

NAVAL POSTGRADUATE SCHOOL



CS 4203 STARTUP ANALYSIS CAPTURE THE FLAG

by

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I. INTRODUCTION

Capture the Flag is designed to be a multi-cast, interactive, 3 dimensional game. It originally began as a class project in a graphics class at Naval Postgraduate School (NPS). The class was researching the concept of a Virtual Reality Transfer Protocol (VRTP), and this game was one realization of that concept. There is no current development work being done on the project, as the class involved is no longer in session. However, further development is expected as personnel at NPS work in conjunction with individuals at University College of London (UCL).

In studying the usability of this application, our team will focus solely on the startup of the game, providing the developer with an assessment of current successes and shortcomings of the design and making recommendations for future design adjustments.

II. BACKGROUND

A. CTF DETAIL

Capture the Flag emerged as a product of research that was being conducted on Virtual Reality Transfer Protocol, and it enables the user to operate in a multi-cast, 3D, virtual environment, supported by VRTP. It is a 3 dimensional, multi-cast, web-based, multi-user, interactive video game combining Java-based programs and a VRML environment. It is currently implemented using Cosmo Player as the VRML player for the application. In more general terms, Capture the Flag is a war-game where two teams compete using two vehicle interfaces (helicopter and tank) to capture their flag from the opposing team's home base. The game allows vehicles to be destroyed by opposing team members using weapons associated with each vehicle. A referee application running separately determines hits, kills, flag capture, and revolves any other actions that can occur simultaneously and result in multiple instances of unique objects

Current start-up process is described in Appendix A. The CTF has to be downloaded from the web-site and star-up process has to be in given order. The game uses two command prompt initiated Java programs to initialize the control panel (Figures 3 & 4) and the referee (Figures 5 & 6). Cosmo Player, a web browser plug-in, is used to display the virtual world in which the game is played (Figures 1 & 2) and drives all view perspectives used throughout the execution of the game. All other actions occurring in the virtual world are driven by the Java-based control panel. These VRML and JAVA applications running separately force the user to change focus between two windows in order to play the game. Once the VRML and JAVA applications are executing, players are allowed to select between two teams, red and blue, and subsequently select from 6 vehicles (three helicopters and three tanks). The user drives the vehicle in the world, attempting to maintain situational awareness of the location of friendly and enemy forces while striving to capture its flag from the enemy base and return it to its home base. Each vehicle has its own weapon system that can be used to destroy enemy vehicles during attempts to capture and return the flag to its home base or while defending the home base against enemy attempts to capture their own flag.

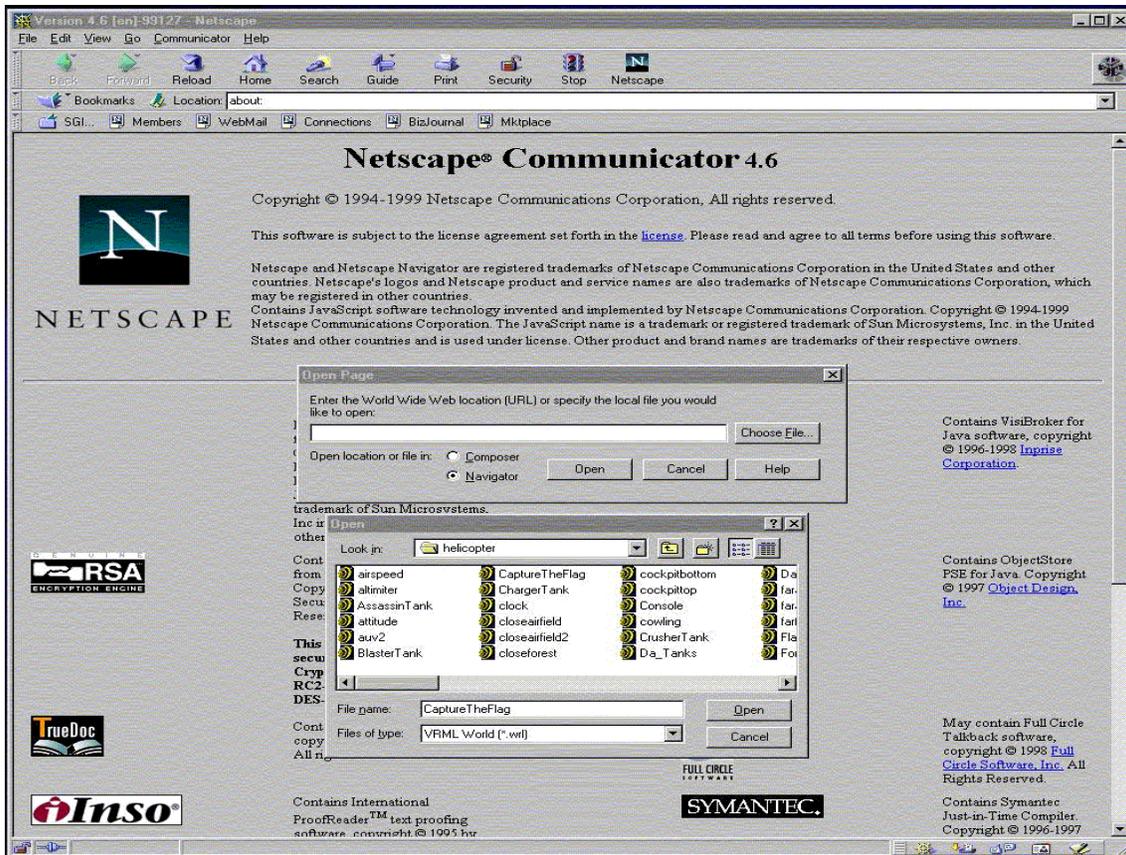


Figure 1: VRML Startup



Figure 2: VRML Capture the Flag Environment



Figure 3: Control Panel Startup

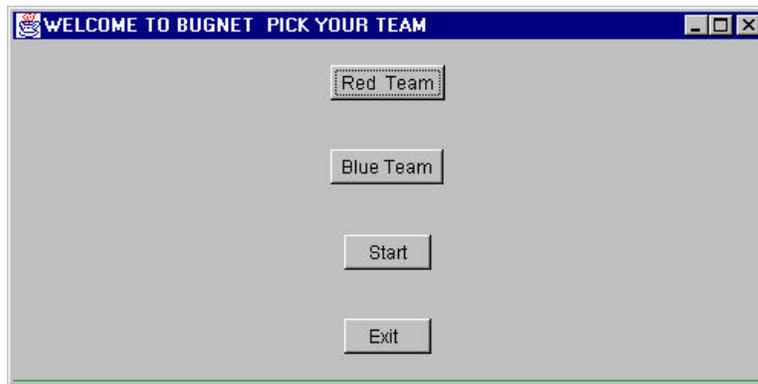


Figure 4: Control Panel Initial Screen



Figure 5: Referee Startup

```
C:\WINNT\System32\cmd.exe - java demo helicopter Referee
C:\nortp\demo\helicopter>java demo.helicopter.Referee
multicast timeToLive ttl=15
Got strategy of org.web3d.vrtp.security.SunSecurityStrategy
DatagramStreamBuffer: joined multicast address 224.2.181.145/224.2.181.145
found Port15wInTerrain.unl
send red Pdu
send blue pdu
sent keepAlive red PDU      sent keepAlive blue PDU
sent keepAlive red PDU      sent keepAlive blue PDU
sent keepAlive red PDU      sent keepAlive blue PDU
```

Figure 6: Referee Execution

B. TARGET USERS

In characterizing the users of this application, we must do so from the perspective of the proposed development stages: short-term, mid-term, and long-term. Short term users consist primarily of students and faculty who are working on development of the game and the VRTP. They know one or more programming language like C++ or Java. They have a good deal of awareness with computer architecture and can implement different interfaces. Although there may be others who are familiar with the current interface and play the game recreationally, the primary user audience are those mentioned above. Mid term users are expected to be members of the United States Military Academy and United States Naval Academy. This group has basic familiarity with the computer and willing to play this kind of game. The developer envisions teams of cadets and midshipmen competing against each other, and in reality serving as a test-bed for the proposed long term users: the average web gamer. These users have a much broader demographic, and given their number and dispersion, they will extensively test, and ultimately validate or invalidate this implementation of the multi-cast, 3D, web-based virtual environment concept. They don't necessarily have programming language experience or basic computer architecture.

For all user group we can generalize that people are reluctant to read-me files, and set-up instructions. They are looking for real smart, easy and fast interfaces.

C. DESIRED END-STATE

In depicting what the developer envisions as the end-state functionality of this application, we must look at near term, mid term and long term goals. As the near term target audience is program developers, there is not so stringent a requirement for the startup interface of the game to be simple to implement. Recognizing that at this stage, the start up procedures may be difficult for the average user, they should not be so complicated that even experienced programmers have difficulty getting the game running. Following startup, the game should run without crashing, and allow players to enter the game, choose a team, take control of a vehicle, and work with their team members to capture the flag. All events mentioned above should happen without creating conflicts which interfere with execution of the game (i.e., multiple players should not be allowed to control the same vehicle simultaneously).

In the mid-term, a fairly robust startup interface should be developed, providing the user with a simple, three-step method that will open related files via short-cuts on desktop for launching the game. In essence, by the time this game is ready for the mid-term user the startup procedure should be mature, virtually identical in functionality and usability to that which will ultimately be implemented for the long-term user: the game player. All other aspects of the game should also be at or near maturity, as the mid-term user will serve as a test bed for the final product

In the long term, the target user becomes the game player on the web. By this time the Capture the Flag game should be fully robust, providing a simple one-click start-up interface and a single-window gaming interface that is error free and allows for cooperative interaction between team members as they work toward their common goal of capturing their flag from the enemy camp.

D. EVALUATION PHILOSOPHY

With these goals in mind, the developer has requested that usability studies be performed on the current implementation to further aid him in refining the design of the game. As no previous evaluations have been conducted, and there is a wide range of issues to be examined, two teams will be performing separate usability studies on

distinct aspects of the game. Our focus will be on the startup/initialization of the game. Of particular interest to us are the VRML player and the Command line interface, both of which are used to launch various portions of the game. They are the focal point of our examination of the startup of the game because currently, they are the three distinct applications that must be initialized in order to utilize the game.

