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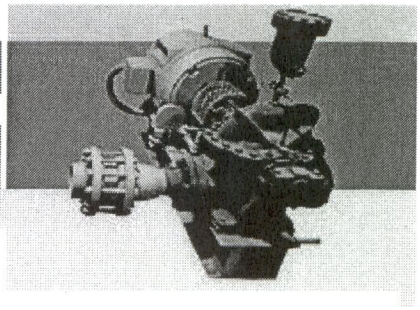

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Journal of Engineering Systems Simulators

Volume 1 Number 4 Winter 2004

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In This Issue

Welcome to the inaugural issue of the Journal of Engineering Systems Simulators. This journal was created to specifically present research advances and creative applications in the areas of engineering, operations, and management related interactive multimedia training simulators. By focusing on the design, development, and use of simulators rather than specific subject areas, we hope to provide more fertile ground for the exchange of information.

In this issue, you will find three technical papers, one methodological paper, and two descriptive papers. Two of the three technical papers focus on the design and development of equipment type training simulators. The third focuses on an engineering design process software training simulator. The methodological paper discusses a new approach for simulation modeling analysis. Lastly, the two descriptive papers present information on engineering application education training simulators. The papers published in this issue should provide readers with guidance on the content of typical journal manuscripts. Prospective authors may review the submission instructions accessible from the main Journal webpage.

As a special feature of the Journal, a number of these papers are accompanied by the simulators described in the manuscripts. We hope that these will be of utility above and beyond the information presented in the papers. While every effort has been made to insure the proper functioning of the simulators, it is inevitable that some reader's systems will have difficulties with the simulators. We suggest that you first contact the paper's author for assistance should these types of problems arise.

Since publicly announcing the Journal, we have received many inquiries into subscribing and submitting manuscripts for publication consideration. There have also been inquiries into publishing a hard copy of the Journal. This possibility is currently under investigation. Lastly, we are in the process of establishing contact with a number of indexing services. This should provide additional value to both journal authors and readers. All of these activities and responses have been very encouraging and we look forward to the continued development and publishing of the Journal.

Erick C. Jones, Executive Editor

Christopher A. Chung, Managing Editor

Journal of Engineering Systems Simulators

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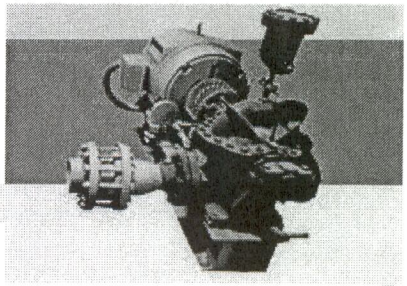

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Journal of Engineering Systems Simulators, Vol. 1 No. 4 Winter 2004, pp. 44-51.

A TRAINING SIMULATOR FOR RADIO FREQUENCY IDENTIFICATION EDUCATION

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Abstract

Over the last decade new computerized training technology has become more popular due to the fact that it has become more user-friendly and cost effective than in the past. This technology is typically called Computer Based Training (CBT). Various studies have shown that CBT's are more effective than other training methods in various fields. There are many different software tools used to design CBT's, Digital Simulator (DS) is one of the more modern and effective software tools. This exploratory research seeks to show the effectiveness of a DS in the training of engineering students on Radio Frequency Identification (RFID) technologies.

Key Words

Radio Frequency Identification, training simulator

1. Introduction

Radio Frequency Identification (RFID) is a technology that uses electromagnetic tags to uniquely identify and track a product, vehicle or person. RFID may, in the near future, replace the metal tags and bar codes that are widely used in industry. The advantage of this technology is that it does not need direct line of sight for of the tag to identify the product. Both Wal-Mart and the US military have already mandated their hundred largest suppliers have their entire inventory in cartons and pallets be equipped with unique passive RFID tags by January 2005 (Boyle, M., 2003).Further, MasterCard and American Express have been testing RFID enabled credit cards. Mobil has been using RIFD based "speed pass" since 1997. Some high-end cars now come with RFID "immobilizer" circuits that won't let the cars start unless the correct RFID enabled car key is in the ignition. Companies like Parco integrates RFID into their asset based management system for there real-time location system in order to track items in proactively. The system allows hospitals and clinics to track the status and exact location of patients, staff and essential equipment.

