoy their work on AE as much as they want. One of the AE members clearly explained that his passion and his mind are more involved with the AE project but he has to work on other projects. On the other hand, another expert emphasized that in the first day of creating
AE teams one of the project leaders expressed his unwillingness to work on that project. Here is the exact words; “mindset of people is important, One of our leaders from the first days told us this project is not going to have any success, it is an absolute failure. Can you imagine? If people do not like the project why they get assign to them?”

Based on the results of this current research, matching people with right challenge has strong impacts on moderating negative aspects of light project overload. However, the challenge factor in AE project is seems to be neglected. It is somehow closer to randomly allocate employee to the projects. In other words, most eligible employee will be assigned to the most eligible project which is the open and urgent one. Having deep understanding of individuals inside organization and taking care of matching people to the project and also together has incredible positive impact on creativity.

In addition, another influential factor on creativity is freedom, means having autonomy and enough time to discuss the problems and make connections in social networks in order to exchange ideas[1][2]. Freedom also means giving the employees autonomy to make decisions and think out of the box, in contrast, when freedom is missing individuals prefer to stick to already existing routines and do not risk acting innovatively [1]. In last interviews with one of the AE project members, it was realized that if any of people have a new idea for the project or wants to offer new solutions for problems, they have to set up a formal meeting time, book a time and formally present their ideas. Here it is the words; “It makes it tricky to book a meeting time and invite all people and then present the idea that you are not sure if it is going to work. People prefer not to do this risk”. Sometimes in organizations creativity is killed without managers even being aware of the reasons, but the reason is so simple. In AE project managers, leaders and employees with several projects in hand, are having an intense work schedule that they cannot deal with extra times to risk on new ideas or new solutions.

Another element which is examined in empirical research about project overload is its impact on less activity for improvement [6] and less time for skill improvements. No adherence to time plan is another results of project overload which usually brings fragmentation on individuals’ work [6]. Focus is important for creating something novel and original [24], project overload interrupt people from focusing on one work efficiently [6]. In AE
project, mainly because of low percentage of time commitment, individuals cannot focus on work. Lack of focus on project is more likely to limit creativity and innovative actions.

Lack of time for recuperation considered as the most important variables in project overload [6]. People need a budget of time for recovery after a peak period in work; in addition, individuals need time as reflection time to reflect on their work and what they learnt and what they challenged with. Project overload has the risk to limit people to meet their need to relax and spend time for recuperation [6]. High level of stress reactions is another elements caused by project overload [6]. Burnout is a response to work overload and stress that leads to some severe symptoms such as depression, hopelessness and fatigue [40]. If project overload and workload leads to burnout for employees, the productivity would be close to zero and also motivation and creativity would be close to zero [40].

Besides Amabile and Ekvall’s theories, this research studied Hoegl and Gemuenden concept of team-work quality which leads to innovation and creativity in organizations. Six facets 1) communication, 2) coordination, 3) balances of member contributions,4) mutual support,5) effort and 6) cohesion [28] (figure12) are the main factors have impact on quality of team work. An investigation was pursued on circumstances of project overload on these six facets as well as relationship between AE project attributes and these six facets.
Communication and coordination in teams are significant elements have impact on team performance. When team members openly communicate and contribute together and exchange their information it is more likely that creativity occur [2]. In other words, Information processing and communication between the team members in an organization with high degree of autonomy over project decision is more likely to increase the creative action due to ability of sharing ideas and ability to debate and have a discussion on problems [3].

Group-work feature refers to design and create a team with appropriate chemistry [2][3] that they communicate and support each other very well. The consequences of project overload such as tight time schedule and psychological stress is more likely to limit people to communicate efficiently together [6]. According to the results of this research, a good group-work feature can moderate the negative aspects of light project overload and help creativity to be more likely to happen. The project’s team size as an influential structural variable could have significant impact on quality of team process as a consequence of its impacts on the quality of
team’s collaboration and communication [28]. Larger team size would be more difficult and uncomfortable interaction between members of the team, because in teams with large size, people cannot communicate regularly and effectively with each other [28]. Coordination of task activity and information flow is also much more difficult as team size grows [28]. Communication plays a key role in creativity; In AE projects team members are not locally available in the same place. According to one of the interviews, individual’s links between their networks is weak and insufficient. “We prefer to talk eyes to eyes, exchanging ideas or improving something over phone is not possible”, one of the AE experts said. Lack of communication would decrease the quality of work and more likely the ability of team for creative actions.