Our objective in performing this usability study is to provide the developers with performance data on the current state, and recommendations (alternative design) of mid and long-term solutions. We will design a usability test that examines the Capture the Flag startup process. After examining the data from those tests, we will provide the developer with a report detailing the general history and goals of the Capture the Flag project, test procedures that we used in examining usability, results of those tests, and recommendations for changes in future development cycles.

Our approach to this study will be formal in nature. Although the game itself may very well be played in somewhat unpredictable patterns, thus lending itself to an informal study, the startup of the game should be very predictable. Given that this program is still very much in the development phase, and the results, therefore, will be used in further clarifying the design of the end product, a more formal, structured approach is clearly the best method for performing this study. Additionally, given the current level of development of the game, our evaluation will be a formative one, enabling the developer to assess and improve the user interface design, thereby ultimately ensuring usability of the interactive components of the game.

Consequently, we will attempt to answer the following questions in support of this study. This is a representational list of major topics and should not be mistaken for an exhaustive list.

1. Are current startup procedures sufficiently simple that the average experienced programmer can execute them with little or no difficulty?
Average gamer?
2. What recommendations should be made in short, medium and long terms to improve the startup interface?

3. What should the optimal startup interface look like in short, medium and long terms?

E. CONCLUSION

Capture the Flag's current implementation is clearly focused toward developers, however, the long-term goal is to make this game attractive to average web gamers. In order to attract that target audience, it is essential to develop an interface that entices gamers to test, and ultimately habitually play the game. This will not happen if the interface is poorly designed, thus becoming a repellant rather than a magnet to draw gamers in. By using the results of this evaluation, the developer will be much better equipped to accomplish that ultimate goal.

III. METHODOLOGY

A. RESEARCH APPROACH

This study involves the analysis of the start up procedures for the game. It is typically a benchmark study. The purpose of this analysis is to provide the developers with some constructive feedback on what the current user base feels are some of the successes and failures of the present implementation.

B. INITIAL ENHANCEMENT REQUIREMENTS TO CONDUCT STUDY

Currently there is no documentation for Capture the Flag. Therefore, it is impossible for anyone to start the game without any prior knowledge about it. In order to conduct this study for near term users, minimal instructions will have to be provided to

the participants. A read-me file (Appendix A) has been created for use in the study of near term users. For the mid-term, a sample paper “prototype” (Appendix B) providing simplified instructions will be used in the study of the same users. Ultimately, the game should be able to be started using a simple interface such as one simple mouse click on an icon.

C. DATA COLLECTION

1. Participants

10 participants for this study will be recruited at the Naval Postgraduate School (NPS) in Monterey, California. All participants will be military officer students, half of the participants will have basic computer knowledge/exposure (i.e. able to use MSWord and MSEXcel) and other half of them will have knowledge in any computer programming language and understanding of operating systems. No other special qualification will be required for the participants to perform this experiment.

2. Instruments

This study will provide a benchmark task list (Appendix C) across usability objectives. A usability script (Appendix D) and post-task questionnaire (Appendix E and H) will be administered to all participants. Primary focus of the study will be initial performance, learnability, retainability, and first impression. The study will not focus on advanced usage and retainability, because this is a continuing project and this study is the first usability evaluation for the project. Descriptions for specific definitions of the objectives are as follows:

- 90% error free rate. (an error may be opening wrong file, wrong syntax on MSDOS command prompt)
- 90% of 3 or better on a 7 point scale (e.g., 1 = easy, 3 = somewhat easy, 5 = somewhat difficult, and 7 = difficult) in ease of use

- 90% of 3 or better on a 7 point scale (e.g., 1 = satisfied, 3 = somewhat satisfied, 5 = somewhat dissatisfied, 7 = dissatisfied) in user satisfaction

3. Procedure

First Trial: The following procedures are used to conduct the study:

- Participants complete an informed consent form and demographic questionnaire (Appendix F and G).
- Participants receive a usability task script and are read a brief background description of the evaluation scenario.
- Participants are seated directly in front of a 21-inch computer monitor and asked to execute the task script.
- Participants are directed to read aloud and execute the tasks provided them in the task script.

Participants are timed on the completion of all tasks. The participants are required to carry out the tasks as detailed in the read-me file. All mistakes (i.e. typing error, clicking the wrong button, incorrect actions and procedures) and requests for assistance are considered errors. The number of errors is recorded. Following the series of tasks, a post task questionnaire concerning their first impression of the system is presented. Upon completion of the questionnaire, participants are asked to redo the task script. This is done to observe the learnability of tasks.

Second Trial: Participants will then return in a week to complete the task again. The participants will be prompted to start the game but will not be prompted to open the read-me file. Opening the read-me file will not be considered an error, however any other errors that occurred during program start-up will be recorded.

Observations about the retainability of the minimal instructions are recorded. Upon completion of the second study, the participant will be presented with a pencil “prototype” of a mid-term interface proposal. This prototype will be created using analysis and feedback from the first study. The participant will complete a questionnaire developed from the results of the first study.

Throughout each usability session, the following measurements will be taken during the performance of user tasks. These measurements will be used to assess whether or not each usability objective had been met. These measurements include:

- **Task Completion Rate:** The proportion of participants who completed the task successfully and independently without critical errors. A critical error has occurred when the participant either requests assistance from the usability engineer or commits and uncorrected error that results in an incorrect outcome for the task. If this rate zero (meaning the task failed), this can be due to system error or critical subject error. In case of system error, the test will be repeated with the same subject beginning from the last point he/she has reached in failed trial. In case of critical subject error, the test will be repeated with the same subject or with a new subject. This decision will be given by usability engineer.

- **Error Free Rate:** The proportion of participants completing the task without any errors, critical or non-critical. Non-critical errors include any error corrected by the test participant without intervention by the usability engineer or an error left uncorrected, but which does not affect the correctness of the outcome of the task.

- **User Satisfaction:** The User Satisfaction rating is derived from a series of questions which the user rates on a 7 point scale, ranging from very dissatisfied to very satisfied. The questions solicit user opinions with regard to ease-of-use, simplicity of the human-computer interaction, system functionality, and general satisfaction with the game.

D. DATA ANALYSIS

The occurrence of each of the measurements listed above will be recorded in a spreadsheet. This data includes any associated user-feedback information associated with the measurement. Frequencies of the various measurements in the database will be determined, both in aggregate and by measurement type. Participants will be categorized based on their demographic classification (i.e. programming experience or

not). This should provide us with a representative sample of how the current user and the projected user perform under this implementation. We will perform a simple ANOVA test to determine the difference between the two groups of participants. Further data analysis will be conducted to determine the participants' retainability of the startup procedures (i.e. compare the performance of the participants between the first and second study).

At a minimum, this study will answer the question of whether the current startup procedures are sufficiently simple that the average gamer and/or experienced programmer can execute them with little or no difficulty. Upon completion of the study, we will provide feedback on the current startup implementation and make recommendations for improving and optimizing the startup interface, based on the result of data analysis and feedback elicited from the participants.

E. PILOT TESTING

No pilot testing has been conducted to date.

IV. USABILITY EVALUATION RESULTS

(For this part please refer to “RESULTS” file)

V. SUMMARY, RECOMMENDATIONS, AND CONCLUSIONS

A. SUMMARY

The current implementation of the startup for Capture the Flag failed to measure up to the benchmarks set by this study. Although results showed that the Control Panel and Referee startup tasks met the 90% benchmark for ease of use, the overall measurement for ease of use failed to exceed 90%. In addition, all tasks failed to meet the error-free rate benchmark, and overall user satisfaction was also less than 90%. This was reflected in both user groups' responses to questions about their first impression. In general these responses indicated that they found the startup procedures to be neither easy nor difficult, however, comments reflected dissatisfaction with the number of steps that had to be performed just to start the game.

For each of the three tasks involved in starting the game, measurements are taken against all benchmarks. During the first trial, only 60% of both experienced and non-experienced programmers felt that starting up the program was fairly easy. During this trial, 12% of the experienced programmers and 25% of the non-programmers experienced errors during the start-up process. When the trial was conducted a second time, 80% of the experienced programmers and 60% of the non-experienced programmers felt that starting up the program was fairly easy. During the second trial, both user groups exceeded the 90% error free benchmark by demonstrating 98% and

91% error free rates among experienced and non-experienced programmers respectively. In this case both user response and performance indicate a reasonably high degree of retainability (User performance showed a 10 percentage point increase in error free rate among experienced programmers and a 16 percentage point increase in error free rate among non-experienced programmers). Capture the Flag also failed to meet the user satisfaction benchmark of 90% during the first trial. Only 50% of the experienced programmers and 70% of the non-experienced programmers were satisfied with start-up procedures for Capture the Flag. After the second trial, there was a significant increase in the user satisfaction with 90% of the experienced programmers and 100% of the non-experienced programmers expressing satisfaction with the procedures. There is no clear data to indicate why there was such a significant improvement in the user satisfaction, however, given the users' demonstrated retainability of the startup tasks, it would appear that their familiarity with the startup procedures contributed to their comfort, and thus the significant increase in their expression of satisfaction.

For the task of opening the virtual world, Capture the Flag failed to meet the required benchmark for error free rate and ease of use. For the first trial, the experienced programmer error free rate was 92.5%, the non-experienced programmer error free rate was 85%, and the conglomerate error free rate was 88.75%. The second trial reflected excellent retainability as the error free rate increased to 97.5% for both user groups. Measurements against the ease of user benchmarks showed that 83% of the experienced programmers and 80% of the non-experienced programmers felt that opening the virtual world was fairly easy. During the second trial, 90% of the experienced programmers and 83% of the non-experienced programmers felt that opening the virtual world was fairly easy.

For the task of opening the control panel, Capture the Flag met the usability objectives of 90% with experienced programmers during the first trial. 100% of experienced programmers felt that this task was easy. Only 80% of the non-experienced programmers felt that the task of opening the control panel was fairly easy. During the second trial, 97% of the experienced programmers and 87% of the non-

experienced programmers felt that this task was easy. The task failed to meet the error free benchmark, however. For the first trial, the experienced programmer error free rate was 80%, the non-experienced programmer error free rate was 70%, and the conglomerate error free rate was 75%. The second trial reflected excellent retainability, however, the error free rate was still below the 90% benchmark. The experienced programmer error free rate was 90%, the non-experienced programmer error free rate was 85%, and the conglomerate error free rate was 87.5%.

