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LEADERSHIP USING VIRTUAL SIMULATION

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— Abstract—

It is estimated that American companies spend approximately \$14 million annually on leadership development. Although leadership skills provide a future competitive advantage, technology and engineering fields have concluded that technical skills are not enough to encourage companies to places of excellence. As a result, traditional methods of teaching leadership have been shown poor results. The absence of effective leadership development at work and to not apply appropriate practices of leadership in the business environment are some of the major causes of failure. Charles J. Pellerin from NASA illustrates a great method to analyze and structure the behavior of individuals and teams called the 4-D system. In this paper we present how to use and improve the 4-D system, based on the experience with cases that reflect different business environments learning. This learning process take place through the use of virtual simulation system, where humans can represent avatars and thus dramatize real situations. In addition, these avatars can be combined with others of the same characteristics that reflect behaviors (almost human) using Artificial Intelligence (AI). This methodology enables engineers, technologists, and computer scientists develop leadership skills in a synthetic environment.

Keywords

Leadership, virtual simulation, 4-D system, social behavior, engineering education, training.

Leadership skills are one of the traits necessary to succeed in professional life. Leadership can be acquired by experience (McCleskey, 20014, pp. 114-130). In a study conducted by the department of chemical engineering at the Universitat Rovira i Virgili in Tarragona, Spain, a conceptual framework that can be used to develop leadership skills, such as cooperation, interpersonal communication, and commitment to achieve objectives was introduced. The results of this framework also indicate that the effectiveness of student leadership was perceived as satisfactory (Özgen, 2013, pp.65-75). This study concludes that leadership can be taught at universities. However, technical courses are not enough to prepare engineering students and computer scientists for satisfactory performance in their future jobs. Engineering and computer science offers some skills that are solely based on techniques and this form of teaching is no longer sufficient for future work needs (Schuhmann, 2010, pp.61-69). This requirement to add more subjects to technology schools to incorporate techniques and thus empower students with leadership skills is in order to help them survive in the work environment. Because of the importance of leadership development, it has become an essential task for many organizations, such as the North American National Health Service (NHS) where leaders have the responsibility to become exceptional leaders (Jeavons, 2011, Pp. 24-25).

1.1 Leadership Development

In today's job market, leadership is considered one of the main factors in business management. This is fundamental to the existence of any organization. Therefore, this makes its development very essential in any industry (Laglera, *et al.*, 2013, pp. 7-16). In a recent study, five hundred managers were surveyed and asked to rank the main concerns of the human resources department. Concern for leadership development was rated as the highest (Gurdjian, 2014, p. 211). One study has shown that 21st century engineers and technologists need leadership and management skills before graduating because of the importance of these skills (Özgen, 2013, pp. 65-75). In a study by Farr, engineering programs have shown that there is a lack of leadership development and management skills in their students. By obtaining these skills an engineer will connect with his co-workers, internal and external clients, and be able to adapt to the current demand of outsourcing and global competition. Companies committed to maintaining a competitive advantage are investing in the education of their engineers and technologists in order to direct teams and combine know-how with business knowledge (Farr, 2009, pp. 3-8).

One of the most important publications in the field of engineering education in the last 50 years is the Grinter Report. This document called for the strengthening of basic sciences and the inclusion of six engineering sciences (solid mechanics, fluid mechanics, thermodynamics, transfer and speed mechanisms, electrical theory, and material properties) for all engineering curricula. In addition, emphasis was placed on the inclusion of very important skills such as teamwork skills, communication skills, leadership, acceptance of diversity, and ethics and morals in curricula (Farr, 2009, pp. 3-8).

