EFFECTIVENESS OF TRAINING THROUGH THE IMPLEMENTATION OF A VIRTUAL REALITY COMPUTER LAB

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ABSTRACT

This article presents an analysis for the proposal of a virtual reality lab to improve the effectiveness of training in all types of manufacturing and service corporations; the virtual reality lab would allow employees to learn in a risk-free environment, and companies would significantly improve their training outcomes, reducing costs associated with traditional training methods by allowing for a safe and controlled environment and fostering innovation. The benefits of a virtual reality lab go beyond mere training; they encompass safety, cost reduction, and improved employee engagement. Case studies from diverse sectors such as healthcare, aerospace, manufacturing, retail, and emergency services illustrate the broad applicability of virtual reality technology. By leveraging immersive experiences, companies can transform their training programs, leading to better-prepared employees and ultimately improved organizational performance.

Keywords: Virtual reality, effectiveness of training, manufacturing and service corporations.

1. INTRODUCTION

Over the past few years, various companies (Facebook, Google, Amazon, Sony, etc.) have been working on developing virtual reality-related products; these developments have allowed the products needed for virtual reality to become increasingly affordable and easy to use. A virtual reality lab is a specialized facility equipped with technology that simulates real-world environments and situations. This immersive environment allows employees to interact with 3D representations of objects and scenarios, enhancing their learning experiences. By using virtual reality, companies can create customized training programs that replicate the complexities of real-world tasks, increasing skill acquisition, improving knowledge retention, and generating higher performance.

The center of a virtual reality lab lies in advanced computer modeling and simulation systems. These systems use state-of-the-art software and hardware, including high-performance computers, graphical processing units (GPUs), and virtual reality headsets. The integration of motion tracking technology allows for real-time interaction within the simulated environment, making the experience more realistic, and as virtual reality technology continues to evolve, it becomes increasingly feasible for companies to implement these systems into their training and development programs.

2. OBJECTIVE

To display a comprehensive analysis for the proposal of a virtual reality lab to improve the effectiveness of training at all type of manufacturing and service organizations; where this lab of virtual reality incorporates a computer modeling and simulation system (virtual reality

program) that enables employees to interact with an artificial three-dimensional (3-D) optical or other sensory environment to integrate and update their knowledges, skills and practices during training provided at any corporation.

3. SIGNIFICANCE OF THE STUDY

The following examples illustrate the use of virtual reality:

1. Manufacturing. Here manufacturing companies use virtual reality to train employees in the operation of complex machinery. By allowing workers to interact with virtual models of machines, companies can minimize the downtime associated with traditional training. Employees can become familiar with equipment operations, maintenance procedures, and safety protocols before starting actual manufacturing operations.

2. Remote medical operations. This is the case of one of the most complicated operations in surgery, such as prostate removal, which could be performed using a robotic arm operated by a doctor 20 thousand kilometers away from the patient. This procedure was performed by Dr. Zhang Xu, surgeon and director of urology at the general hospital in Beijing; The doctor was in Rome Italy, while the patient was in Beijing China. This procedure carried out on June 7 of this year but was carried out thanks to a virtual reality console which allows the patient to be seen in real time and in the same way, thanks to the help of the 5G network, there are no delays in arm movements and real feedback from the patient [4]. In the hospital industry: There are numerous other cases of the use of virtual reality for the training of doctors and nurses [9].

3. Counseling in occupational psychology
The treatment of certain personality problems in employees who suffer from some type of behavioral disorder or who suffer from certain phobias that can affect their productivity; here employees are taken on virtual tours where they learn to increase their self-esteem and improve their work productivity.

4. Industrial fire, accident simulation, and nuclear reactor operation. Here support and security teams (firefighters) practice techniques in high-risk situations with a high level of realism. The logistical, technical and financial requirements necessary to implement such a simulation are also evaluated to prevent accidents, as well as the benefits of virtualization in terms of cost and risk reduction. Besides, employees who need to review the operation of a nuclear reactor could do so virtually without the risk of being exposed to any source of radiation.

5. Project design. The use of versatile software such as SAP2000, which is used for a wide range of projects, from simple buildings to complex bridges. It offers non-linear analysis capabilities and integrates well with other programs for 3D structural analysis and design [1].

6. Aerospace operations: The aviation industry has long used simulation for pilot training. Virtual reality takes this a step further by offering highly realistic flight simulations that replicate various flight conditions and emergency scenarios. Pilots can practice their responses to malfunctions, adverse weather conditions or other unexpected situations without leaving the ground, thus improving their preparation for real flights.

7. Remote control of robots: This is the case of the workers at NASA's Jet Propulsion Laboratory (JPL) in California, who operate the Curiosity robot on Mars from the operations room.

8. The technical potential of this laboratory is unlimited, for example, employees from the Molecular Biology department who need to review virology collections of viruses or other pathogens could do so using virtual reality.

9. Civil engineering employees can use virtual reality to test the operation of machines used to measure the tension of steel samples and the compression of solid cement models.

10. Also, in the export and import operations, employees that have been taking training courses of transportation and logistics received interesting questions from their co-workers; here is an example: Can we visit industrial parks (concentration of maquilas or maquiladoras) and logistic fields (concentration of trucking industries) to review the activities for export and import of commodities?
In other words, the employees were expecting, for example:
1. To see in action and to learn about the merchandise classification via the harmonic system.
2. To review and to learn about foreign trade documentation to comply with all government requirements.
3. To observe and to learn about export/import traffic forwarding.