Initializing the referee was a virtually identical task to that of opening the Control Panel and as such, provided an indication of the learnability of these two startup tasks. The error free rate for the Referee was actually worse than for the Control Panel during the first trial, however, it improved over the Control Panel in the second trial. This demonstrates the positive impact that retainability had on the learnability of these tasks. As with the Control Panel tasks, Capture the Flag Referee startup met the usability objectives of 90% with both sets of participants during the first trial. 97% of the experienced programmers and 90% of the non-experienced programmers felt that initializing the referee was fairly easy. The second trial resulted in 100% of the experienced programmers and 93% of the non-experienced programmers felt that initializing the referee was fairly easy. Against the error free benchmark, the experienced programmer error free rate for the first trial was 85%, the non-experienced programmer error free rate was 60%, and the conglomerate error free rate was 72.5%. The second trial continued to reflect excellent retainability with the conglomerate error free rate exceeding 90%. The experienced programmer error free rate was 100%, the non-experienced programmer error free rate was 85%, and the conglomerate error free rate was 92.5%.

When asked about their ability to re-execute the startup tasks, it was interesting to note that 80% of the experienced programmers and only 20% of the non-experienced programmers felt they would be able to perform the startup procedure again without assistance. This directly contrasted with the demonstrated performance, as results showed excellent retainability throughout all measured tasks.

B. RECOMMENDATIONS

As part of the usability study, participants were given a post-task questionnaire to complete. Many participants stated that the start-up procedures were too involved for a game. Participants suggested that making the start-up procedures easier by reducing the steps or providing short-cut keys would make starting the game more enjoyable.

As a result of our participants' comments, a prototype was created for Capture the Flag start-up procedures. A single icon was created that accomplished all tasks with a single mouse click. A third trial was conducted using the prototype and the results showed that both experienced programmers and non-programmers undoubtedly preferred the single icon to the current method. When measured against the same benchmarks used during the first two trials, the prototype resulted in a 100% error free rate, 100% ease of use, and 100% user satisfaction.

We recommend that future implementations of Capture the Flag start-up procedures incorporate the use of a single icon for starting the game. This simplification will make the game more inviting for users resulting in greater use of the game.

C. CONCLUSIONS

This study examined the usability of Capture the Flag start-up software in a systematic manner and established where the Capture the Flag start-up software is today against usability criteria. Furthermore, participants identified usability issues that can be addressed in future design efforts. Based on the information obtained from the evaluation, recommendations to address the usability issues were made. Overall, in terms of ease-of-use and satisfaction, participants reacted negatively to the current procedures used to start Capture the Flag. Participants felt that there were too many steps involved in the start-up process. Simplifying the process will result in a more positive experience for the user and a heightened interest in playing and developing Capture the Flag.

Appendix A: Read-Me File

There are three components that must be started in order to start the game. The VRML environment is used for the game virtual world itself. A Java program must be started that runs the Control Panel used to maneuver the vehicle in the virtual world. Another Java program that runs the referee must also be started. Procedures for starting each interface are as follows:

Procedures for opening the virtual world window:

- Open Netscape
- Select File -> Open
- Select Browse Files
- Change file type to VRML World (.wrl)
- Change Directory to C:\vrtp\Demo\Helicopter\
- Select File "Capture the Flag.wrl"
- Select Open twice
- Grant all permissions as prompted

Procedures for opening the Control Panel window:

- Open a MSDOS Window
- Change drives to C:\
- Change directory to C:\vrtp\Demo\Helicopter\
- Type "java demo.helicopter.StartPanel"

Procedures for initializing the Referee:

- Open a second DOS Window
- Change drives to C:\
- Change directory to C:\vrtp\Demo\Helicopter\
- Type "java demo.helicopter.Referee"

Appendix B: Prototype

Depending upon results of the first test two prototypes are implemented;

- Medium-term : A three-icon file which allow user open three interfaces separately
- Long-term: An icon which will startup the whole process with one mouse click.

(Please, refer to "PROTOTYPE" file for prototypes)

Appendix C: Benchmark Task List

Benchmark #1 (measure task performance time, number of errors)

- Open the Virtual World Window

Benchmark #2 (measure task performance time, number of errors)

- Open the Control Panel Window

Benchmark #3 (measure task performance time, number of errors)

- Initialize the Referee

Appendix D: Background and Usability Script

Capture the Flag was designed to be a multi-cast, web-based, multi-user, interactive, 3-dimensional game. It originally began as a class project in a graphics class at Naval Postgraduate School. The class was researching the concept of a Virtual Reality Transfer Protocol, and this game was one realization of that concept.

In more general terms, Capture the Flag is a war-game where two teams compete using two vehicle interfaces (helicopter and tank) to capture their flag from the opposing team's home base. The game allows vehicles to be destroyed by opposing team members using weapons associated with each vehicle. A referee application running separately determines hits, kills, flag capture, and resolves any other actions that can occur simultaneously and result in multiple instances of unique objects.

Further development is expected to address the startup design and our team will be studying the usability of this application, and assess the current successes and shortcomings of the startup design. Your task is to complete the game startup tasks as follows:

Open the Capture the Flag read-me file on the desktop, and execute the following tasks:

1. Open the Virtual World window
2. Open the Control Panel window
3. Initialize the Referee

**Appendix E: Post Task Questionnaire
(First Trial)**

First Impression

1. How easy/difficult was it to start the game?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

2. In your opinion which is the most difficult procedure?

Comments:

What might have made this procedure easier?

Opening the virtual world

1. How easy/difficult was it to change the file type to VRML World (.wrl) after opening Netscape?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

2. How easy/difficult was it to browse and find the file 'Capture The Flag.wrl'?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

3. How easy/difficult was it to open the file 'Capture The Flag.wrl'?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

4. How comfortable were you in granting all permissions as prompted?

| | | | | | | |
|--------------------|-----|--------------------------------|-----|----------------------------------|-----|----------------------|
| | | | | | | |
| Comfortable (1) | (2) | Somewhat Comfortable (3) | (4) | Somewhat Uncomfortable (5) | (6) | Uncomfortable (7) |

Comments:

5. Did you understand what you were granting permissions for?

| | | | | | | |
|-------------------------------------|-----|-----------------------------------|-----|---|-----|---|
| | | | | | | |
| Completely Understandable (1) | (2) | Somewhat Understandable (3) | (4) | Somewhat Difficult to Understand (5) | (6) | Very Difficult to Understand (7) |

Comments:

6. How do you rate your understanding of these setup steps?

| | | | | | | |
|---------------------------|-----|-------------------------|-----|----------------------------------|-----|------------------------------|
| | | | | | | |
| Completely Understandable | | Somewhat Understandable | | Somewhat Difficult to Understand | | Very Difficult to Understand |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |

Comments:

What might have made this task easier to understand?

7. In your opinion which is the most difficult task in opening the virtual world?

Comments:

What might have made this task easier?

Opening the control panel

1. How easy/difficult was it to open a MSDOS window?

| | | | | | | |
|------|-----|---------------|-----|--------------------|-----|-----------|
| | | | | | | |
| Easy | | Somewhat Easy | | Somewhat Difficult | | Difficult |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |

Comments:

What might have made this task easier?

2. How easy/difficult was it to change the drive to C:\?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

3. How easy/difficult was it to change the directory to C:\vrtp\Demo\Helicopter\?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

4. How easy/difficult was it to start the control panel?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

5. How easy/difficult was it to use the command prompt in opening the control panel?

| | | | | | | |
|-------------|-----|----------------------|-----|---------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

6. How do you rate your understanding of these setup steps?

| | | | | | | |
|----------------------------------|-----|--------------------------------|-----|---|-----|-------------------------------------|
| | | | | | | |
| Completely Understandable (1) | (2) | Somewhat Understandable (3) | (4) | Somewhat Difficult to Understand (5) | (6) | Very Difficult to Understand (7) |

Comments:

What might have made this task easier to understand?

8. In your opinion which is the most difficult task in opening the control panel?

Comments:

What might have made this task easier?

Initializing the Referee

1. How easy/difficult was it to open a second MSDOS window?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

2. How easy/difficult was it to change the drive to C:\?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

3. How easy/difficult was it to change the directory to C:\vrt\Demo\Helicopter\?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

4. How easy/difficult was it to initialize the referee?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

5. How easy/difficult was it to use the command prompt in initializing the referee?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

6. How do you rate your understanding of these setup steps?

| | | | | | | |
|-------------------------------------|-----|-----------------------------------|-----|---|-----|---|
| | | | | | | |
| Completely Understandable (1) | (2) | Somewhat Understandable (3) | (4) | Somewhat Difficult to Understand (5) | (6) | Very Difficult to Understand (7) |

Comments:

What might have made this task easier to understand?

7. In your opinion which is the most difficult task in initializing the referee?

Comments:

What might have made this task easier?

User Satisfaction

1. How do you rate your satisfaction of this start-up procedure?

| | | | | | | |
|-----------------------------|-----|---------------------------|-----|-----------------------------|-----|-------------------------|
| | | | | | | |
| Completely Satisfied (1) | (2) | Somewhat Satisfied (3) | (4) | Somewhat Unsatisfied (5) | (6) | Very Unsatisfied (7) |

Comments:

What might have made this task more satisfying?

2. How well do you think you can do this procedure if asked to do it again without help?

| | | | | | | |
|-----------------------------|-----|---------------------------|-----|-----------------------------|-----|-------------------------|
| | | | | | | |
| Completely Confident (1) | (2) | Somewhat Confident (3) | (4) | Somewhat Unconfident (5) | (6) | Very Unconfident (7) |

Comments:

What might have made this task easier to perform?

Appendix F: Consent Form

CONSENT FORM

Usability Evaluation of the 'Capture The Flag' Software

Principal Investigator:

I, _____, consent to my participation in the research project titled Usability Evaluation of the 'Capture The Flag' Software.