To study these leadership skills, a team from the University of Central Florida (UCF) studied the most important skills in this area. One of the instruments for doing this was a survey of two types of participants. The first group is engineers who worked in the field of leadership for many years and the other group is made up of students of engineering and technology. The study revealed that participants believe that team building / teamwork, personal development / continuous learning and communication skills are the most useful factors in a leadership position. In addition, the surveys helped to sort out the leadership characteristics that the participants considered to be the most important. Participants rated characteristics such as being honorable, credible and determined with the highest score, while the skills like being visionary were rated as the lowest score. The study also concluded that it is essential that all universities should develop an engineering leadership program to improve these skills such as the ability to control a group, critical thinking, how to be visionary and inspiring, a good communicator, and a creator of effective work networks. Finally, the study concluded that by obtaining the above skills, engineers and technologists may be able to handle the challenges of future engineering work (Crumpton-Young, 2010, pp. 10-21).

Engineering faculties have been putting a lot of effort into teaching students, both in the knowledge of theory and in the techniques required of engineers in the real world. Schuhmann believes, however, that the problem is that these types of skills and competencies are no longer sufficient for success. Many skills like communication, project management, and leadership are becoming more important than ever. When it comes to developing new products, there is a great demand for the ability of engineers to work and direct groups of people with diverse backgrounds and cultures. These areas include non-profit and government sectors. This responsibility will have a greater emphasis on postgraduate students (Schuhmann, 2010, pp.61-69). It is important that the next generation study leadership more than before. The demand for jobs has changed and puts pressure on the education system to make changes in order to keep up with market demand. This demand has been changing due to the traditional change of the structure of the companies. Companies are no longer operating in a region,

nor manufacture their products in one place. These days, the different parts of the product are designed in several countries. Afterwards, all parts are sent to a certain place in the world and are put together for the final product. Accounting and financing processes sometimes recommend that companies relocate their production lines to different countries to reduce labor costs. Many studies have recommended that there is a need to modify curricula for the purpose of creating leaders who can bring effective results to companies. In order to achieve this goal, an exceptional reform of education must take place (Kotnour et al., 2014, pp. 48-57).

1.2 Reasons for the failure of leadership development

The traditional method of leadership teaching is not providing great results. In the winter of 2014 McKinsey Quarterly report, one study pointed out that for years organizations have lost huge amounts of money in developing leadership to nurture new leaders. The cost of some leadership development programs can reach \$ 150,000 per person (Gurdjian, 2014, p.121). With this huge investment in leadership development, 500 managers were surveyed to rank their main concern about human resources; Leadership development has been ranked as the highest priority (2014, p.121). As a result, the study identifies four reasons why there is a failure in a leadership development program. These reasons are as follows (2014, p.121) .

1. There is no correspondence between leadership skills and specific features to the context that occupies us.
2. Leadership development is not integrated with work.
3. Fear By researching the mental models of leaders and
4. There is no way to monitor the impact of improvements over time.

Therefore, using virtual simulation in leadership development will help overcome the second reason that makes the development of leadership fail.

1.3 Virtual simulation

The simulation process can represent the environment or the interaction (Putman, PG, 2013). Simulation can be defined as several activities in which the best solution to some problem can be found and identified. "The simulation game is a simplified experiential environment that contains sufficient plausibility or the illusion of reality, to include real-world responses, for those involved in the exercise." (Siewiorek, 2013, pp. 1012-1073). When it comes to using simulation in research, there are huge benefits. When simulation is used, the analytical approach becomes

simpler, in order to answer several research questions in any field of study with the purpose of elaborating an accurate conclusion. Without the use of simulations, researchers might not be able to answer research questions carefully, accurately, practically and morally (Cheng, A., *et al.*, 2014, pp. 1091-1101).

Use of simulations and games began in the 1950s. Since then, the use of simulation has increased exponentially in education (Showanasai, P., 2013, pp. 71-91). The use of simulations in education is mainly to handle very important objectives, such as (Showanasai, P., 2013, pp. 71-91).

1. Improve the competencies for decision making.
2. Improve teamwork.
3. Encourage thinking and reflection skills.
4. Learn to use knowledge as a tool for problem solving.