Balance in contribution is another facet discussed in Hoegl and Gemuenden pattern. More individuals contribute their knowledge to their highest potential more the quality of team work would be [28]. In one project balance in contribution makes everything easier for members to adapt themselves with problem and focus on solving it. One of the most visible reactions during the workshop which was hold for observing teams and individuals with different commitments was the negative aspect of unbalance in people contribution. 91% of participants (11 out of 12 people) found it hard to communicate with other members with huge difference between their involvements. For example people with 100% commitment explain their difficulties to deal with individual with 20% involvement while they have had some progress and they had slow down and explain about what they had done so far. This situation made people with few percentage commitments disappointed and they preferred to just be listeners not that much active. AE project has a large size and very various members’ commitment (from 100% to less than 10%) 45 person involve in AE just dedication 10% of their time to the project therefor; it seems that quality of team work and as its consequence probability of creative actions is more likely to be low.

Cohesion in team and the structure and composition of team affects the feelings of belongingness of members to the group [25]. More enhance team cohesion and more attraction to the group, members work with more loyalty and commitment to the team vision and goal [28]. Cohesion in simple term means; are team members motivated to maintain the team? [28]. Appropriate communication is essential for maintaining cohesion inside a team moreover, one unit clear vision and purpose between
members is important as well as understanding of team work which means that people should have high understanding of advantages of working together rather than by their own [121]. In AE projects there is a sense of lack of cohesion inside team and between members; one of the AE experts express his as follows: “I wish my colleagues in Korea were here because right now it is felt like we are different teams not one team”. Reciprocally support each other’s idea or in problem solving situations, establish high effort in team work and enhance the fact of team cohesion where team members maintain in group all together would lead to high teamwork quality [28].
7 Conclusion

This study has focused on the impacts of project overload on creativity inside VCE organization. This research aimed to identify the pros and cons of multiple project involvement. Literature reviewing and running workshop as well as interviewing with some members of AE project –the case study inside VCE- were used to pursue the research question and gather the essential data for this research. Computation simulation and testing was utilized with ABM approach as the primary research methodology.

Creativity inside organizations is a function of various factors, namely; appropriate challenge and good group-work feature. Creative climate inside organization is seen as common perception arising from interaction between organization’s members. On the other side of this research, the main characteristic of multiple project setting is that several projects are performing simultaneously. Companies tend to use human resources in an efficient manner by using scares resources in many projects. There are advantages in this strategy, however in the individual level working on several projects at the same time would bring project overload and may cause disruption and fragmentation from work as well as high level of psychological reactions for people. Switching frequently between several projects is interrupting individuals focus and would cost considerable amount of set-up time.

One of the significant variables that can alleviate the risk of project overload for individuals and increase the likeliness of creative actions is considering a right challenge for people with assigning them to the right projects that play with their expertise. Perfect matches stretch individuals’ abilities; hence the amount of stretch is crucial. Involving employees with multiple projects makes a higher risk of not assigning them to the right challenge, and that is due to complexity of the multi-project settings. Project overload brings the risk of fragmentation, lack of opportunity for recuperation and low development of skills along which are more likely to limit creativity. Based on the final simulation results, it could be observed that teams with project overload show unsatisfactory results in creative actions, however light project overload could be moderated by appropriate challenging goal and good group-feature. This could be interpreted as follows: employees should be able to focus on their work, and since project
overload more probably would cause fragmentation and disruption it is more likely to hinder creativity. If culture of creativity exists and organizational strategy ignites intrinsic motivation of employees, negative aspects of light project overload could be moderated. In addition, organizations should pay careful attention to the design and structure of their project teams. What is necessary is a mutual supportive group with right diversity of perspectives that all members express willingness to help each other through difficult situations and the excitement to reach the shared goal together. Creating such a team requires managers to have a deep understanding of their people in order to make the best matches between both individuals and the task in projects.