I understand that I am free to withdraw my participation in the research at any time and that if I do I will not be subjected to any penalty or discriminatory treatment.

I have been given the opportunity to ask questions about the research and received satisfactory answers.

I understand that any information or personal details gathered in the course of this research about me are confidential and that neither my name nor any other identifying information will be used or published without my written permission.

I understand that if I have any complaints or concerns about this research I can contact:

Rudy Darken
MOVES Department
656-4072

Signed by:

.....

Date

.....

Appendix G: Demographic Questionnaire

Name: _____ Rank: _____

Years of Service: _____ Curriculum: _____

Years of using computer: _____

Do you own a computer? _____

Do you play computer games? _____

If so, how often do you play computer games? _____

- a) Daily
- b) A few times a week
- c) A few times a month
- d) A few times a year

Rate yourself from 1(Novice) to 3(Experienced) on the following:

Typing skill: _____

Computer expertise: _____

Computer programming skill: _____

Computer operating system knowledge: _____

Knowledge of MS DOS commands: _____

Understanding of interfaces: _____

Understanding of computer networks: _____

Ability to work on multi-window environment: _____

**Appendix H: Post Task Questionnaire
(Second Trial)**

First Impression

8. How easy/difficult was it to start the game?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

9. In your opinion which is the most difficult procedure?

Comments:

What might have made this procedure easier?

Retainability

1. How easy/difficult was it for you to recall the procedures without referring to the Read-Me file?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

2. How well do you think you can do this procedure if asked to do it again without assistance?

| | | | | | | |
|--------------------------------|-----|------------------------------|-----|--------------------------------|-----|----------------------------|
| | | | | | | |
| Completely Confident (1) | (2) | Somewhat Confident (3) | (4) | Somewhat Unconfident (5) | (6) | Very Unconfident (7) |

Comments:

What might have made this task easier to perform?

Opening the virtual world

6. How easy/difficult was it to change the file type to VRML World (.wrl) after opening Netscape?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

7. How easy/difficult was it to browse and find the file 'Capture The Flag.wrl'?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

8. How easy/difficult was it to open the file 'Capture The Flag.wrl'?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

9. How comfortable were you in granting all permissions as prompted?

| | | | | | | |
|--------------------|-----|--------------------------------|-----|----------------------------------|-----|----------------------|
| | | | | | | |
| Comfortable (1) | (2) | Somewhat Comfortable (3) | (4) | Somewhat Uncomfortable (5) | (6) | Uncomfortable (7) |

Comments:

10. Did you understand what you were granting permissions for?

| | | | | | | |
|-------------------------------------|-----|-----------------------------------|-----|---|-----|---|
| | | | | | | |
| Completely Understandable (1) | (2) | Somewhat Understandable (3) | (4) | Somewhat Difficult to Understand (5) | (6) | Very Difficult to Understand (7) |

Comments:

6. How do you rate your understanding of these setup steps?

| | | | | | | |
|---------------------------|-----|-------------------------|-----|----------------------------------|-----|------------------------------|
| | | | | | | |
| Completely Understandable | | Somewhat Understandable | | Somewhat Difficult to Understand | | Very Difficult to Understand |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |

Comments:

What might have made this task easier to understand?

9. In your opinion which is the most difficult task in opening the virtual world?

Comments:

What might have made this task easier?

Opening the control panel

2. How easy/difficult was it to open a MSDOS window?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

2. How easy/difficult was it to change the drive to C:\?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

10. How easy/difficult was it to change the directory to C:\vrtp\Demo\Helicopter\?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

11. How easy/difficult was it to start the control panel?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

12. How easy/difficult was it to use the command prompt in opening the control panel?

| | | | | | | |
|-------------|-----|----------------------|-----|---------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

13. How do you rate your understanding of these setup steps?

| | | | | | | |
|----------------------------------|-----|--------------------------------|-----|---|-----|-------------------------------------|
| | | | | | | |
| Completely Understandable (1) | (2) | Somewhat Understandable (3) | (4) | Somewhat Difficult to Understand (5) | (6) | Very Difficult to Understand (7) |

Comments:

What might have made this task easier to understand?

10. In your opinion which is the most difficult task in opening the control panel?

Comments:

What might have made this task easier?

Initializing the Referee

4. How easy/difficult was it to open a second MSDOS window?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

5. How easy/difficult was it to change the drive to C:\?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

6. How easy/difficult was it to change the directory to C:\vrtp\Demo\Helicopter\?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

4. How easy/difficult was it to initialize the referee?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

5. How easy/difficult was it to use the command prompt in initializing the referee?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

6. How do you rate your understanding of these setup steps?

| | | | | | | |
|-------------------------------------|-----|-----------------------------------|-----|---|-----|---|
| | | | | | | |
| Completely Understandable (1) | (2) | Somewhat Understandable (3) | (4) | Somewhat Difficult to Understand (5) | (6) | Very Difficult to Understand (7) |

Comments:

What might have made this task easier to understand?

14. In your opinion which is the most difficult task in initializing the referee?

Comments:

What might have made this task easier?

Executing the Prototype

1. How do you rate the prototype (shortcut methods) as compared to command line inputs?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

2. How easy/difficult was it to execute the prototype (shortcut methods)?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

3. How easy/difficult was it to open the virtual world using the shortcut method?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

4. How easy/difficult was it to open the control panel using the shortcut method?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

5. How easy/difficult was it to initialize the referee using the shortcut method?

| | | | | | | |
|-------------|-----|-------------------------|-----|------------------------------|-----|------------------|
| | | | | | | |
| Easy (1) | (2) | Somewhat Easy (3) | (4) | Somewhat Difficult (5) | (6) | Difficult (7) |

Comments:

What might have made this task easier?

User Satisfaction

3. How do you rate your satisfaction of this prototype start-up procedure?

| | | | | | | |
|-----------------------------|-----|---------------------------|-----|-----------------------------|-----|-------------------------|
| | | | | | | |
| Completely Satisfied (1) | (2) | Somewhat Satisfied (3) | (4) | Somewhat Unsatisfied (5) | (6) | Very Unsatisfied (7) |

Comments:

What might have made this task more satisfying?

4. How well do you think you can do this procedure if asked to do it again without help?

| | | | | | | |
|-----------------------------|-----|---------------------------|-----|-----------------------------|-----|-------------------------|
| | | | | | | |
| Completely Confident (1) | (2) | Somewhat Confident (3) | (4) | Somewhat Unconfident (5) | (6) | Very Unconfident (7) |

Comments:

What might have made this task easier to perform?

Appendix I: Subject Comments

First Impression

15. How easy/difficult was it to start the game?

Comments:

- Somewhat difficult compared to all games currently on market.
-
- Would have been harder if I did not know the MS DOS, Windows file structure, or the icons. Would have been difficult on a Unix, Mac, or OS2 operating system.

NCS (non-CS subjects)

- It was easy but I think it requires some experience to fire it up quickly.
- Troublesome.
- User friendly options will make the user feel more comfortable.

What might have made this task easier?

- Batch file or script attached to an Icon.
- GUI
- Reduce the steps

NCS

- A script that does the typing for me.
 - Short-cut keys and easy explanations would make it easier to start.
 - Single click, i.e., batch file concept.
 - I think a small “help” or “read-me” window does help.
 -
-

16. In your opinion which is the most difficult procedure?

Comments:

- Change directory
 - Switching between windows and DOS interaction
 - The nested files
 - Opening the Control Panel and the Referee
 - **NCS**
 - Finding the file type, starting MS DOS
 - Searching for file type (long list)
 - Understanding the “grant” stuff
 -
-

What might have made this procedure easier?

- Instructions in an always viewable location or GUI

- Less directories
 - Give some hints on the window.
 - **NCS**
 - Creating icons might be another solution
 - Use GUI, i.e., clicking thru menu type activation
 -
-
-

Opening the virtual world

11. How easy/difficult was it to change the file type to VRML World (.wrl) after opening Netscape?

Comments:

- There are too many file types
 - I would have had to know about the arrow down
 - There are lots of file types in choose file dialog box file types. Read me is not good in here. You could say “choose all types” and select “Capture the Flag.wrl”.
 - If I want to just “play a game” this all should be automatic.
 - **NCS**
 - To find the file type was somewhat difficult
 - Long list of file types to search through
-

What might have made this task easier?

- I think we can put the VRML world (.wrl) in the first place so we can find the file type easier.
 - Batch file or script
 - Not user friendly – will be a resistance to someone to play this game.
 - **NCS**
 - Using GUI icon
 - “Open” window would be larger to see the items easily
 - File type options could have been easier to find.
-
-

12. How easy/difficult was it to browse and find the file 'Capture The Flag.wrl'?

Comments:

- Batch file or script
 - If I want to just "play the game", this should all be automatic
 - **NCS**
 - It requires basic computer skills
-

13. How easy/difficult was it to open the file 'Capture The Flag.wrl'?

Comments:

- The "Grant Permission" part was confusing
 - If I want to just "play the game", this should all be automatic
 - **NCS**
 - No comments
-

What might have made this task easier?

- Batch file
 - Should be double click on initial icon and program places you in virtual world window.
 - **NCS**
 - No comments
-
-

14. How comfortable were you in granting all permissions as prompted?

Comments:

- If I were a new user, I would have been more worried.
 - I did because it was written in read-me
 - Option needed to Grant All.
 - Not my computer.
 - I need to grant too many permissions
 - **NCS**
 - Somewhat uncomfortable because of the "high risk" cautionary message
-

15. Did you understand what you were granting permissions for?

Comments:

- Yes, but not completely
 - Did not pay attention, merely instructed to grant all
 - No.
 - Put some instructions about permission. If I don't grant the permission, then I can't play the game.
-

- **NCS**
 - Did we really pay attention to the implication since the startup instructions say to grant all. Basically followed the instructions.
-

16. How do you rate your understanding of these setup steps?

Comments:

- Change read-me
 - Enable instructions to be continuously viewed so don't have to continuously switch between windows.
 - As long as I have a printed copy
 - Too many steps I need to finish before I begin to play the game
 - **NCS**
 - Finding the game could be more user friendly
 - Reading from a file to startup is not user friendly
-

What might have made this task easier to understand?