There are some empirical studies that recommend simulation-based education as a great method that can help students understand (pp.71-91). When researchers were able to design an exact computer simulation, it made it more possible to create a form of virtual reality (pp.71-91). Therefore, well-designed simulation software has the potential to mimic any real scenario. Also simulation games can be used extensively in leadership training and other professional skills that require working environments (Siewiorek, A., *et al.*, 2012, pp. 121-135). There are many advantages of using simulation in education. Some of these advantages are that students can live and feel the complexity of real-life scenarios. In current curricula at many universities, students will not have the opportunity to handle the complexity of real challenges. However, education that includes simulation would be able to introduce real challenges in the environment to students and make them face those challenges, both in individual and team settings. In addition, simulation in education helps students share the same experiences and offers opportunities to open discussions. Simulation encourages students to take risks and do more exploration for the sake of learning new ideas and techniques (Siewiorek, A., *et al.*, 2012, pp. 121-135).

1.4 Use of Virtual Simulation in Leadership

Business leaders have realized the importance of virtual simulations in education. They have found that it helps to reduce the cost and time in the preparation of the future leaders without much complexity. In addition, virtual simulations can mimic real business operations and make workers interact with their leaders using remote communication. Companies such as Microsoft, Dell and General Electric have recognized the usefulness of these

practices. They recognize the benefits to help meet corporate goals (Conine, 2014, pp. 17-28).

2. METHODOLOGY

To carry out this study on leadership scenarios, we used simulation software and the 4-D system. The software used to perform the simulations uses a virtual environment consisting of avatars that communicate with other avatars. This software is known as Military Open Simulator Enterprise Strategy (MOSES). The 4-D system will be used to determine leadership types and measure the transformations that we can achieve.

2.1 Virtual World Development Platform (MOSES)

The MOSES project (Military Open Simulator Enterprise Strategy) is an exploratory effort designed to evaluate the open simulator's ability to provide independent and secure access to a virtual environment. "(MOSES Project) MOSES is controlled by the Simulation Technology Center training of the USA Army Research Lab. It is an open simulation source available to the public, for both industry and academic purposes. For the purpose of scripting in MOSES, the "Linden Scripting Language" (LSL) is normally used. LSL is a simple language that allows the user to connect the behavior to the object. According to (Brashears, A., *et al.*), "The text of the script is compiled into an executable byte code, just like Java. This byte code is re-executed inside a virtual machine in the simulator. Each script receives a portion of the total time of the simulator assigned to the scripts, so a simulator with many scripts would allow each script-individual less time instead of degrading their own performance. In addition, each script runs inside its own piece of memory, preventing scripts from scripting in the memory of the protected simulator or in other scripts, making it much more difficult for scripts to block the simulator".

2.2 How does NASA build teams?

Charles J. Pellerin has created the 4-D system based on his experience at NASA. As shown in the following figure, the 4-D system shows a classification of the four styles of leadership. These styles are represented by four colors: blue: representing the visionary, green: representing the cultivator, yellow: representing the inclusive and orange: representing the director / coordinator par excellence (Charles, PJ, 2009).

Figure 1. 4-D system

Pellerin described his contribution to the development of the "4-D system" leadership as follows (Charles, PJ, 2009):

- Emotional Dimension and Perception (Inclusion): It is based on the emotional experiences that come from relationships with other people. The color of the inclusive dimension is yellow.
- Logical and Intuitive Dimension (Vision): Encourage thinking about possible futures. Visionary leaders often create what they want. The dimension of the vision dimension is blue.
- Logical Dimension and Perception (Direction): This dimension is about taking actions and directing others. Some actions of this type of leadership are management, planning, organization, direction and control. The color of this dimension is orange
- Emotional and Intuitive Dimension (Cultivate): It recommends deep feelings and the achievement of a better world, and caring deeply for other people. The color of this dimension is green.

3. DISCUSSION AND CONCLUSIONS

The following is a case study in which the above is put into practice.