This thesis discussed that creativity should be a culture inside organization not a function of chance. Organizations that have the goal of creating an everyday creative climate should consider their employees as individuals with specific characteristics and do not treat all the same. Individuals should not be treated as machines without feelings or interests, all are not just similar. Assigning so many projects to employees disturb people focus and kill the time needed for recuperation and reflection. Many great ideas usually linger on, for a while, in the back of peoples’ mind, where we called it incubation time in this research. Project overload because of its consequences, such as tight time schedules and no enough time for incubating ideas, is more likely to hinder creativity.

In the future studies for creativity inside AE project, it is essential to investigate on the communication part of this project. Appropriate communication and idea debate and support is known as a key element for creativity and innovation, therefore the disadvantages and shortages of not being located at the same place should be under consideration. It is obvious for the author that the problem of AE projects is not only project overload, although lack of focus on projects, because of involvement in so many projects, acts as obstacle for creativity. Next step for VCE could be defined as developing a culture of creativity and innovation. The precondition for technological innovation is organizational innovation. VCE needs to bring a revolutionary approach in its organizational climate in order to spark creativity and innovation inside the teams. Innovation no longer should be seen as a moment of insight, but, as a daily culture inside organization.
References


[12] European synthesis of surveys on working time & work load of professional and managerial staff Eurocadres synthesis 2003, ref.: 03-836 C November 2003


[38] Netlogo official homepage, http://ccl.northwestern.edu/netlogo


Appendix: Trial and error; Experimental learning in ABM:

Failed prototypes:

During this thesis I used experimental learning in modelling method and tried so many ABM prototypes in order to learn how precisely build a model and also to understand more accurately what my research question tries to answer. Even though there were tough moments of failure in models and I did too many model tests, I feel grateful for all I learned from this experimental Trial and error. In this chapter I would like to bring some of the failed test-models of mine in order to appreciate my process of learning.

One of the failed prototypes:

This prototype was almost one of the best failed-prototype of my experimental modeling. It was much more like a system dynamic model rather than ABM. It helped me a lot to understand more about what I am seeking to understand while modeling. This model was based on many assumptions.

States and variables:

In this model agents have seven attributes that they can be recognized with them.

(1) Number of projects that each agent is involved with: in this model the assumption is that agents are dividing their time equally on all projects.

PN = number of project agent is simultaneously working on

(2) Downtime: units of time that agent can work each work-day.

Each agent has 8 hours a work day equal to 8 * 60 minutes or 8*60 = 480 chunks of time, each time agent is switching between projects 20^i chunks of time is using as a set-up time.

D\textsubscript{i} = daily work time of agent (i) = 8 * 60 – (PN * 20)
(3) Information gathering box: it may act as memory; each agent has ability to gather information from its environment and from communication with other agents, more projects agents involved more other agents they can meet and more information could be gathered and more knowledgeable they could be.

\[ K_i(t) = \text{knowledge of agent (i) in time (t)} \]

(4) Idleness defined how busy agent is: during the agent’s 480 chunks of there is a peak of busyness and usually at the beginning there is more idleness. In this model it is assumed that in the middle of projects is the peak time.

\[ I_i(t) = \text{busyness of agent (i) in time (t)} \]

\[ I(t) = \{y / 0 < y < 3\} \]

(5) Pressure: defines agent’s level of pressure which is stress because of time pressure. Pressure has relation with idleness and downtime.

\[ P(t) = \{y = \text{true or } y = \text{false}\} \]

(6) Motivation: agent either has motivation or doesn’t have motivation. Motivation has relation with idleness, pressure and balance in team communication.

\[ M_i(t) = \{y = \text{true or } y = \text{false}\} \]

(7) Likelihood of creativity: agents are more likely to be creative if they motivated, if they have relevant knowledge and have appropriate idleness.

\[ L(t) = \{y / 0 < y < 5\} \]

**Environmental attributes:**

Environment in which agents behave and make decisions also has two attributes; team-size and level of communication.

(1) Team-size: size of team

(2) Communication-level: the ability of team to coordinate members to communicate with each other as well as ability of each agent to
communicate with other, talk and share. More communication-level more information-gathering and more knowledge gaining as a consequence more likeliness of creativity would be.