- Steps good. Details would have been better for a new user.
 - Enable instructions to be continuously viewed so don't have to continuously switch between windows.
 - Not user friendly – will be a resistance to someone to play this game.
 - I suggest that you put the shortcut on the window. If I want to play the game, just click on the shortcut.
-
-

11. In your opinion which is the most difficult task in opening the virtual world?

Comments:

- Permission understanding
 - Switching between windows
 - The cumulative "laundry list"
 - Grant all permissions as prompted
 - **NCS**
 - Changing file type
 - Granting permission
 - So far, I haven't feel any difficulty
 - All were the same
 - Searching for file type
-

What might have made this task easier?

- Batch file or script
 - Auto
 - I suggest that you put the shortcut on the window. If I want to play the game, just click on the shortcut.
 - Creating shortcut
 - It is simply a game . Use "wizard" concept
-
-

Opening the control panel

3. How easy/difficult was it to open a MSDOS window?

Comments:

NCS

- No shortcut?
 - I usually do not use MSDOS in my computer work
-

What might have made this task easier?

- MSDOS icon on initial screen.
 - GUI button for “execute” the java file
 - Batch file
-
-

2. How easy/difficult was it to change the drive to C:\?

Comments:

- I did not know DOS would have been harder
 - Average user has not used DOS ever or in long time NSC
 - I had to remember basic computer knowledge.
-

What might have made this task easier?

17. How easy/difficult was it to change the directory to C:\vrtp\Demo\Helicopter\?

Comments:

- DOS is uncomfortable to most user including me.
 - Typing mistakes can occur
-

What might have made this task easier?

18. How easy/difficult was it to start the control panel?

Comments:

What might have made this task easier?

- Batch file

19. How easy/difficult was it to use the command prompt in opening the control panel?

Comments:

- DOS is uncomfortable
- It is difficult to use . Errors can occur

NCS

- I did not like it.
 - too many characters to type
-

What might have made this task easier?

- GUI
- Have a batch file or lower the root directory that can run the start up
- In stead of typing , GUI or mouse click

20. How do you rate your understanding of these setup steps?

Comments:

What might have made this task easier to understand?

- In stead of command prompt, a single click

NCS

- An icon and a mouse click
-

12. In your opinion which is the most difficult task in opening the control panel?

Comments:

- Change directory
- Typing that whole line
- Finding the command prompt in NT
- Open MSDOS window

NCS

- Too much typing
 - Opening DOS window
 - To run the program(start panel)
 - Finding MSDOS option
-

What might have made this task easier?

- Windows type reference
 - Reducing the number of steps
-
-

Initializing the Referee

7. How easy/difficult was it to open a second MSDOS window?

Comments:

- Same as previous, need GUI button for average user
- NCS
- Easier than the first one
-

What might have made this task easier?

8. How easy/difficult was it to change the drive to C:\?

Comments:

What might have made this task easier?

- Batch file

9. How easy/difficult was it to change the directory to C:\vrtp\Demo\Helicopter\?

Comments:

NCS

- Typing errors can occur
-

What might have made this task easier?

- Icon with batch file or script.
 - Icon with a mouse click
-
-

4. How easy/difficult was it to initialize the referee?

Comments:

What might have made this task easier?

5. How easy/difficult was it to use the command prompt in initializing the referee?

Comments:

What might have made this task easier?

- Icon with a script
- NCS
- too much typing needed

6. How do you rate your understanding of these setup steps?

Comments:

What might have made this task easier to understand?

- Again an icon with a script.

21. In your opinion which is the most difficult task in initializing the referee?

Comments:

- Change directory
- If the whole process were in the windows medium (one click) , it would be easier.

What might have made this task easier?

User Satisfaction

5. How do you rate your satisfaction of this start-up procedure?

Comments:

- Too many steps are needed to finish
- It does not assist the average hacker
- Interesting but not enjoyable

NCS

- User must not be writing detailed things
- Too many steps involved
- More user friendly options would be preferred

What might have made this task more satisfying?

- Make it easier
- GUI

NCS

- Direct start-up
- Reduce the steps
- Short-cut keys

6. How well do you think you can do this procedure if asked to do it again without help?

Comments:

- Without manual , I will have some difficulties
- I can't remember the procedure.

What might have made this task easier to perform?

- GUI
- Click one button to finish all steps.

FIRST TRIAL

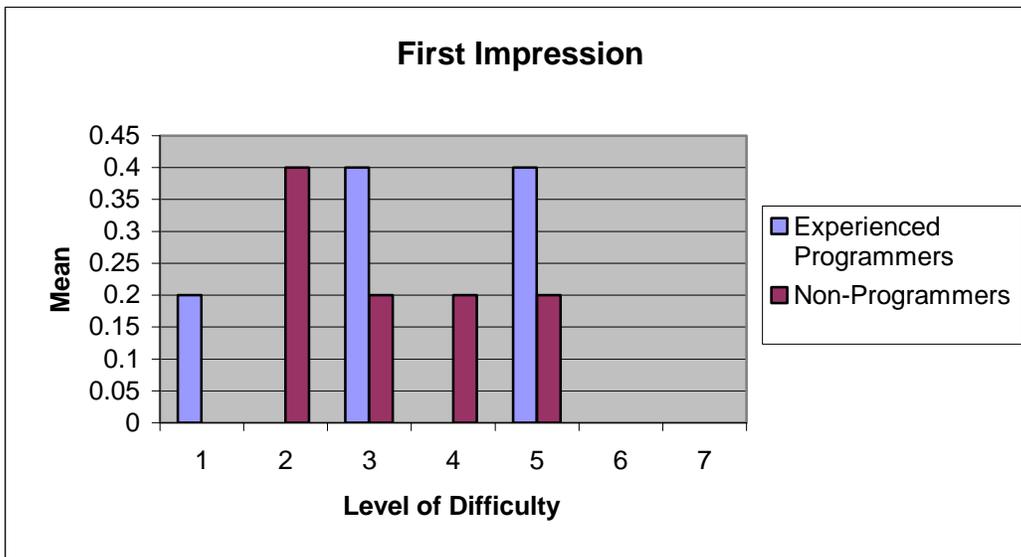
First Impression

Experienced Programmers

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-------------------------|-----|---|-----|---|-----|---|---|
| Q1 | 1 | | 2 | | 2 | | |
| Experienced Programmers | 0.2 | 0 | 0.4 | 0 | 0.4 | 0 | 0 |
| Weighted Value | 0.2 | 0 | 1.2 | 0 | 2 | 0 | 0 |

Non-Programmers

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-----------------|---|-----|-----|-----|-----|---|---|
| Q1 | | 2 | 1 | 1 | 1 | | |
| Non-Programmers | 0 | 0.4 | 0.2 | 0.2 | 0.2 | 0 | 0 |
| Weighted Value | 0 | 0.8 | 0.6 | 0.8 | 1 | 0 | 0 |



Experienced Programmers

Mean Level of Difficulty 3.4

Non Programmers

Mean Level of Difficulty 3.2

FIRST TRIAL

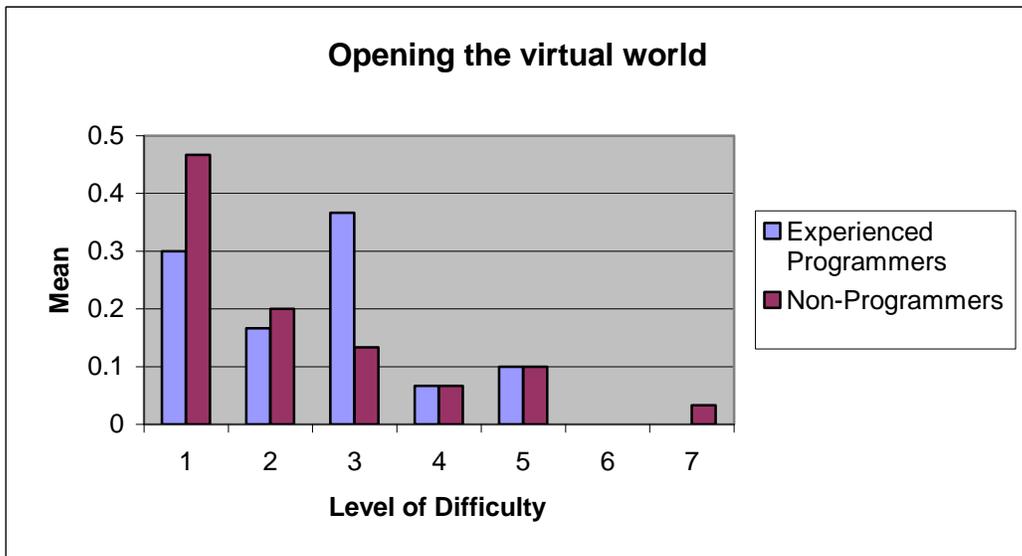
Opening the virtual world

Experienced Programmers

| | Number of Errors: 3 | | | | | | |
|--------------------------------|---------------------|-----------------|-----------------|-----------------|------------|----------|----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Q1 | 1 | 1 | 2 | | 1 | | |
| Q2 | 3 | 1 | 1 | | | | |
| Q3 | 3 | 1 | 1 | | | | |
| Q4 | 1 | | 3 | | 1 | | |
| Q5 | 1 | | 2 | 1 | 1 | | |
| Q6 | | 2 | 2 | 1 | | | |
| Experienced Programmers | 0.3 | 0.166667 | 0.366667 | 0.066667 | 0.1 | 0 | 0 |
| Weighted Value | 0.3 | 0.333333 | 1.1 | 0.266667 | 0.5 | 0 | 0 |

Non-Programmers

| | Number of Errors: 6 | | | | | | |
|------------------------|---------------------|------------|-----------------|-----------------|------------|----------|-----------------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Q1 | 2 | 1 | 1 | | 1 | | |
| Q2 | 2 | 3 | | | | | |
| Q3 | 4 | | 1 | | | | |
| Q4 | 2 | | | 2 | 1 | | |
| Q5 | 2 | | 1 | | 1 | | 1 |
| Q6 | 2 | 2 | 1 | | | | |
| Non-Programmers | 0.466667 | 0.2 | 0.133333 | 0.066667 | 0.1 | 0 | 0.033333 |
| Weighted Value | 0.466667 | 0.4 | 0.4 | 0.266667 | 0.5 | 0 | 0.233333 |