The emergence of this technology leads to the need of highly trained personnel. Training can be provided with the actual equipment. Since RFID equipment is costly, effective traditional training programs may be expensive. For example is when Ohio Governor Bob Taft presented a $63,000 check from the Ohio Department of Development's Ohio Investment for a training program by The Kennedy Group (Material Handling Management, 2004). In this paper we propose using a Digital Simulator that will provide a cost effective and economic training equipment system for the RFID technology.

2. Previous Research:

A literature search was conducted to identify research of similar work. It resulted in large number of research which employed DS in effective training in various other fields. For example the U.S. army has large number computerized training programs in use (White, Carson, Wilbourn, 1991). U.S. Air force uses digital flight simulators to train their pilots (Hess, 1995). These simulators are not only found their applications in the defense systems, but also used widely in other industries. Operators in steel companies are trained with CBT's and students in academic settings use it in class and through distance learning. Previous research has demonstrated CBT's applied in remote training in industrial fields. The literature search showed a limited number of DS in the RFID field (Kennedy Group Inc, 2004).

RFID is a technology that has been around for over 20 years but is now coming of age in today's society. The need to understand the RFID technology has also become important due to mandates by the Department of Defense and Wal-Mart.

This research has categorized the areas for training for RFID into ten categories or constructs. The training areas are listed as within the chapters on the simulator and they test the following constructs; industry applications, tags, antennas, transponders, readers, frequency, EPC standards, other standards, and general workings. The most common industry applications are related to placing tags on cartons and pallets so that they can be tracked through the supply chain. Tags are classified as active and passive based on the power. Tag is the one which contains the information about the product. The transponder is the electronic identification (EID) tag itself, often serving as the female button attachment for a traditional visual identification tag.

The reader, also called as transceiver sends the electronic signal to the transponder that provides the power for the transponder to send the signal back to the reader with the in formation contained in the transponder's electronic circuit. Readers can be powered by batteries or plugged into a traditional power supply. The EPC is an Electronic Product Code. It is the code that is used to locate and identify the products.

3. Objective

The main objective of this research is to develop an effective training method to train the personnel on the RFID technology. Computer Based Training (CBT) is one of the latest and modern techniques used to develop a cost effective and user friendly training. Creating a CBT using a Digital Simulator (DS), is an effective, cost efficient way of training. We hope to demonstrate how using a DS is more effective than traditional on the job training techniques.

4. Methodology

RFID Training simulator was developed in Macromedia Authorware 7.02. This software package is designed for the development of interactive multimedia mission critical training applications. In an Authorware application, different logic, text, graphic display, sound, and video clip icons are arranged into a flow line to create the programming sequence. This simulator explains the basic components of RFID, Standards, working, etc. The training module has a background audio explaining and giving instructions to the user. It also has interactive pictures. Figure 1 illustrates a partial screen capture of the Authorware program code.