3.1 Case study: Simulation scenario for leadership development at Starbucks

On March 19, 2008 almost 6,000 Starbucks shareholders met at McCaw Hall in Seattle for a meeting annual. During that time, the CEO and founder of the company, Mr. Howard Schultz, appeared to the audience and was praised with loud applause. This great leader addressed them with an incredible and inspiring speech that included recognition of problems and the promise of a great investment. Part of his inspirational speech was "I humbly acknowledge and share both your concern and disappointment at the company's performance and how it has affected your Starbucks investment" (Starbucks Coffee Company, 2008). In this scenario, Mr. Schultz's leadership quality is critical, which is virtually simulated in all dimensions. All engineers who go through this virtual leadership development exercise feel in the real environment and can practice how to get to know other people who have to do leadership actions and listen to inspiring leadership speeches.

Figure 2: Starbucks Virtual Meeting Using Avatars



Figure 3: Starbucks Virtual Meeting Using Avatars .



Figure 4: Starbucks Virtual Meeting and 4-D System.



At the Starbucks meeting, Mr. Schultz unveiled six major changes in company strategies for leading the change towards an ever better future for it: Three strategies directly related to their coffee and espresso, two Starbucks-related strategies and relationships with their customers; and one about their customer rewards program (Starbucks Coffee Company, 2008). These strategies indicate leadership style. We can classify the leadership style based on these decisions in blue, green, yellow or orange by simulating these events, since as shown in figures 2, 3 and 4 attendees (students with avatars representing Starbucks executives) pass through all stages of the meeting and discuss important issues with regard to future strategies that were of concern to Starbucks. These strategy implementation discussions will help future engineering leaders to observe examples of real leadership. Also by performing different roles in the company, engineers can assess their leadership ability to lead a change in certain scenarios and make their audiences, employees and the general public happy, satisfied and confident to move on to the next achievement. The scenario replicates a virtual "Starbucks Company" board meeting and discusses different financial situations like

- Starbucks made a big profit
- Starbucks lost some market shares
- Starbucks lost a lot of market shares
- Starbucks had a big loss and management wants to file for bankruptcy
- Starbucks has normal operation

After creating a scenario, the student will be asked to study the proposed and current Starbucks scenario and will be asked to address the hearing and come up with various initiatives to address the current situation proposal.

After the student's speech (representing an executive role through the avatar), the public will ask several questions about how these initiatives could address the current status of Starbucks and give followers some kind of satisfactory expression of their investment. The leader will be judged based on treating both the situation and being able to convince the audience and their employees. Based on the actions of the leader, he speaks and addresses the questions of the audience; he is classified as a blue, green, yellow or orange leader based on Pellerin's leadership classification. This classification is taken from the actual treatment of the leader in a real live example. After the student completes their leadership role on the stage and records their leadership style, a leadership specialist will show the styles they lack. Afterwards, the engineer shows that people who have other leadership styles could decide on that specific scenario. This simulation gives students the opportunity to observe an example of a real-life case in a virtual world and therefore gives future engineers and technologists the opportunity to make some decisions based on the current situation and then identify their style of leadership, as well as the leadership styles they lack.

4. THE FUTURE OF OUR INVESTIGATION

In the future every company should create a unique leadership program, and research could focus on choosing the best program for each company separately. Also the investigative work could focus on leadership programs on how to select the best program for a specific field of study. For example, in the article entitled "Effective Leadership Development in a Civil-Engineering Culture: Finding the Balance between Experience and Experiment", the author expressed the need to have a leadership program within the civil engineering profession to help companies establish their own internal program for the promotion of future generations of civil engineering for the study and practice of leadership, and become successful leaders (Kenner, 2004: 105-109).

Our future research focuses on the use of different technological methods in the development of leadership. Although simulation software can help in coaching the same, it was found that students focused less on financial goals and customer goals than the other styles. Thus, through the use of other techniques, researchers think that they are able to solve this problem more effectively and efficiently (Gurley, 2011, p.15).

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