Experienced Programmers

Mean Level of Difficulty 2.5

Non Programmers

Mean Level of Difficulty 2.266667

FIRST TRIAL

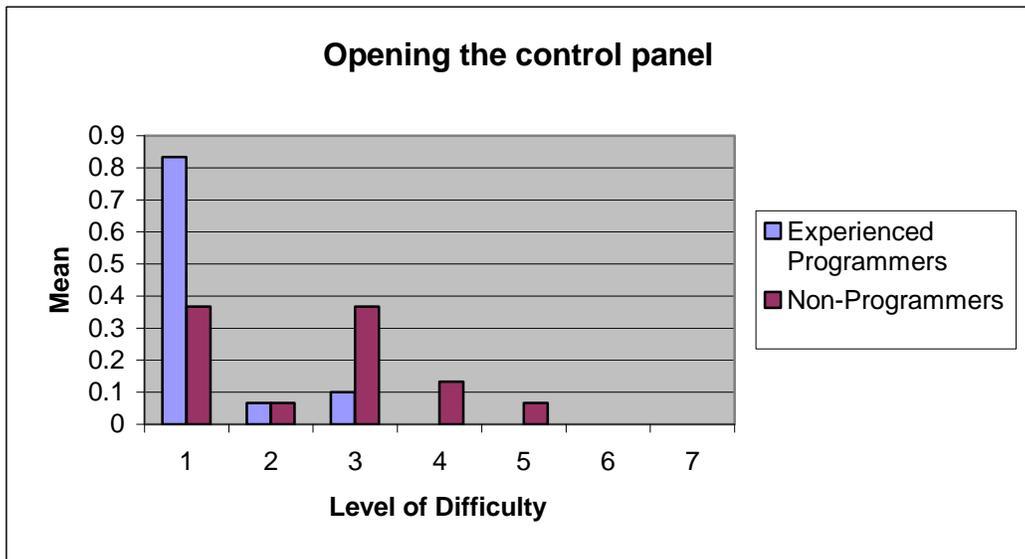
Opening the control panel

Experienced Programmers

| | Number of Errors: | | | | | | |
|--------------------------------|-------------------|-----------------|------------|----------|----------|----------|----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Q1 | 4 | 1 | | | | | |
| Q2 | 4 | 1 | | | | | |
| Q3 | 5 | | | | | | |
| Q4 | 5 | | | | | | |
| Q5 | 4 | | 1 | | | | |
| Q6 | 3 | | 2 | | | | |
| Experienced Programmers | 0.833333 | 0.066667 | 0.1 | 0 | 0 | 0 | 0 |
| Weighted Value | 0.833333 | 0.133333 | 0.3 | 0 | 0 | 0 | 0 |

Non-Programmers

| | Number of Errors: | | | | | | |
|------------------------|-------------------|-----------------|-----------------|-----------------|-----------------|----------|----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Q1 | 2 | | 1 | 1 | 1 | | |
| Q2 | 2 | 1 | 2 | | | | |
| Q3 | 2 | | 3 | | | | |
| Q4 | 2 | 1 | 1 | 1 | | | |
| Q5 | 2 | | 1 | 1 | 1 | | |
| Q6 | 1 | | 3 | 1 | | | |
| Non-Programmers | 0.366667 | 0.066667 | 0.366667 | 0.133333 | 0.066667 | 0 | 0 |
| Weighted Value | 0.366667 | 0.133333 | 1.1 | 0.533333 | 0.333333 | 0 | 0 |



Experienced Programmers

Mean Level of Difficulty 1.266667

Non Programmers

Mean Level of Difficulty 2.466667

FIRST TRIAL

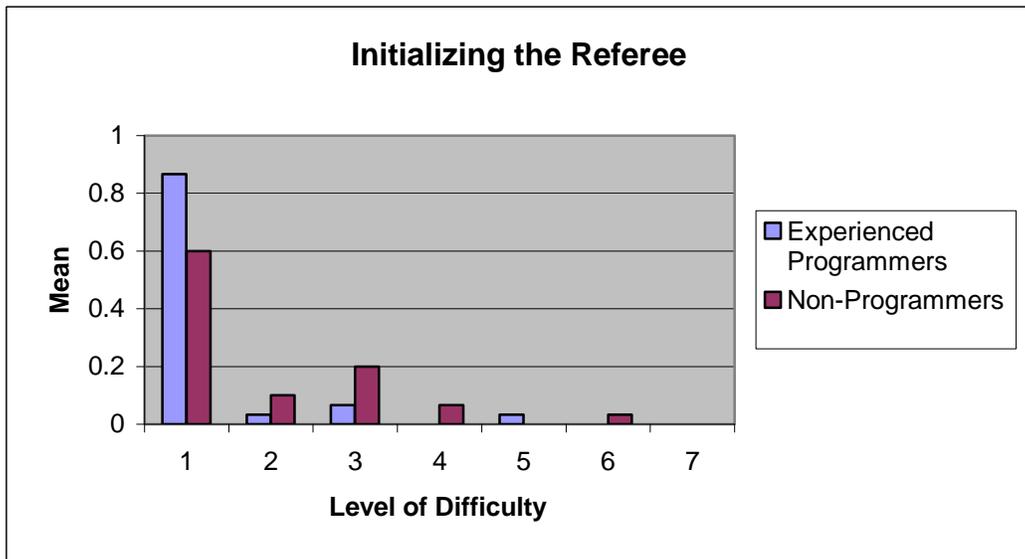
Initializing the Referee

Experienced Programmers

| Number of Errors: | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|--------------------------------|-----------------|-----------------|-----------------|----------|-----------------|----------|----------|
| Q1 | 5 | | | | | | |
| Q2 | 5 | | | | | | |
| Q3 | 5 | | | | | | |
| Q4 | 4 | 1 | | | | | |
| Q5 | 4 | | | | 1 | | |
| Q6 | 3 | | 2 | | | | |
| Experienced Programmers | 0.866667 | 0.033333 | 0.066667 | 0 | 0.033333 | 0 | 0 |
| Weighted Value | 0.866667 | 0.066667 | 0.2 | 0 | 0.166667 | 0 | 0 |

Non-Programmers

| Number of Errors: | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------------------------|------------|------------|------------|-----------------|----------|-----------------|----------|
| Q1 | 3 | 1 | | 1 | | | |
| Q2 | 4 | 1 | | | | | |
| Q3 | 3 | 1 | 1 | | | | |
| Q4 | 3 | | 2 | | | | |
| Q5 | 3 | | 1 | | | 1 | |
| Q6 | 2 | | 2 | 1 | | | |
| Non-Programmers | 0.6 | 0.1 | 0.2 | 0.066667 | 0 | 0.033333 | 0 |
| Weighted Value | 0.6 | 0.2 | 0.6 | 0.266667 | 0 | 0.2 | 0 |



Experienced Programmers

Mean Level of Difficulty 1.3

Non Programmers

Mean Level of Difficulty 1.866667

FIRST TRIAL
User Satisfaction

Experienced Programmers

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-------------------------|-----|-----|-----|---|-----|---|-----|
| Q1 | 1 | 1 | | | 3 | | |
| Q2 | 2 | | 1 | | 1 | | 1 |
| Experienced Programmers | 0.3 | 0.1 | 0.1 | 0 | 0.4 | 0 | 0.1 |
| Weighted Value | 0.3 | 0.2 | 0.3 | 0 | 2 | 0 | 0.7 |

Non-Programmers

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-----------------|-----|-----|-----|-----|-----|---|---|
| Q1 | | 2 | | 2 | 1 | | |
| Q2 | 2 | 1 | 2 | | | | |
| Non-Programmers | 0.2 | 0.3 | 0.2 | 0.2 | 0.1 | 0 | 0 |
| Weighted Value | 0.2 | 0.6 | 0.6 | 0.8 | 0.5 | 0 | 0 |



Experienced Programmers

Mean Level of Satisfaction 3.5

Non Programmers

Mean Level of Satisfaction 2.7

SECOND TRIAL

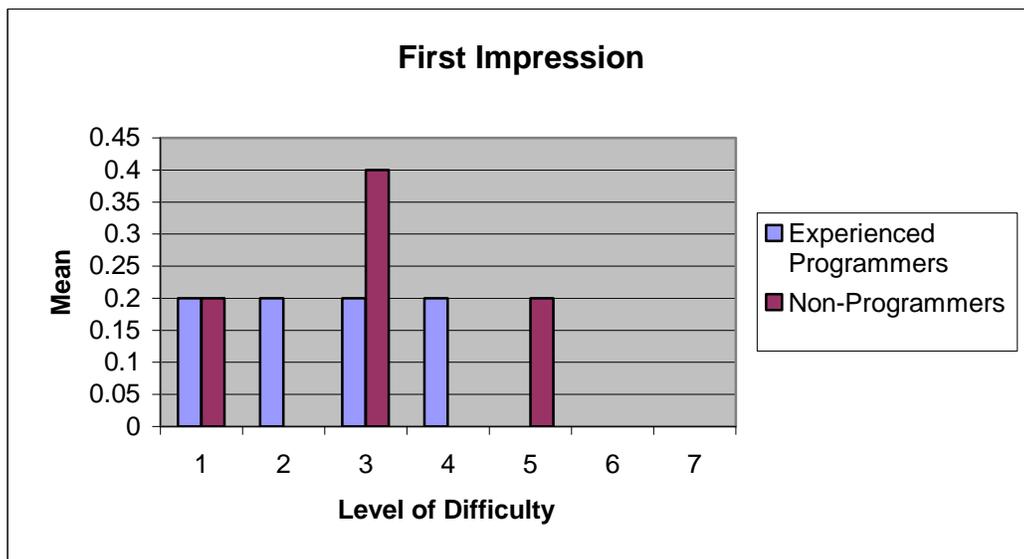
First Impression

Experienced Programmers

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|--------------------------------|------------|------------|------------|------------|----------|----------|----------|
| Q1 | 1 | 1 | 1 | 1 | | | |
| Experienced Programmers | 0.2 | 0.2 | 0.2 | 0.2 | 0 | 0 | 0 |
| Weighted Value | 0.2 | 0.4 | 0.6 | 0.8 | 0 | 0 | 0 |