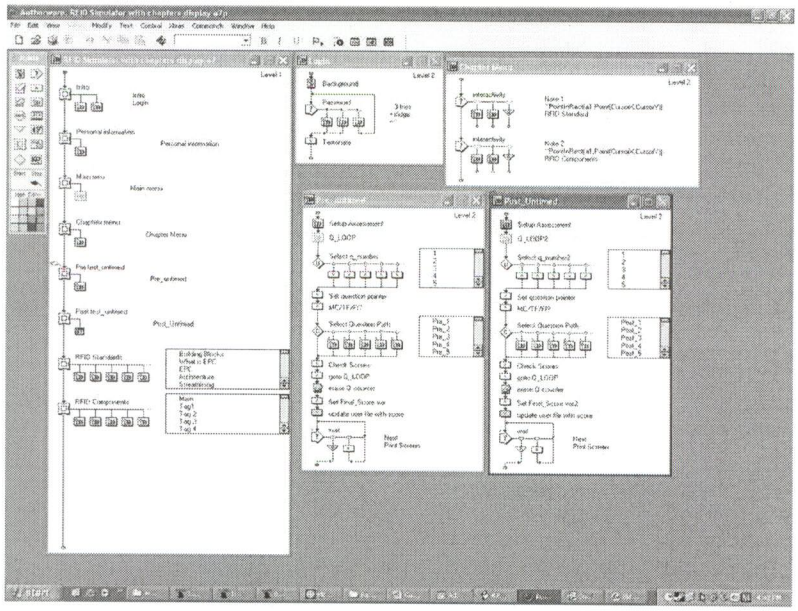

Figure 1: Partial Screen Capture of Program Code

5. Model Description

The flow chart of the entire RFID components is illustrated in figure 2.