**Rules:**

Balance in team work is one of the key elements that have impact on creativity. More balance of member’s contribution more quality of team work.

Agents-agents rules:

Agents based on their ability of communication and team ability for communication would meet other agents and would gain knowledge.

\[
X = pn \ast \text{random communication-level}
\]

1) \[K_i(t) = x \ast \ln(1 + \text{ticks})\]

2) \[I(t) = pn \ast \sin(0.5 \ast \text{ticks})\]

Calculate Average of team idleness

3) \[\text{Creativity} = \text{motivation} \ast \left(\frac{1}{\text{idleness} + 1}\right) \ast \text{information-gathering}\]
Another earlier-failed-model:

This prototype was based on too much assumption and I could not manage to validate part of its assumption, moreover, this model could not address my research question.

Scenario 6: Update to include multiple problems at the same time.

Problems overlap some, but not too much. i.e. there is a problem space of 0 to 9999. Most problems are only searching for solutions within a small range of that problem space (say 100-199 or 1500 to 1599). But sometimes there are bigger problems, and they must search in a broader space, e.g. 1500 to 2500). If they have memory - they will already know the best of 1500-1599, so they reduce search space.

Teams with memory in solving complex problems ….

In this model I was developing my model based on three available researches.

First research is talking about organizational innovation and the tendency of entrepreneurial teams trying to develop organizational innovation; the capability of creative action and being innovative is seen to be a function of
the ability of entrepreneurs to 1: obtain non-redundant information from their social network and from open media information flows 2: avoid the pressure of conformity 3: sustain trust in developing novel – and potentially profitable- innovations.

Second research is talking about how the motivation and knowledge of individuals participating in innovation projects broadcast on the Internet affect their contribution performance; [Performance = f (Motivation x Ability)]. Here ability is defined as knowledge and skill of individual.

Third research investigates psychosocial aspects of work in multi-project settings and how project members and project managers at operational level perceive their work situation. In this research important factors were: (1) lack of opportunities for recuperation, (2) inadequate routines, (3) scarce time resources, and (4) a large number of simultaneous projects. Further, the study indicated that there are associations between high level of project overload and (a) high levels of psychological stress reactions, (b) decreased competence development, and (c) deviations from time schedules.

<table>
<thead>
<tr>
<th>Number of projects</th>
<th>Setup-times</th>
<th>Recuperation time</th>
<th>Transferring knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>↑</td>
<td>↓</td>
<td></td>
</tr>
<tr>
<td>Pressure for conformity</td>
<td>↑</td>
<td>↓</td>
<td></td>
</tr>
<tr>
<td>Sustaining trust</td>
<td>Obtaining non-redundant information</td>
<td>Creativity</td>
<td>↓</td>
</tr>
</tbody>
</table>

(Figure c)
1: For creativity capability in order to be innovative:
   • The importance of sustaining trust in developing novel ideas
   • The importance of avoiding pressure of conformity
   • The importance of information flows, ability to obtain non-redundant information from social networks

2: For performance in innovative projects:
   • Innovative performance = F(Motivation x knowledge)

3: On the other hand in multi-projects or workload:
   • Has lack of opportunity for recuperation = psychological stress problems
   • Lack of time for reflection and improvement
   • Considerable set-up time waste
   • Ability for transferring knowledge

Assumption (reference 1):

1: in all scenarios there equally understands of the importance of sustaining trust in developing novel ideas and the importance of information flows, ability to obtain non-redundant information.
2: Person involved in one project, with high knowledge and skills, is more likely to be innovative if he has high motivation.

Hypotheses:

People juggling with multiple projects simultaneously are more likely to be at risk of pressure of conformity.

- Person with two projects is more likely to be innovative than person with one project; when there is no pressure for conformity, there is access to non-redundant information flows and there is sustaining trust in developing novel ideas. So we got all these factors equally constant in the model. We suppose that environment by itself has no pressure for conformity on individuals, there is free open access to information and environment by itself sustain trust on new ideas.
- Person with three projects is more likely to be less innovative than person with two when there is no pressure for conformity, there is access to non-redundant information flows and there is sustaining trust in developing novel ideas.
- Person with four projects is more likely to be less innovative than person with one/two/three projects when there is no pressure for conformity, there is access to non-redundant information flows and there is sustaining trust in developing novel ideas.