Non-Programmers

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------------------------|------------|----------|------------|----------|------------|----------|----------|
| Q1 | 1 | | 2 | | 1 | | |
| Non-Programmers | 0.2 | 0 | 0.4 | 0 | 0.2 | 0 | 0 |
| Weighted Value | 0.2 | 0 | 1.2 | 0 | 1 | 0 | 0 |



Experienced Programmers

Mean Level of Satisfaction 2

Non Programmers

Mean Level of Satisfaction 2.4

SECOND TRIAL

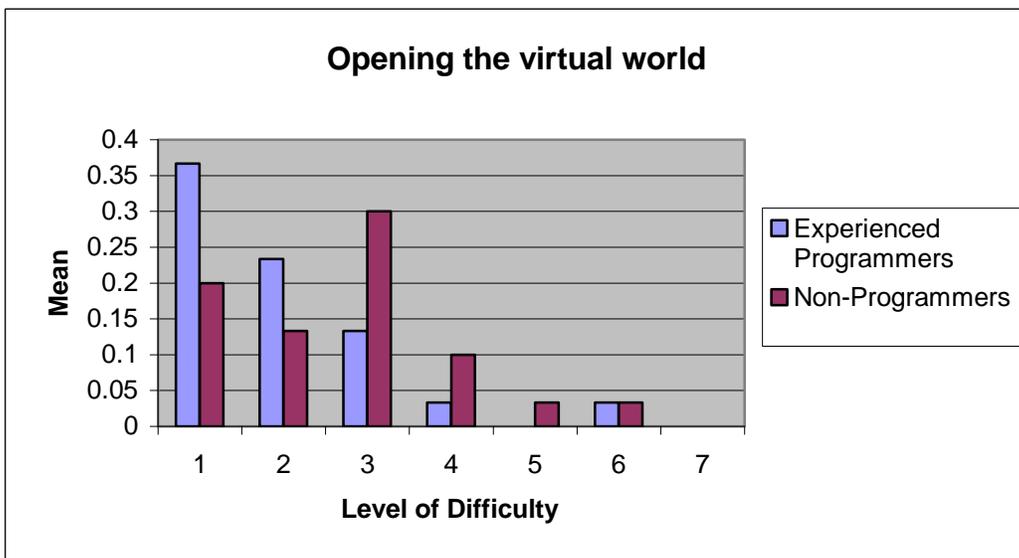
Opening the virtual world

Experienced Programmers

| Number of Errors: | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|--------------------------------|-----------------|-----------------|-----------------|-----------------|----------|-----------------|----------|
| Q1 | 2 | | 1 | 1 | | | |
| Q2 | 1 | 2 | 1 | | | | |
| Q3 | 3 | 1 | | | | | |
| Q4 | 2 | 2 | | | | | |
| Q5 | 1 | 1 | 1 | | | 1 | |
| Q6 | 2 | 1 | 1 | | | | |
| Experienced Programmers | 0.366667 | 0.233333 | 0.133333 | 0.033333 | 0 | 0.033333 | 0 |
| Weighted Value | 0.366667 | 0.466667 | 0.4 | 0.133333 | 0 | 0.2 | 0 |

Non-Programmers

| Number of Errors: | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------------------------|------------|-----------------|------------|------------|-----------------|-----------------|----------|
| Q1 | | 1 | 2 | 1 | | | |
| Q2 | 1 | 1 | 1 | 1 | | | |
| Q3 | 4 | | | | | | |
| Q4 | 1 | | 2 | | 1 | | |
| Q5 | | | 2 | 1 | | 1 | |
| Q6 | | 2 | 2 | | | | |
| Non-Programmers | 0.2 | 0.133333 | 0.3 | 0.1 | 0.033333 | 0.033333 | 0 |
| Weighted Value | 0.2 | 0.266667 | 0.9 | 0.4 | 0.166667 | 0.2 | 0 |



Experienced Programmers

Mean Level of Difficulty 1.566667

Non Programmers

Mean Level of Difficulty 2.133333

SECOND TRIAL

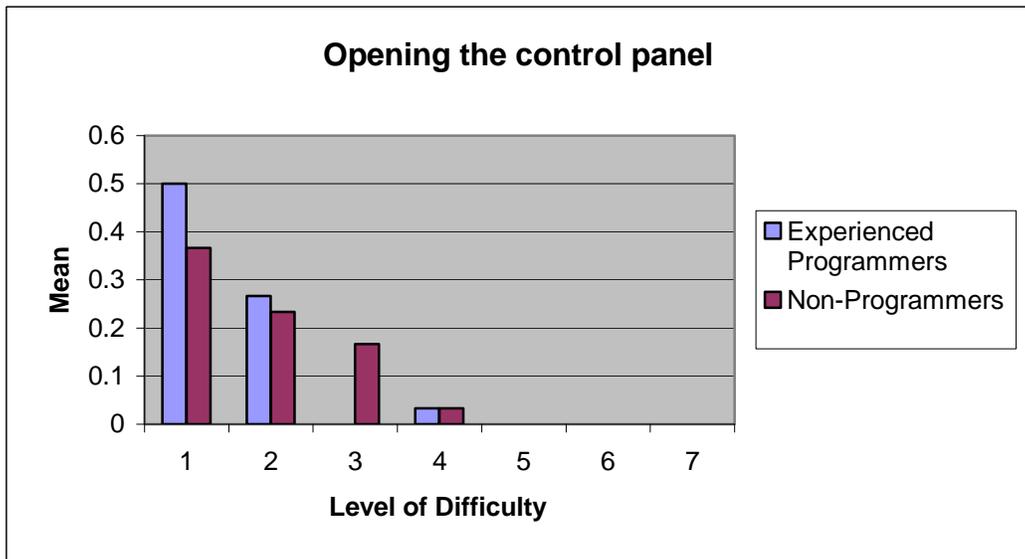
Opening the control panel

Experienced Programmers

| | Number of Errors: | | | | | | |
|--------------------------------|-------------------|-----------------|----------|-----------------|----------|----------|----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Q1 | 3 | 1 | | | | | |
| Q2 | 4 | | | | | | |
| Q3 | 3 | 1 | | | | | |
| Q4 | 3 | | | 1 | | | |
| Q5 | 1 | 3 | | | | | |
| Q6 | 1 | 3 | | | | | |
| Experienced Programmers | 0.5 | 0.266667 | 0 | 0.033333 | 0 | 0 | 0 |
| Weighted Value | 0.5 | 0.533333 | 0 | 0.133333 | 0 | 0 | 0 |

Non-Programmers

| | Number of Errors: | | | | | | |
|------------------------|-------------------|-----------------|-----------------|-----------------|----------|----------|----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Q1 | 2 | 1 | | 1 | | | |
| Q2 | 2 | 2 | | | | | |
| Q3 | 1 | 1 | 2 | | | | |
| Q4 | 3 | | 1 | | | | |
| Q5 | 3 | | 1 | | | | |
| Q6 | | 3 | 1 | | | | |
| Non-Programmers | 0.366667 | 0.233333 | 0.166667 | 0.033333 | 0 | 0 | 0 |
| Weighted Value | 0.366667 | 0.466667 | 0.5 | 0.133333 | 0 | 0 | 0 |



Experienced Programmers

Mean Level of Difficulty 1.166667

Non Programmers

Mean Level of Difficulty 1.466667

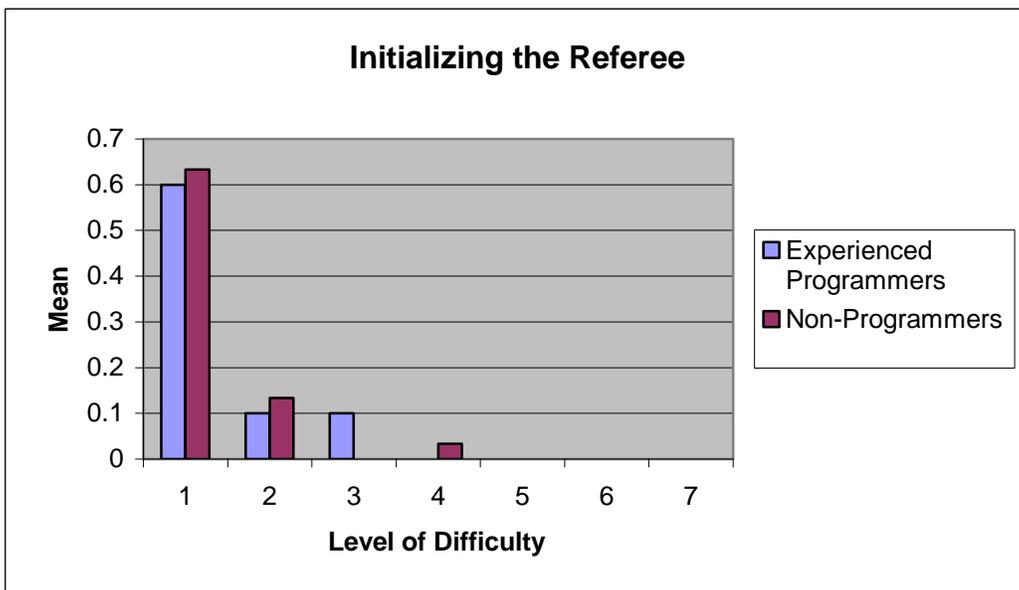
SECOND TRIAL
Initializing the Referee

Experienced Programmers

| Number of Errors: | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|--------------------------------|------------|------------|------------|----------|----------|----------|----------|----------|
| Q1 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 |
| Q2 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Q3 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 |
| Q4 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 |
| Q5 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 |
| Q6 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| Experienced Programmers | 0.6 | 0.1 | 0.1 | 0 | 0 | 0 | 0 | 0 |
| Weighted Value | 0.6 | 0.2 | 0.3 | 0 | 0 | 0 | 0 | 0 |