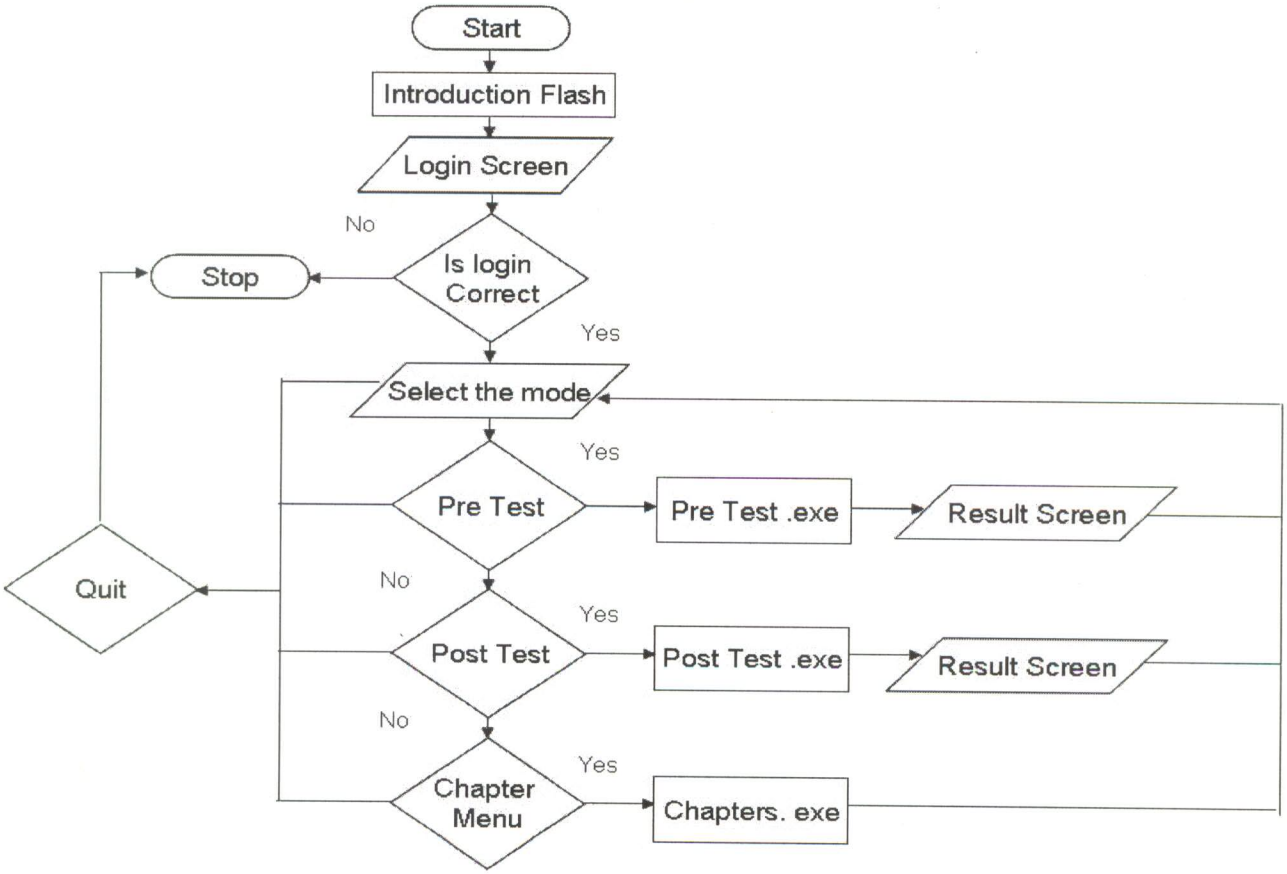

Figure 2: Menu System

On running the RFID simulator, the program will start an introduction flash movie. After the introduction, the user is required to enter a password in order to restrict the access of the program to certain users (figure 3). If the user enters the wrong passwords more than three times, the program will be terminated. Once the correct password is entered the program will take the user to a screen where they have to enter their username. The test scores of the users will be saved to a text file using their username as the filename. The next time the user runs the program they will be able to see their previous scores and keep track of their progress.

The simulator will enable the introduction executable file which will run the credits. Next the simulator takes the user to the selection menu (figure 4), where the user can make choice between the tests and training. The selection menu gives the user three choices namely: pre test, chapters menu, post test. The pre and post tests consist of 40 questions which are appear in randomized order on each run.