Besides, there are many more real problems that the employees are facing during and after taking training courses in international trade and logistics at any corporation.

At present time, due to security reasons and risky situations such as the COVID-19 employees cannot cross the US-South border to visit the industrial parks and logistic fields.

Although, some of the international maquiladoras (**assembly plants** [11]), and trucking industries have headquarters in US: the problem (lack of access) remains, because their directors and managers do not show availability of time to attend visits, and/or they do not want to share experiences about all the official documents used in their export and import transactions.

In addition, there are geographical barriers that greatly hinder IN-PERSON visits to acquire knowledge, skills and practices, so VIRTUAL visits [13] represent the optimal solution.

4. MOTIVATIONS

1. COVID-19 Restrictions on travelling and attending classic traditional training courses should be taken as an opportunity for innovation in training styles.
2. The incorporation of US Veterans into the civil life represents a great opportunity for all US Corporations that will be offering “Special Programs reinforced by Virtual Reality” [3].
3. Training courses *supported by a computer lab of virtual reality* [8]. may be pondered as the First Special Program at any organization.

Example, for employees whose main goal will be to pass the **Customs Broker License Exam:** The corporation needs to offer something better (a new technology) than the traditional training style, for instance a computer lab of virtual reality for learning export and import operations represents the optimal solution to reach this goal.

Table 1. Explanation: Employee learning retention rate: A study conducted by the University of Maryland found that participants in virtual reality training retained information up to 70% better than those trained through conventional methods [12]. Moreover, an analysis by the

International Journal of Training and Development reported a 90% satisfaction rate among employees (satisfaction metrics) who participated in virtual reality training programs, compared to 60% satisfaction with traditional methods [12].

Table 1. Training methods comparison

Index	Training method	
	Traditional	Virtual Reality
Employee learning retention rate	40%	70%
Employee satisfaction rate	60%	90%

5. THEORETICAL BACKGROUND AND RESEARCH METHOD

Plan in seven steps:

1. Identify industrial parks and logistic fields for potential export and import operations.
2. Identify export & import key problems and areas of opportunity.
3. Prepare a project plan (Tabular and Graphical Representations).
4. Create an inventory list (data collection) of export and import transactions.
5. Review & select hardware and software of virtual reality.
6. Design the computer program of virtual reality for the learning of export and import operations.
7. Use a project milestone to track accomplishments.

Information gathering steps

A. Develop an initial approach for transportation and logistics operations [10].
B. Virtual information pretest.
C. Revise virtual information as needed [7].
D. Operations review for 90 days.
E. Test and error checking.
F. Virtual information filtered & updated [6].
G. Virtual information delivered.

Preliminary Design Schedule of 23 to 25 weeks

Some of the following activities overlap on time**:**
I. Identify industrial parks and logistic fields for potential export and import operations: 4 to 5 weeks.
II. Review & select hardware and software of virtual reality: 3 to 4 weeks [5].
III. Onsite visits: Virtual information (data) collection (filtered & ordered): 10 to 12 weeks [13].
IV. Design the virtual reality (VR) program: 4 to 5 weeks.
V. Test the VR program: 2 to 3 weeks.
VI. Reporting: Submit a copy of a complete reviewed project to the Operations Management Project Design Director's office before ending the year
VII. Feedback for upcoming research: 1 to 2 weeks.

Table 2. Approach Summary

Steps Summary				
Initiate Project Design	**Study Design**	**Fieldwork**	**Images Analysis**	**Recommend**
Develop work plan	Design pretest	Create and reproduce images	Assess images adequacy	Provide guidelines for training improvement
Formulate action plans to address study objectives	Prepare images analysis plan	Pretest the images	Evaluate strengths & weaknesses	Present findings for Implementation and reassess implementation

6. PRELIMINARY COSTS

Preliminary costs for setting up a Virtual Reality (VR) lab can vary significantly depending on the scale of deployment and the quality of the equipment selected. Below is a breakdown of initial costs for a median size VR lab (Table 3).

Table 3. Preliminary costs for a median size VR lab

Equipment	**Preliminary Cost (USD)**
VR headset (10 units)	5000 - 10000
Motion tracking sensors (10 units)	2000 – 5000
High-performance computers (10)	15000 - 30000
Annual Software licenses	3000 – 10000
Audiovisual equipment	4000 - 10000
Total	**$29000 - $65000**

7. CONCLUSIONS

The costs mentioned in Table 3 are an initial investment that can be recovered in the medium and/or long term by systematically reducing the costs of traditional training.
Virtual reality as a tool is a huge advantage for employees training in all types of organizations and/or corporations. It allows for being in a safe environment and making mistakes without the cost that a real process would entail. In addition, with the investment that many companies are making in this area, the accessories needed to have a virtual experience are increasingly more accessible from an economic point of view [2].

Thus, we can conclude that Virtual Reality is a technology used in training and tactical training for manufacturing and/or service operations that creates simulated three-dimensional (3D) environments to replicate scenarios in risky situations. In other words, Virtual Reality allows employees to train in realistic conditions without the inherent risks of live training.

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