Non-Programmers

| Number of Errors: | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------------------------|-----------------|-----------------|----------|----------|-----------------|----------|----------|----------|
| Q1 | 0 | 4 | 2 | 3 | 4 | 5 | 6 | 7 |
| Q2 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Q3 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Q4 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| Q5 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Q6 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 0 |
| Non-Programmers | 0.633333 | 0.133333 | 0 | 0 | 0.033333 | 0 | 0 | 0 |
| Weighted Value | 0.633333 | 0.266667 | 0 | 0 | 0.133333 | 0 | 0 | 0 |



Experienced Programmers

Mean Level of Difficulty 1.1

Non Programmers

Mean Level of Difficulty 1.033333

SECOND TRIAL

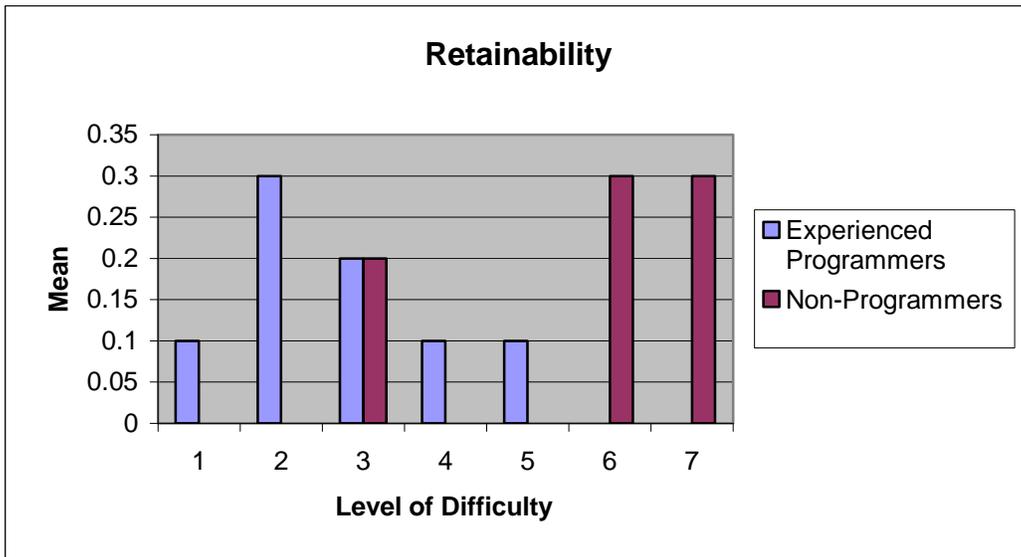
Retainability

Experienced Programmers

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-------------------------|-----|-----|-----|-----|-----|---|---|
| Q1 | | 2 | 1 | 1 | | | |
| Q2 | 1 | 1 | 1 | | 1 | | |
| Experienced Programmers | 0.1 | 0.3 | 0.2 | 0.1 | 0.1 | 0 | 0 |
| Weighted Value | 0.1 | 0.6 | 0.6 | 0.4 | 0.5 | 0 | 0 |

Non-Programmers

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-----------------|---|---|-----|---|---|-----|-----|
| Q1 | | | | | | 1 | 3 |
| Q2 | | | 2 | | | 2 | |
| Non-Programmers | 0 | 0 | 0.2 | 0 | 0 | 0.3 | 0.3 |
| Weighted Value | 0 | 0 | 0.6 | 0 | 0 | 1.8 | 2.1 |



Experienced Programmers

Mean Level of Difficulty 2.2

Non Programmers

Mean Level of Difficulty 4.5

SECOND TRIAL

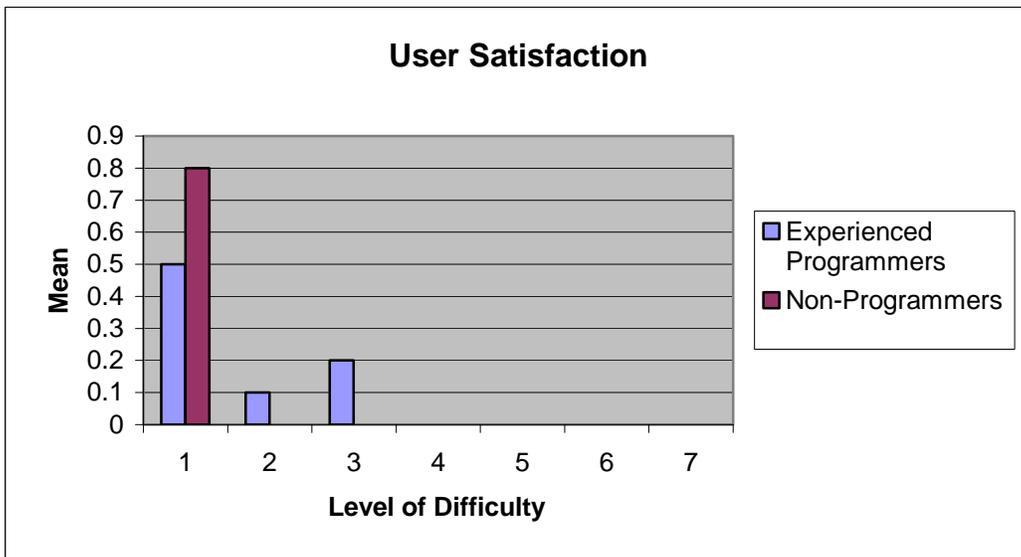
User Satisfaction

Experienced Programmers

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-------------------------|-----|-----|-----|---|---|---|---|
| Q1 | 2 | 1 | 1 | | | | |
| Q2 | 3 | | 1 | | | | |
| Experienced Programmers | 0.5 | 0.1 | 0.2 | 0 | 0 | 0 | 0 |
| Weighted Value | 0.5 | 0.2 | 0.6 | 0 | 0 | 0 | 0 |

Non-Programmers

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|-----------------|-----|---|---|---|---|---|---|
| Q1 | 4 | | | | | | |
| Q2 | 4 | | | | | | |
| Non-Programmers | 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |
| Weighted Value | 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |



Experienced Programmers

Mean Level of Difficulty 1.3

Non Programmers

Mean Level of Difficulty 0.8

SECOND TRIAL

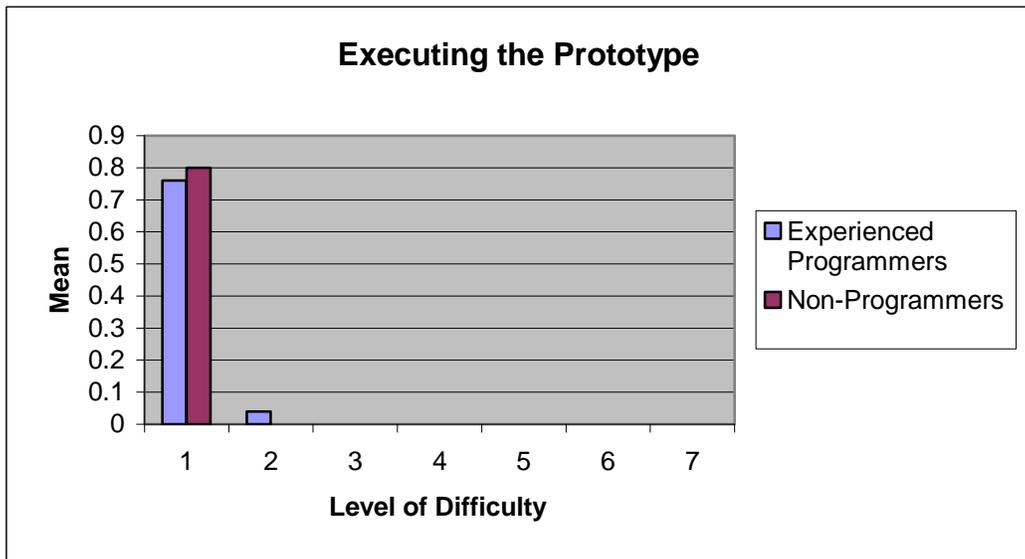
Executing the Prototype

Experienced Programmers

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|--------------------------------|-------------|-------------|----------|----------|----------|----------|----------|
| Q1 | 4 | | | | | | |
| Q2 | 4 | | | | | | |
| Q3 | 4 | | | | | | |
| Q4 | 3 | 1 | | | | | |
| Q5 | 4 | | | | | | |
| Experienced Programmers | 0.76 | 0.04 | 0 | 0 | 0 | 0 | 0 |
| Weighted Value | 0.76 | 0.08 | 0 | 0 | 0 | 0 | 0 |

Non-Programmers

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------------------------|------------|----------|----------|----------|----------|----------|----------|
| Q1 | 4 | | | | | | |
| Q2 | 4 | | | | | | |
| Q3 | 4 | | | | | | |
| Q4 | 4 | | | | | | |
| Q5 | 4 | | | | | | |
| Non-Programmers | 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |
| Weighted Value | 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |



Experienced Programmers

Mean Level of Difficulty 0.84

Non Programmers

Mean Level of Difficulty 0.8

ReadME for Prototype

- a. Copy all four files into the root C:\ directory
- b. Right click on CTF.bat and create shortcut
- c. Right click on the new shortcut and select the tab which enables you to change icon (the same one that shows the path for the shortcut)
- d. Selecting change icon will bring up a selection of icons. Find the Window's flag and select it.
- e. Once you have changed the icon on the shortcut, drag and drop the shortcut to the desktop

(This should only be done just before the test subject is going to run the prototype. Prior to this point, the only Capture the Flag related icon that should be on the desktop is the read-me file)

Batch Files

PROTOTYPE/medium_term/StartPanel.bat

```
c:  
cd\vrtp\demo\helicopter  
java demo.helicopter.StartPanel  
cd\  

```

PROTOTYPE/medium_term/Referee.bat

```
c:  
cd\vrtp\demo\helicopter  
java demo.helicopter.Referee  
cd\  

```

PROTOTYPE/medium_term/CaptureTheFlag.bat

```
c:  
cd\Program Files\Netscape\Communicator\Program\  
netscape file://c:/vrtp/demo/helicopter/CaptureTheFlag.wrl  
cd\  

```

PROTOTYPE/long_term/Ctf.bat

```
c:  
start c:\CaptureTheFlag.bat  
start c:\StartPanel.bat  
start c:\Referee.bat  

```