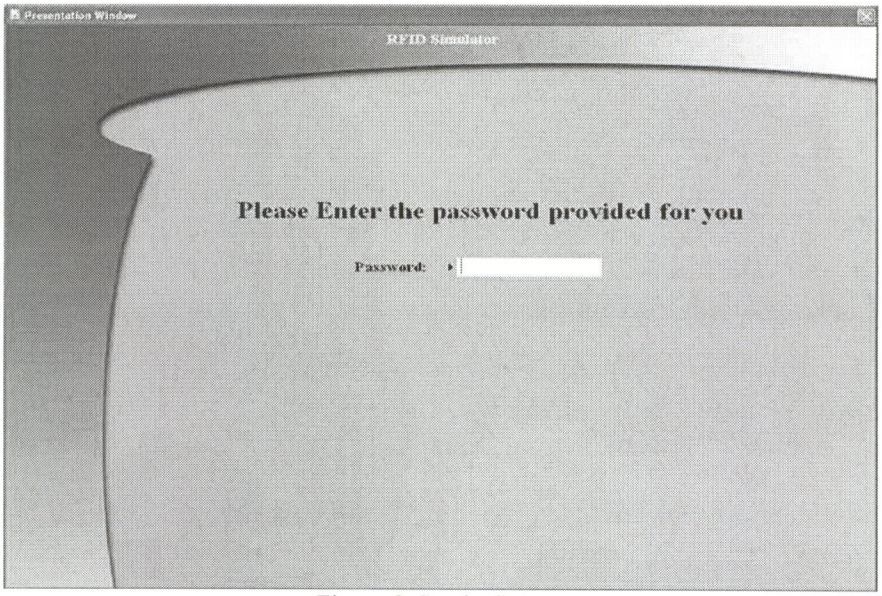

Figure 3: Login Screen

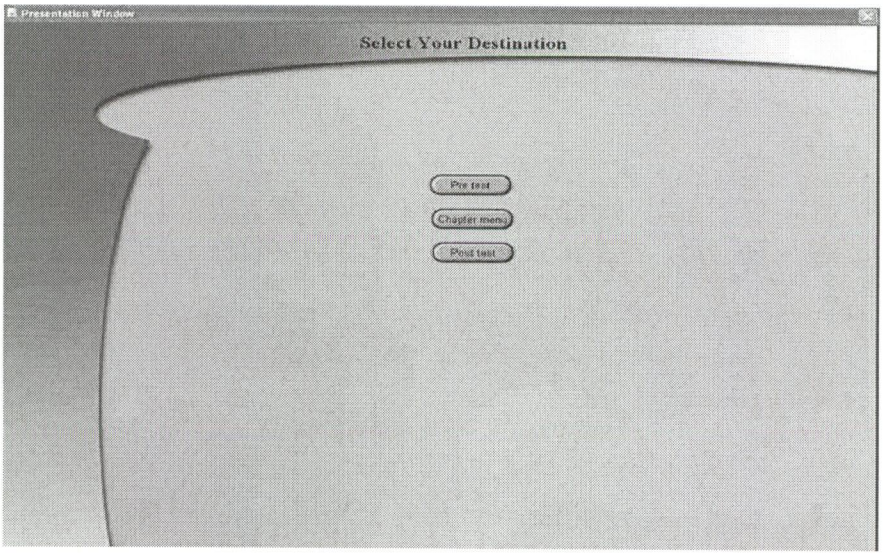

Figure 4: Test and Training Selection menu

The test results screen will present the score obtained in the test and provide the users with option of printing. The results are saved to the file and available for the future reference.

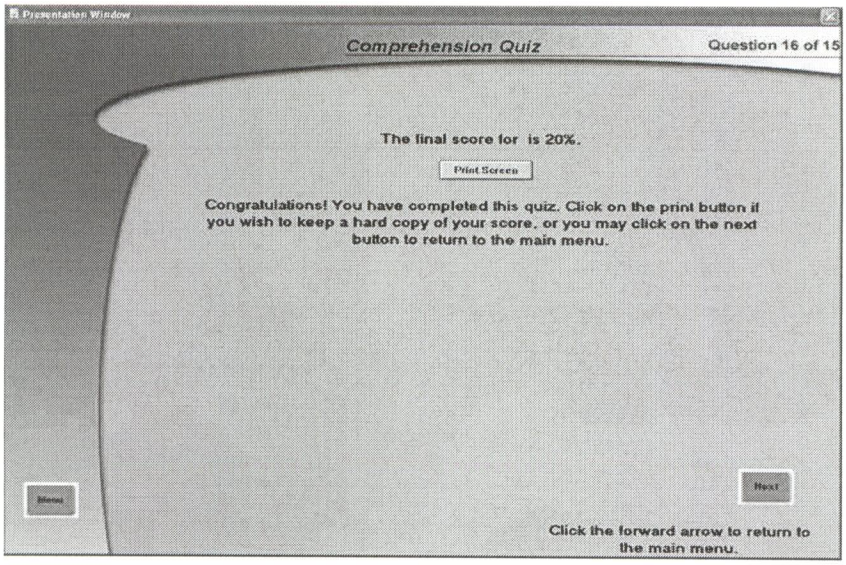

Figure 5: Test Results Screen

Once the training menu is selected it takes the users to the chapter's selection menu. The users can navigate to any of the chapter's of their choice or can run in sequence. When the cursor is pointed to a particular chapter, a menu displays showing the contents of the chapter (figure 6), from where the user can navigate to a particular topic in a chapter.