Now, we can change the motivation level manually and test different situations and the result accordingly.

Simply stated, when there is lack of motivation, an individual’s skills will either remain untapped or will be devoted to other activities - but, conversely, motivation is unlikely to lead to high performance levels unless accompanied by a minimum level of knowledge and skills (Amabile, 1998).

Now, when individuals are playing the game in our model, each of them has 40 minutes (4 chunks of time) to guess a number and express it. If the member is also involved in other projects each set-up times takes 20 minutes of his time (2chunks). Each person has 8 hours (480 minutes) daily work. $\Rightarrow \text{AN} = \frac{(480-\text{PN} \times 20)}{40}$
AN = Number of rounds each agent is allowed to guess a number

PN = Number of projects agent is involved

AN=(480-PN\times20)/40

After each agent clarified its rounds to play, the following rules are defining the next guess of each agent:

Each agent use one of three strategies:

- With Bias B1, use agent’s guess from the last round
  \[ B1 = PN \cdot B1 \]
- With B2, agent prefer to skip the game since he is not motivated and doesn’t have time
  \[ B2 = PN \cdot B2 / \text{Motivation} \]
- With B3, randomly explore
  \[ B3 = \text{Motivation} \cdot B1 / PN \]

Probability of choosing strategy x = \( P(C_x) \)

\[ P(C_x) = \frac{B_x \cdot S_x}{\sum_{i=1}^{d} B_x \cdot S_x} \quad \text{ : Where } S_x = \text{Score obtained from Strategy } x \]

Next guess = \( G_x + N \quad \text{ : Add random drift to guess based on Strategy } x \) (N= a variance of 1 as noise)

\[ P(C_x) = \frac{B_x \cdot S_x}{\sum_{i=1}^{d} B_x \cdot S_x} \]

Now, in this model: conformity is increasing as the number of projects is increasing.

The probability of choosing strategy B3 which is randomly choosing is higher when there is no pressure to conformity therefore, is higher when person is in fewer projects and is higher when he is more motivated. \( \Rightarrow \) B3= Motivation. B1 / PN

The probability of choosing strategy B2 which is choosing the best guess of other members is higher when there is (X)amount of pressure to conformity
therefore, is higher when person is in more projects and is higher when he is less motivated. With B2, use the best guess from neighbors in the last round

\[ B2 = \text{PN}.B2/\text{Motivation} \]

Agent each round would measure three \( P(CX) \) AND WILL CHOOSE THE strategy with Higher probability. Then will guess a number based on the strategy.

```
set rand random 50

set pc1 (b1 * s1)/ ((b1 * s1) + (b2 * s2) + (b3 * s3)) ; P(Cx)=Bx.Sx/\sum_{n=1}^{3}Bx.Sx

set pc2 (b2 * s2)/ ((b1 * s1) + (b2 * s2) + (b3 * s3)) ; probability of choosing one of the three strategies

set pc3 (b3 * s3)/ ((b1 * s1) + (b2 * s2) + (b3 * s3))

set pc1 pc1 * 100

set pc2 pc2 * 100 ; pc1+pc2+pc3 = 1 and pc1 pc2 pc3 are like 0.01 => pc1 *100

set pc3 pc3 * 100

set probability random 100

ifelse( probability < pc1)[ strategy1] ; one array with size 100 in order to set the right probability [ 

ifelse( pc1 < probability and probability < pc3) [ strategy2] [ strategy3

Figure D: fitness function in the model and agent-based system example
Innovation

Short memory

Value of number

with several projects

Long Shared memory

Optimum amount of projects

Which one would reach the desirable number more...
“Creativity is the production of novel and useful ideas in any domain. Innovation is the successful implementation of creative ideas within an organization”.

“Thus, no innovation is possible without the creative processes that mark the front end of the process: identifying important problems and opportunities, gathering information, generating new ideas, and exploring the validity of those ideas” (Amabile, 2004).

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