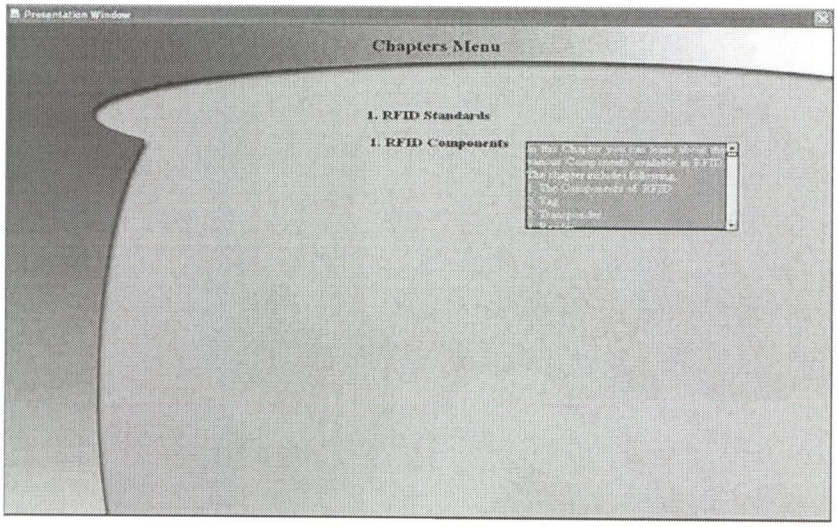

Figure 6: Chapter's selection menu

The chapters include the RFID standards, RFID components. The RFID components chapter explains the users about the standards that are being used in manufacturing, practicing RFID technology. It explains the user from the basic of the standard to the global standards. There are background voices explaining the chapters in which the user can control the volume of the sound, and can repeat the description again if required. The users can pause the sound, and restart and continue from the same position. The explanation is also displayed in the text, so the users have the choice of either audio or visual description. The RFID component chapter covers the various components in the RFID, their classifications, working principles, variety of the applications. The chapters include the pictures of the actual components, which helps the users to see the real components and increase their understanding.

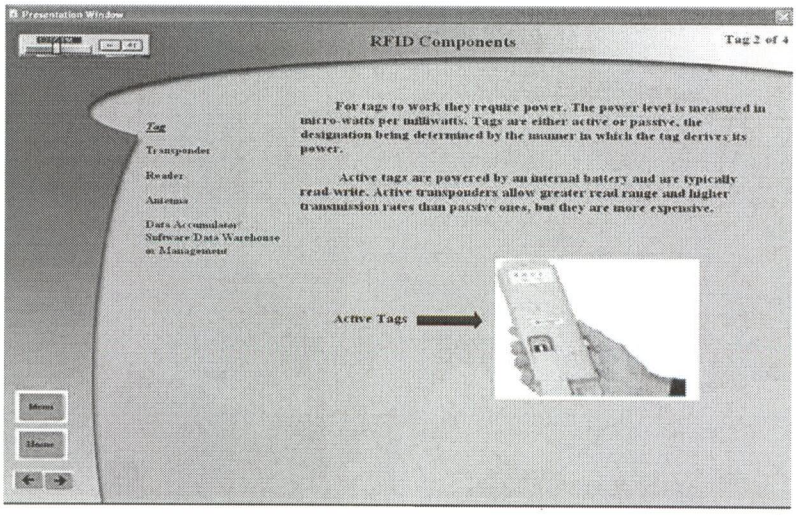

Figure 7: RFID Component – Tag

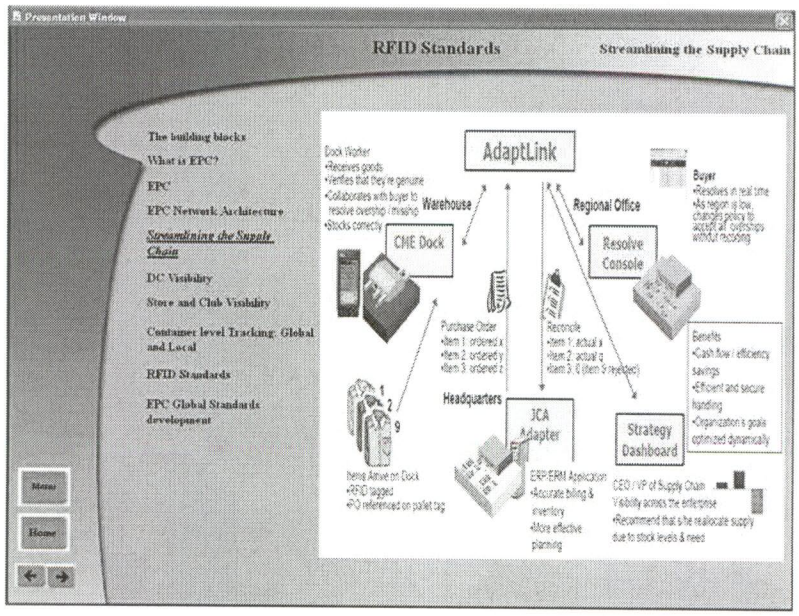

Figure 8: RFID Standards – Stream lining the Supply Chain

6. Future Work

Verification is the process of ensuring that a model operates as intended. The Authorware trace capability will be primarily utilized to perform verification debugging. Validation is the process of ensuring that a model represents reality. The simulator will be examined for both subjective face validity and objective quantitative training validity. Face validity is an assessment by domain experts that the model input and outputs appear reasonable. Face validity will be achieved with the help of expertise group.

Training validity is a quantitative measure of whether the simulator represents reality well enough that the user exhibits improved user performance in the task that the simulator is designed to simulate. To assess the training validity of the DS, a questionnaire will be developed. The questionnaire will consist of a group of questions that test the functional knowledge of

the respondents RFID knowledge. The questions are grouped together into constructs or categories so that these functional areas can be validated.

The test development process consists of designing the test, evaluating its reliability, and assessing its known group validity. The test will be created in two equivalent halves in order to determine its split half reliability. The split half reliability is calculated by determining the correlation between the two halves and then using the following equation:

$$\text{Re}\,liability = \frac{2 \times correlation}{1 + correlation}$$

The Reliability is expected to be more than 0.70 which is the generally accepted minimum value. Known group validity will be determined to ensure that the test instrument is able to measure the level of knowledge of individuals taking the test. To determine the known group validity, the test instrument will administered to 10 RFID expertises from the Universities and industries. The expertise group will be assumed to be knowledgeable about the RFID and the 10 students will be assumed not knowledgeable. The mean and standard deviation of the scores obtained by the expertise group is expected to be higher than that of the students. An F test and independent t – test will be performed to determine if the test could distinguish between the levels of knowledge of these two groups. The F test result will indicate that variance independent sample t-test will be the appropriate for comparing the means of the two groups:

$$t = \frac{\left(\bar{x}_1 - \bar{x}_2\right)}{\sqrt{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}} \sqrt{\frac{n_1 n_2 (n_1 + n_2 - 2)}{n_1 + n_2}}$$

Where $\bar{x}_1, \bar{x}_2$ are sample means, s_1^2, s_2^2 are sample variances, and n_1. n_2 are sample sizes. The resulting t statistic will be statistically significant at an alpha level of 0.05. This result will indicate that the test instrument will be able to distinguish a subject's level of bomb threat knowledge.

The training validity will be assessed by administering a pre-test and post-test after taking the training through the DS. The mean difference between the post-test and the pre-test will be calculated and it is exp. The paired t-test will be utilized to assess the increase in knowledge imparted using the simulator for training:

$$t = \frac{\bar{x} - 0}{s/\sqrt{n}}$$

Where $\bar{x}$ is the mean of the score differences, s is the sample standard deviation of the core differences, and n is the number of paired observations.

In future we indented to bring in timed and interactive tests. In addition to that the users will be able to see and browse their previous tests and scores.

7. Expected Results

We propose that we there will be a significant difference in the performance on the pre-simulator and post-simulator tests. This will indicate the Digital simulator has been effective in training personnel on the basics of RFID. Next, we hope that the post-simulator scores are not significantly different than the scores of an expert group on RFID. This would indicate that after taking the simulator that people unfamiliar with RFID could use the DS to improve their understanding of RFID to that of an expert on RFID. If this research is proven valid than the RFID simulator could be considered a cost effective solution to RFID Training. The publication of the results and the Cost/Benefit analysis of the Simulator will expected to present in this journal in the future.

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